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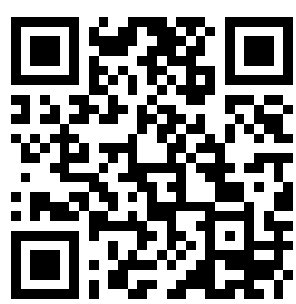

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THE ELECTRICIAN:

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NOTES.

Sir William Thomson has added one more to the long series of electric "balance" instruments to which he has devoted much time and labour during the last two years. The new instrument was described in a Paper recently read before the Philosophical Society of Glasgow, of which an abstract will be found in another column. It is designed for the purpose of providing in one apparatus the means of measuring difference of potential, current, and rate of working. Like each of its predecessors in this beautiful series, it is capable of dealing both with direct and alternate currents. It is to be regretted that hitherto comparatively little use has been made of these instruments in the practice of electrical engineering. In their truly marvellous accuracy and extraordinary range no other instruments can pretend to compete with them. We do not, of course, advocate their employment for small isolated plants, but for central station work, particularly with alternating currents, we believe that good results would ensue from the adoption of standard voltmeters of this type. We may also refer to their value as secondary standards for the calibration of the instruments which are placed in the hands of workmen.

One reason which militates against their more general adoption is no doubt the question of cost. But their apparently high price largely arises from the fact that, like all Sir William Thomson's inventions, every smallest detail has been worked out with elaborate care and skill, and with an expenditure of time and labour which finally leaves the instrument as nearly perfect as its materials will ever allow it to be. For instance, we may mention a very elaborate series of experiments upon the behaviour of the band of fine copper wire under prolonged strain, which has been carried out with a view to the elimination of any error which might ultimately arise from this cause. Another thing which has tended to retard their introduction is the idea (which we believe to be a mistaken one) that their use is attended with a good deal of difficulty and delay. It is true the instruments are not direct reading. it is necessary to wait until the beam is in equilibrium; but this disadvantage is easily over-estimated, and of course in practice it is only necessary to see that the pointer makes equal swings on either side of zero. Some few months ago we had the opportunity of receiving instruction in the use of the balance from its distinguished inventor, and with this advantage in our favour we were speedily able to take readings nearly if not quite as rapidly as they can be taken with, say, a Siemens dynamometer, and with incomparably greater accuracy. We feel sure that the time will come when the practical value of these beautiful instruments will be as highly appreciated as their theoretical ingenuity is already.

In the current number of the *Phil. Mag.* Mr. Bosanquet once more does battle on behalf of the phrase "magnetic resistance." Denying that the term "resistance" necessarily implies a linear function, Mr. Bosanquet advocates its general definition as the measure of the ratio of *cause* to *effect*. The term is certainly in ordinary use in this sense, as, for instance, when we speak of the resistance of a body to compression, or of the resistance to the flow of water in pipes. In these and many other cases no one would dream of saying that the term is misapplied, unless it can be shown that the "resistance" varies simply directly as the cause and inversely as the effect. But this is all that the scholastic argument really amounts to, and, notwithstanding the array of eminent names by which it is supported, we should be slow to admit that objections of this character ought to overrule the pressing considerations of practical convenience which demand the use either of this or of some still more appropriate term.

We have, however, the very great satisfaction of announcing that a term has at length been discovered which we are inclined to think renders further controversy needless—a term which, to say the least, is free from any of the objections raised against its predecessor. Several weeks ago we appealed to the Nomenclature Committee appointed by the Council of the Society of Telegraph-Engineers and Electricians for an authoritative decision of the question; but our readers must be prepared for the disappointment of learning that it is not from this source that deliverance has arrived. The new term is proposed by Mr. Oliver Heaviside, to whom we are already indebted for such well-established and invaluable terms as "impedance" and "inductance." As a substitute for "magnetic resistance," Mr. Heaviside suggests the term "Reluctance." It is not a small advantage that we are thereby enabled to drop the prefix "magnetic," which becomes superfluous. The analogue "reluctivity," though not a pretty word, is still quite possible.

Electricity, says the *Lancet*, is not to be depended upon for doing the execution business. Of course it is hard to be told that electricity cannot do everything, but in this relation we are not disposed to resent the imputation. Every elec-

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trician worthy the name would, it is true, undertake to supply current that would "rupture the veins" (we quote the *Lancet's* words) of the most hardened criminal; but then, happily, only a very few electricians have had any practical experience of its efficacy; and, after all, even the New York "authorities" (whoever they may be) will hardly be inclined to entrust the capital punishments of the Empire City to amateurs, or to let them treat the subject experimentally. Electricity, as the *Lancet* points out, sometimes produces a state of catalepsy closely simulating death, but from which the sufferer sometimes recovers; and it would be a scandal, even in New York, to bury a man alive, or have to slay him over again. Any way, when they come to think of it, the American electricians will not find it "good business" to take credit for supplying the public with an article of such deadly capabilities as a successful response to the "authorities'" invitation would clearly imply.

DR. GORE'S discovery of the effect of chlorine upon the E.M.F. of a voltaic cell, which formed the subject of a Paper read last week before the Royal Society, has enabled him to detect the influence of a chlorine solution differing from pure water by one part in 500,000 millions. This reminds one of the prescription said to have been written by an American homœopathic physician, which ran something like this:—"Take a little aconite (less would be better); put it, with care, into Lake Superior; stir the mixture well. Dose: Half a drop in water."

THE *conversazione* at the Royal Society's rooms on Wednesday evening, although a pronounced success in every sense of the word (which goes, perhaps, without saying), was nevertheless not marked by the display of any striking novelties in electrical experiments or apparatus. Undoubtedly, the most interesting and the most beautiful exhibit of this description was the apparatus employed by Mr. SHELFORD BIDWELL in his researches on the elongation or retraction of the magnetic metals in powerful fields. The latest results of these experiments were recorded in a Paper read before the Royal Society on February 9th, 1888, and printed in *The Electrician* on March 23rd. The marvellous delicacy of the observations is comparable to that of Dr. GORE'S experiment alluded to above—a variation in length amounting to one two-and-a-half-millionth part of an inch being readily perceptible. Mr. STEPNEY RAWSON exhibited a new photometer designed for use with the pentane standard lamp of which our readers will doubtless hear more shortly. Messrs. WOODHOUSE AND RAWSON also showed specimens of the "adamant" carbon which they have recently introduced. This is an extraordinarily hard variety of carbon made by a secret process, and capable of taking a jet-like polish. It is said to give excellent results in the Blake Telephone Transmitter. Some unflashed lamp filaments of this substance were also shown. The Edison-Swan and the Schanschieff miners' lamps, the Bruce signalling balloon, the large Wimshurst machine, and the Robertson Writing Telegraph, although scarcely novelties, contributed to the interest of the Exhibition. We must also not omit to mention Mr. VERNON BOYS' electric "radio-micrometer," which furnishes the most delicate means of appreciating minute variations of temperature yet devised. During the evening Dr. MARCET repeated the simple but striking experiment which he recently showed the Meteorological Society, and which consists in throwing upon a screen a magnified image of an ordinary electric spark; the spark is then seen to possess all the visual characteristics of a lightning flash.

WE have reserved the mention of one exhibit for a separate note. A contemporary journal last week inquired in large type, "Where is Prof. FORBES'S Coulomb meter?" On Wednesday evening the latest and most improved type of this apparatus was to be seen at the rooms of the Royal Society. No important alteration has been made in the design, the improvements having been chiefly confined to matters of detail, tending to make the instrument more suitable for every-day usage. A very simple and highly ingenious device has, however, been adopted, in order to give as it were a final touch to the accuracy of the record. It will easily be understood that after the current has traversed the coil for some time, the whole apparatus has risen slightly in temperature, and the base-plate, from its mass and position, takes longer to cool than the exposed wire. Consequently the vanes tend to rotate for a short time after the current has ceased. In order to check this tendency, a deep ring or collar of india-rubber is placed around the base-plate within the cover. Owing to the higher specific heat and lower radiating power of india rubber compared with the metal, the ring of india-rubber, in spite of its smaller mass, takes as long to part with its heat as the base-plate does. But the convection currents arising from the ring flow upward at the sides of the glass cover and tend to descend in the centre; they thus meet and check the upward current arising from the plate, so that in this way the vanes are speedily brought to rest. The device seems to be very effective. It is, however, an obvious suggestion that a more positive action could be obtained by an electro-magnetic arrangement for locking and unlocking the spindle as the current is turned off or on. We believe, however, that the correction is of little importance in any case.

THE affairs of the Maxim-Weston Company did not receive much further elucidation at the extraordinary general meeting which Mr. HUGH WATT thought fit to call together (as reported last week). The ostensible object of the meeting was "to elect two additional Directors, and to fix the remuneration of the Board." Seeing that the shareholders had only just decided to strengthen the Committee of Investigation by sixteen additional members, it is not surprising that the question of "remuneration" should have been considered scarcely ripe for discussion. The legality of the meeting being challenged, after a protracted and undignified squabble the assembly was dissolved. Since the sixteen additional members of the committee of shareholders have not yet been selected, the announcement that Mr. HUGH WATT intends to prosecute the five original members is doubly interesting, and, whether intentionally so or not, will doubtless tend *pour encourager les autres.*

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IT seems to us a little unfair for learned counsel to treat scientific experts in the witness-box as if they were hardened criminals. When a leading scientific man gives evidence he places the facts as they present themselves to him as clearly as he can before the legal but unscientific mind—the anecdote of the three degrees of inaccuracy notwithstanding. The ATTORNEY-GENERAL'S manner in cross-examining Mr. CROOKES in the Edison-Swan action out-Buzfuzed Buzfuz. We felt as if nothing better than drawing and quartering was fit punishment for Mr. CROOKES. This style, though sometimes effective, entirely failed on this occasion to confuse the witness. That, however, is not the point; we hold that it is neither necessary nor proper for counsel to assume a hectoring tone towards men of high standing and reputation while tendering evidence of a purely scientific character.

AS might have been expected, so pernicious an example having once been set has not been long in bearing fruit. From an important (but in point of years, a junior) witness in this case, we have received a communication of a most irreverent character in the shape of a commentary upon the behaviour of his elders in the witness-box. We print a few extracts solely as "shocking examples" to enforce the justice of our complaint:—

"The defendants," says this sprightly critic, "chose their witnesses with some sense of humour. Dr. TIDY appears to be a good witness, but he indulged in a facial accompaniment which made an observer wonder if his identity were really continuous. Prof. SILVANUS THOMPSON had evidently been transplanted from Finsbury College unconsciously. He immediately lectured the judge on the elements of electricity in his very best manner. He was a conjuror, too. He produced a continuous supply of huge wall diagrams from his hind pockets. His lordship seemed an apt pupil, and appears to know more about the case than all the others rolled together. Prof. PERRY must have been called as witness much before his usual hour of rising. All the same, he was really very wide-awake. He objected to cross-examination on moral principles. He complained bitterly that he could not see beforehand where the ATTORNEY GENERAL might lead him. He led him nowhere, however, except into abstruse mathematics. Calculation of an involved kind was his *forte*. On the least provocation he revelled in differential equations. He was full of quantics and graphs. He computed a table of logarithms to nineteen places in the witness-box. His cross-examination was adjourned over night. Next morning he wanted to go through all his calculations again, to show they were right. This the judge gently but firmly declined to permit."

WE print this week a valuable paper on "Electric Oscillations," by Prof. J. A. FLEMING, in which the theory of this somewhat obscure phenomenon is explained in very simple terms. The existence of the phenomenon has long been known—at least, to the mathematical school of electricians—but its practical importance had never been appreciated until Dr. OLIVER LODGE showed what an important part it plays in the lightning flash, and how much that has hitherto seemed inexplicable in the behaviour of lightning conductors is thereby accounted for. Dr. FLEMING extends this explanation in other directions, particularly in regard to the anomalous results of magnetisation by static discharge.

OWING to the extreme pressure upon our space during the last few weeks from the length of the legal intelligence, we have been compelled to omit our Patent Record. We shall shortly take an opportunity of bringing this list up to date.

WITH the present number of *The Electrician* we commence a new volume (the Twenty-First), with which the journal enters upon the eleventh year of its existence. The index of the twentieth volume, which accompanies this issue, has been prepared upon a new plan, which we believe will considerably facilitate its use.

The Electric Lighting Bill.—Lord Thurlow's Bill was read a second time in the House of Commons on Tuesday.

Carthagena.—The Spanish Government is contracting for the construction and working of a telephonic system at Carthagena.

Brussels.—The palace of the Comte de Flandre is now lit by electricity, one Lohmeyer dynamo and a set of Julien accumulators being used.

The British Association.—Prof. Flower has been nominated as President of the British Association for the Newcastle meeting next year.

Personal.—We have to announce the marriage, on the 1st May, at Koenigsberg, of Mr. John Gordon, Electrician of the Swan United Electric Light Company's factory, Cologne, to Gertrud, daughter of the late Sanitaetsrath Doctor Marschall, of Leipzig.

River Plate, Brazil, and United States District Telegraph Company.—Mail advices report that the Argentine Government has approved of a contract with this company for a telegraph and telephone service between Buenos Ayres, Montevideo, and Brazil.

The Schanschieff Electric Light and Power Company.—We understand that a petition has been presented by Mr. Barber Starkey for the revocation of a patent proposed to be purchased by the above company. Application was granted by Mr. Justice North to allow the case to stand over to enable the company to prepare their evidence, and the case has been placed in the witness list for trial.

Primary Battery Syndicates.—The *Financial News* says:—"It is reported that Mr. Newton's new electric light syndicate have entered into arrangements with Colonel J. T. North to dispose of Mr. Newton's patents to a joint-stock company with a capital somewhere in the hundred thousands. Electric lighting is about the only branch of industry in which the indefatigable Colonel has not yet embarked."

Telegraphing at Railway Stations.—In the House of Commons, on May 4, Mr. Raikes, in reply to Mr. Joicey, said there were nearly 1,600 railway stations now open for the transaction of telegraphic business during hours fixed by the companies; that in cases of emergency telegrams were, with his entire concurrence, accepted at other times and also at other stations. Such telegrams were included in the accounts with the department, and the companies received the usual commission for transmitting them.

The Writing Telegraph.—Being questioned again on this subject in the House of Commons, on Friday evening, the Postmaster-General justified his refusal to grant a license to the proprietors of the writing telegraph; but added, "If there is a substantial demand for the establishment of exchanges to be worked by the instruments of the Writing Telegraph Company, I think it preferable that they should be in the hands

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of the Post Office, the instruments being supplied by the proprietors on terms to be arranged."

The Maxim-Weston Electric Light Company.—The following letter, signed by Mr. J. M. Klenck, has appeared in the financial journals:—"At a meeting of the shareholders held at Cannon-street Hotel on the 3rd inst., after Mr. Watt had vacated the chair, it was resolved to lodge a requisition with the company to call an extraordinary general meeting of the shareholders. The requisition was opened, and signed by numerous shareholders representing a large part of the capital of the company. Shareholders desirous of signing the requisition may do so by calling at my address, where it lies for signature. Provincial shareholders may have a copy of the requisition sent to them for their signature on their intimating their wish to do so."

The Paris Municipal Tariff.—The following is the tariff which the Paris Municipal Council intends to enforce in all future concessions for the distribution of electricity:—The maximum price for the electrical carcel-hour is to be 4·5 centimes, which means about 8 centimes per lamp-hour, for a 16 candle-power light. The *Revue Industrielle* remarks that the same light can be obtained from an ordinary gas burner at the cost of 6 centimes. There is, therefore, only a difference of two centimes between the price of gas and that allowed to be charged for the electric light, and if we take into consideration the cost of mains, wayleaves, and unforeseen items, &c., it is impossible to look upon this tariff as otherwise than injurious to electric lighting enterprise.

Oldham.—The Oldham Free Library and Art Gallery has been lighted by electricity since the end of January last, with 118 16 candle-power and one 500 candle-power Edison 100-volt lamps. The dynamo is placed in the gas works 150 yards away, and an insulated cable is carried overhead. The dynamo is one of Hall's No. 6 C machines, compound-wound, and gives 96 amperes at 110 volts at 720 revolutions, and is driven by an old horizontal engine, which in the daytime does duty for the ordinary requirements of the gas works, and has been in regular work for the last 24 years. The dynamo is made, and the whole installation has been carried out, by Messrs. S. Charlesworth and Co., electrical engineers, Richmond Hill Iron Works, Oldham.

Exports of Telegraphic Wire, &c.—Notwithstanding the favourable results of the Board of Trade returns, especially under the head of metals, &c., which, according to the figures issued this week, show an increase of £263,339 for April, and £1,271,572, or 12 per cent., for the four months, our exports of wire and telegraphic apparatus continue to compare unfavourably with the corresponding figures of the two previous years. The following is a comparative statement of exports of telegraphic wires and apparatus connected therewith:—

	1886.	1887.	1888.
Jan. 1 to March 31 ...	£124,074	... £131,879	... £88,077
April	111,847	... 27,616	... 27,012
Four months	£235,921	£159,495	£115,089

The School of Electrical Engineering, Hanover-square, W.—A very satisfactory report has just been received by the managers from the external examiner, Mr. H. R. Kempe, of the General Post Office, showing that out of fourteen students of the advanced class who went in for the final examination, held on April 18, in which 70 per cent. of the marks is required, eight obtained the Vellum Certificate, with the following percentages:—H. F. S. Crawford, 94·6; A. H. French, 88·6; T. W. Watts, 88; A. O. Jensen, 87·3; H. A. M'Causland, 86; E. L. Simpson, 85·3; E. H. Greg, 80·6; A. E. Beddoe, 71·3. About two months ago, as the result of an examination in engineering, the following students had also obtained the Vellum Certificate:—L. M. Green, 97·3; H. E. Taylor, 97·3; P. T. Heath, 90·6; H. A. Irvine, 88·6; R. Cotton, 87·3.

Royal Institution of Great Britain.—At the general monthly meeting held on Monday, May 7, 1888, Sir James Crichton Browne, M.D., LL.D., F.R.S., Vice-President, in the chair, the following vice-presidents for the ensuing year were announced:—Sir James Crichton Browne, M.D., LL.D., F.R.S.; William Crookes, Esq., F.R.S.; Warren de la Rue, Esq., M.A., D.C.L., F.R.S.; Colonel James A. Grant, C.B., C.S.I., F.R.S.; Sir Frederick Pollock, Bart., M.A.; John Rae, M.D., LL.D., F.R.S.; Henry Pollock, Esq., treasurer; Sir Frederick Bramwell, D.C.L., F.R.S., honorary secretary. John Tyndall, Esq., D.C.L., LL.D., F.R.S., was elected Honorary Professor of Natural Philosophy. The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., F.R.S., was elected Professor of Natural Philosophy.

Bradford.—At a meeting of the Bradford Town Council, on May 8, Alderman Fredk. Priestman said he had expected to be able to bring before the Council a resolution accepting tenders for the execution of the works for electric lighting; but it was found necessary to extend the period during which tenders might be sent in. No less than 61 tenders had been received for the whole of the work, inclusive of buildings, and 140 for sections of the work. An unexpected difficulty had arisen. As a mere matter of form, the Town Clerk applied to the Local Government Board, and the officials appeared to have taken up the question *de novo*, demanding answers to all sorts of questions, and would perhaps send an inspector down to see whether the works were necessary or not, although the Corporation had authority under an Act of Parliament to undertake them. At present, therefore, they were at a deadlock in the matter, and he was afraid they would not get over the difficulty till a deputation went to see Mr. Ritchie. Personally, he had no doubt it was the action of some official who thought he must do something for what he got.

Electric Light v. Gas.—We have received the following communication from Mr. Henry Willmott:—"Having had 30 years' experience of billiard life I venture to give my opinion as regards lighting billiard rooms by electricity in preference to gas. It was thought some few years ago an impossible feat to light a room satisfactorily in this way, and I also shared in that opinion; but this system has lately been adopted in a new room, The Belgrave, Spur-street, Leicester-square, and is in every way advantageous on the score of cleanliness and cost, and what is still more important, *health*. The flickering so often observed with gas is entirely removed. Had this grand invention been known and acted on sooner it might have prevented the loss of many lives of those players who are fond of the game, and also spared many markers who have succumbed in consequence of the foul atmosphere arising from burnt gas, more particularly in the winter months. Under the new system my room is as cool at the end of the evening as it is at the commencement, and gentlemen customers who frequent the room speak in the highest terms of its comfort. Any gentleman who would like to visit it can have ocular demonstration of these facts. I may further add that the whole establishment is lit up in a similar manner."

The Discovery of a Sunken Rock in the Red Sea.—The recent discovery of a coral reef 15ft. below water in the Red Sea is of special interest and importance to the Submarine Cable Companies whose ships are continually cruising in those waters. We believe that the Eastern Telegraph Company's vessels have repeatedly taken soundings in the immediate

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vicinity of this dangerous reef. The following is the notice which has been published by the Hydrographic Department of the Admiralty:—"Telegraphic information has been received from Lieutenant and Commander T. F. Pullen, H.M. surveying vessel 'Stork,' that he has found a small coral patch, with a least depth of 15ft., situated in latitude 14° 22′ 8″ N., longitude 42° 41′ 32″ E. Vessels passing down the Red Sea should keep to the westward of this rock, and should remember that irregular lateral currents sometimes set across the sea; and if when on the homeward voyage they pass eastward of Abu Ail, care should be taken to steer to the westward after rounding that island, until Jebel Zukur summit bears about S.S.E. ½ E. There is little doubt that the loss of the 'Avocet' was due to one of the lateral currents above mentioned, as not only was the steam vessel 'St. Oswald,' in company with the 'Avocet,' also to the eastward of the correct track, but other vessels passed on both sides of the two vessels while stopped to save the crew of the 'Avocet.'"

Science in the City.—At the house dinner on Tuesday of the City Liberal Club, Walbrook, Lord Thurlow, F.R.S., the chairman of the Anglo-American Brush Corporation, presided, and was supported by, among other gentlemen, Dr. Silvanus Thompson and Mr. J. W. Swan. The speeches were entirely non-political, relating solely to science applied to industrial purposes, and chiefly to electricity. The chairman proposed the toast of the evening, "Scientific Industries," and referring to the exceptionally appropriate character of the metropolis for such an assembly, observed that London could not be fed without railways, and that railways could not be run without the telegraph, while nearly half the business of London could not be carried on without the telephone. Speaking of the electric light, he said it would probably confer much greater blessings on the whole community of London than the people of the metropolis were aware of. It would infallibly take its place as the universal lighting agency of this great city sooner or later. Some unfortunate words in the Act of 1882 had hindered the progress of the electric light in this country until now, but the efforts which he had made to get the Act amended appeared now about to become successful.—Mr. Swan, in reply, stated that the electric light, as an established industry, was barely eight years old, and was the youngest member of a rather large family of electrical industries—the telegraph, the telephone, electro-metallurgy, &c. The light had had the misfortune to be, in some sense, an "infant prodigy," and because it had not realised all the extravagant expectations which were formed at the outset respecting it, a shade of disappointment had been created. Great progress had, however, been made, notwithstanding the numerous difficulties which had to be encountered. It had advantages over gas in purity and safety, and on the score of cheapness alone it could in some cases beat gas. Before long he hoped the light would be brought within the reach of everyone by means of central stations. He thought there was an admirable field for the application of electricity in connection with the working of the underground railways, and Mr. Chadwick had just reminded him that the electric light would probably be of great advantage used in collieries.—Dr. Silvanus Thompson, whose name was also coupled with the toast, said that he had electricity as his main subject of daily existence at the Finsbury Technical College; Mr. Swan had spoken entirely—but naturally—about the incandescent form of electric lighting; but he (Dr. Thompson) could not forget that for public uses there was the older form of lamp, the arc lamp. As soon as the Act of 1882 was amended, he believed there would be a great development of arc lighting. Though not behind other countries in electric lighting, we were very far behind the United States in the development of the telephone. Mr. Swan had forestalled him in remarking on the interesting subject of the use of electricity on the underground railways.

The Electric Light and the Gas Companies.—At the annual meeting of the Imperial Continental Gas Association the chairman (Sir Julian Goldsmid, Bart., M.P.), dealing with this subject, spoke as follows:—Now I will come to the question of the electric light. I am told that a gas company has no business to do anything to improve the electric light. I do not think that that is a proposition which will be accepted by the shareholders. I believe if we do not assist, within our reasonable powers, when it is our business to do so, that some one else will step in and take our place. For that reason I advised the Board, and the Board adopted my advice, to go into the business of electric lighting at Vienna, although it might not be altogether profitable; and I do not conceal my intention, if the contracts require it, and if the circumstances induce me to think that the interests of the association require it—I do not say that I will not do it again elsewhere. It appears that for a few days last year the Opera House at Vienna was closed in consequence of the defects in the boilers, which were supplied by an Austrian firm. This gave the authorities reason to complain, and gave us some cause for anxiety. The authorities were a little nervous, and they ordered us to close the house when in the opinion of competent engineers it was not necessary to do so. The result was that we and others were put to considerable expense. I made it my business to investigate that matter, and I think we have abundantly proved to the contractors and everybody else who had to do with the matter that we were not at fault, and that it lay with those who supplied the boilers, which were taken back at no expense to ourselves. We have now supplied Babcock and Wilcox boilers, made in Scotland, which I believe are working satisfactorily. When we have got over some technical difficulties—and they are diminishing every day—and when the two theatres are lighted, I believe we shall be giving as satisfactory a light as we have been giving in the Opera House. The light there is the finest of the kind in any part of the world, and, although the station does not pay the interest on the capital laid out, you will understand that only a third is employed, as we have not yet lighted the second theatre and the Government buildings adjoining, and it is yet impossible to judge what the total result of the central station will be. I believe it will accomplish what we thought it would. Upon the whole, I think the business was undertaken in the right spirit, and, notwithstanding the critics, I am prepared to defend it. . . . It is of no use to look behind. Invention and progress are the order of the day, and in the future invention and progress must continue to be the order of the day with all subjects connected with lighting. I referred on a former occasion to some observations made by a valued friend of my own, who, in his time, was, and is still, looked upon as a great authority on matters of this kind—I mean the late Sir William Siemens. No one disputes the fact that he was an authority on all subjects connected with electricity, as well as on all subjects connected with gas lighting. Well, he always maintained that there was a great future before the electrician and electricity, and that it would be found that it would not interfere with, but promote the business of the gas maker. That also being my opinion, I have acted upon it, and the Board have acted upon it, as I have indicated to you, in carrying out the indispensable policy of the Association, and with the best results, and in so doing, in my judgment and in their judgment, we have acted right.

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ELECTRICAL OSCILLATIONS.

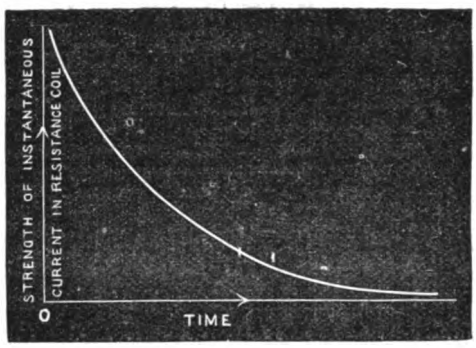
BY J. A. FLEMING, M.A., D.SC.

The important question of discharge through lightning conductors, as well as that of the behaviour of conductors generally towards brief or very rapidly reversed electromotive forces, makes it desirable for electrical students to understand the conditions under which so-called *electrical oscillations* take place in conductors. We may advantageously begin an elementary explanation of the subject by considering a mechanical or rather a pneumatical analogy. Suppose there be two large vessels, or reservoirs, connected by a pipe, closed or closable in the middle by a stopcock. Let one of these vessels, A, be exhausted of its air, and let the other, B, have air in it at the atmospheric, or a greater than the atmospheric pressure. *First*, let the connecting pipe be supposed to be long and narrow; on opening the stopcock air will rush over from B into A, and the flow of air will continue uniformly in the pipe in one direction until the pressure in A and B is equalised. *Second*, let the connecting pipe be very short and large, so that little tubular friction is offered to the flow of air. Under these circumstances the result of opening the top would be that a rush of air would take place, which would be succeeded by a series of oscillations of the air in the tube. The air, in fact, rebounds from side to side, and the equilibrium is only finally established after a series of gradually diminishing oscillations or backward and forward currents of air in the tube. This establishment of equilibrium of pressure by oscillatory movement takes place when the resistance to the flow is small. That this is no fanciful description is proved by the experience of MM. Clément and Désormes in their experiments to determine the ratio of the specific heats of gases. In these experiments a large glass vessel has a partial vacuum made in it. A stopcock is then quickly opened and closed, and the pressure of the air determined after a short time. These experiments were also carried out by MM. Gay Lussac and Welter. See *Journal de Physique*, LXXXIX., 1819, 428, and *Ann. de Ch. et de Phys.* [I], XIX., 1821, 436.

M. Cazin (*Ann. de Ch. et de Phys.* [3], LXVI., 1862, 206) pointed out a source of error which resulted from these air oscillations, and showed that the final pressure depended upon the phase of the oscillation at which the stopcock is finally closed. Helmholtz (*Die Erhaltung der Kraft*, 1847) seems to have been the first to conceive that when a condenser was discharged through a resistance the electrical discharge conducted itself after the fashion of the establishment of pressure equilibrium in the experiment above described on the specific heats of gases. Sir William Thomson took up the question in 1855 (*Phil. Mag.*), and discussed it in a remarkable paper.

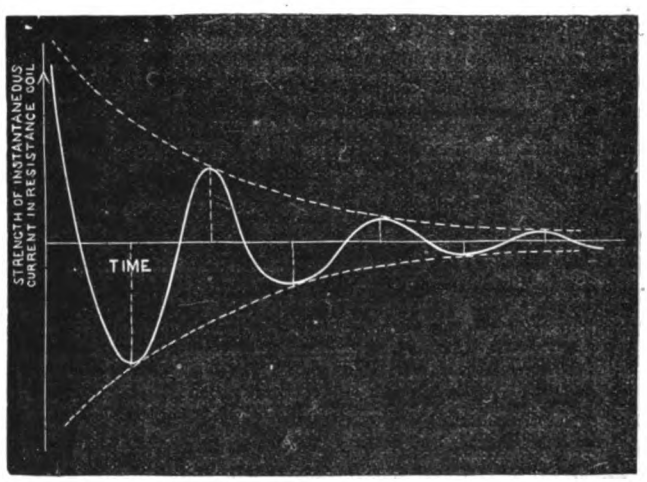
In this important monograph, he considers mathematically the discharge of a condenser through a resistance, and arrives by very ingenious reasoning at the conclusion that when the resistance has a value greater than a certain critical one, the discharge of the condenser will consist in a current which flows uniformly in one direction out of the condenser, dying gradually away in strength according to a certain law. If, however, the resistance is less than the critical one, then the discharge of the condenser consists in a series of waves of electric current, first in one direction and then in the other, each short current being less in maximum than the last. During equal intervals of time the quantities of the alternate discharges decrease in geometrical progression. Graphically, these two cases might be represented by two curves—one an exponential curve (Fig. 1) and the other a periodic curve (Fig. 2). In the first case the current at any instant in the resistance coil is represented by the ordinates of a logarithmic curve which descends gradually to the axis. In the second case, the instantaneous current strengths are represented by the ordinates of a periodic curve, whose maxima descend in geometric progression as the time increases in arithmetic progression. This second form of discharge is called the *oscillatory discharge*.

The foregoing predictions of analysis have been confirmed by the experiments of Feddersen, Paalzow, Bernstein, Blaserna, Helmholtz, and Schiller. Thomson in his original paper pointed out and suggests the application of Wheatstone's mirror to the examination of the discharge. In Feddersen's experiments the spark from a Leyden jar battery was taken between two brass balls placed in front of a revolving mirror. The discharge was passed through a high resistance. The image of the spark was viewed by a telescope. Under these circumstances the image of the spark was drawn out when the mirror revolved into a continuous band of light in a direction perpendicular to that of the discharge. When the resistance was reduced a point was reached at which the image was broken up into a series of separated strips, each strip corresponding to a discharge. This showed that the discharge was intermittent.



Curve representing the Discharge of a Condenser through a Large Resistance. Discharge Unidirectional and Continuous.

FIG. 1.



Curve representing the Discharge of a Condenser through a Small Resistance. Discharge is Periodic and Alternate. Maxima gradually diminishing in Geometric Progression.

FIG. 2.

In Paalzow's experiments a similar discharge from a Leyden battery was passed through a resistance coil and through a vacuum tube, and the image of the discharge in the vacuum tube viewed in a revolving mirror. As before, with a small resistance the image consisted of a number of separate images, each of which corresponded to a discharge, and a bluish light showed itself at both poles of the vacuum tube. When the resistance was increased the bluish light showed itself only at one pole. In the former case a magnet held outside the tube split the discharge into *two* lines of light, showing that it consisted of currents travelling in both directions; but in the last case the magnet did not divide the discharge. This sufficiently indicated that with a low resistance the discharge was oscillatory, and not uniform or unilateral.

Feddersen found that the critical resistance at which the discharge just becomes oscillatory varies inversely as the square root of the capacity of the battery, which is in agreement with the predictions of theory.

Helmholtz and Schiller have investigated the nature of the induced currents produced in the secondary of an induction coil under certain conditions as to resistances and coefficients of induction, and found that under certain conditions the induced currents consist of a series of oscillations gradually dying away.

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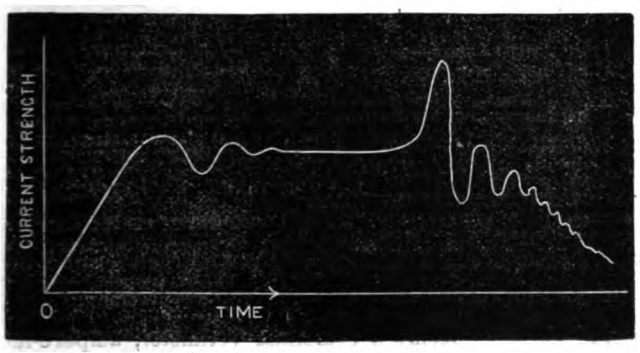
Blaserna also examined the nature of the flow when a current is being established in an inductive circuit, and found that in such a circuit the establishment and interruption of a current may take place by a series of oscillations which may be roughly graphically represented as in Fig. 3. In his experiments the duration of an oscillation was about $\frac{3}{10000}$th or $\frac{4}{10000}$th of a second, and about 50 to 100 oscillations took place before the current was established. Blaserna's experiments were undertaken in 1870 (*Phil. Mag.*, Series IV., Vol. XXXV., p. 318), and in the *Phil. Mag.*, Series IV., Vol. XLII., 1871, is a paper in which Helmholtz has examined and criticised some of Blaserna's results. Other references are to Paalzow, *Pogg. Ann.*, 1861, and Bernstein, *Pogg. Ann.*, 1871; and Schiller, *Pogg. Ann.* 1874, to which the student may be referred for full details, In "Wiedemann's Galvanismus," §§ 801, &c., a good general account of Blaserna's researches will be found.

It is a deduction from theory that if a condenser of capacity C be discharged through a wire of inductance L, and resistance R, that the discharge becomes oscillatory when R is less than $\sqrt{\frac{4L}{C}}$. If R is greater than $\sqrt{\frac{4L}{C}}$ the duration of the discharge is prolonged, and the oscillations quenched. In addition to the paper of Sir William Thomson, above referred to, the student will find a mathematical discussion of the problem on pages 512 *et seq*, of Mascart and Joubert's "Electricity" (Atkinson's translation), and in the article "Electricity," *Encyclopædia Britannica*, 9th Edition, by Prof. Chrystal, and a short discussion of it in a paper by the writer on "Networks of Conductors," *Phil. Mag.*, Sept., 1885, and *Proc.* Physical Society, London, 1885. It may be noted, however, in passing, that in all these investigations the inductance L is assumed to be a constant, independent of the current.



Curve representing the Establishment and Interruption of a Current by a Constant E.M.F. in a series of Electrical Oscillations.

FIG. 3.

Some practical consequences of the fact that such condenser or Leyden jar discharges are generally oscillatory have scarcely received the attention due to them. In experiments on the magnetisation of sewing needles by sending round them the discharge of a Leyden jar through a solenoid of insulated wire, it has been frequently noticed that there is an irregularity in the direction of the polarity produced. These irregularities are only what might be expected when we recognise that in such cases we may be operating with an oscillatory discharge. It has been frequently remarked that a stroke of lightning will demagnetise compass needles, and magnetised sewing needles can be demagnetised by sending through them a powerful discharge. In this case the oscillatory nature of the discharge makes it really consist of a rapidly reduced series of alternate currents. Just as a magnetised watch may be demagnetised by placing it in a coil traversed by an alternate current and drawing it gradually away from the coil, and thus submitting it to gradually reduced alternate magnetisation, so in a similar manner an oscillatory discharge may become a powerful demagnetising agent.

Let us follow the predictions of this theory into a few possible consequences. For a condenser of given capacity, charged to given potential through a wire of inductance L and resistance R, the discharge is *continuous* when L is less than $\frac{R^2C}{4}$, and *oscillatory* when L is *greater* than $\frac{R^2C}{4}$.

Suppose a long wire of resistance R, used as a discharging wire, is first stretched out into a single loop, and secondly coiled up into a coil of maximum inductance, it might be possible that R and C should have such values that in the first case the discharge is continuous, and in the second oscillatory. For circuits of equal inductance the discharge is rendered continuous by increasing the resistance. Hence, a discharge which was oscillatory when made through a copper discharging circuit might become continuous when made through a German silver circuit of equal form and diposition.

It is not difficult to show that at the first instant when the discharge is commencing in the circuit, the counter-electromotive of self-induction of the discharging circuit is equal to the potential difference of the condenser plates, and that the rate of diminution of the counter-electromotive of self-induction is equal numerically to the *reciprocal of the time constant* of the discharge circuit; hence, the greater the time constant the less rapidly is the counter E.M.F. of self-induction removed.

The remarkably interesting experiments of Dr. Lodge on electrical discharges, which he brought before the Society of Arts in the Mann Lectures given on the 10th and 17th of March last, have given the most striking illustration of the surprising and apparently paradoxical results which may arise from the phenomena of oscillatory discharges. In Dr. Lodge's experiments the most startling effect is that two conductors placed near each other, which are connected together by a copper wire, will, if suddenly brought to very greatly different potentials, prefer to discharge through the air in the form of a spark rather than neutralise their potential differences quietly through the wire in the form of a current. The reason for this is to be sought in the fact that the resistance operator of the copper wire or what may, somewhat loosely speaking, be called its instantaneous resistance, is nearly infinite for potential differences very suddenly applied to its ends. The most interesting result is, however, the comparison of the behaviour of conductors of iron and copper. It is now generally well understood that an iron conductor possesses for moderately great periodic, and for steady electric currents a greater impedance than does a copper conductor of equal size. The circular magnetisation of the iron conductor by the current is, of course, the cause of this greater inductance. It might, then, have been reasonably supposed that an iron conductor would be even worse than a copper one in preventing the sudden neutralisation of potential difference of bodies connected by it. The reverse is, however, found to be the case. Iron seems to offer less obstacle to a sudden discharge than copper. The explanation of this, which appears on the face to be at least probable, is that the magnetisation of iron is an effect which takes time. In other words, magnetisation lags behind magnetising force, and if a magnetising force is very suddenly applied and withdrawn, the iron has not time to respond to the force acting on it. Hence, iron is practically non-magnetic for very sudden and brief magnetising forces. A parallel may be found in the behaviour of air to prolonged and very sudden disturbances. If a piece of gun cotton is laid on a board and ignited by a match, the gun cotton burns away with comparative slowness, without damage to the board. It produces a volume of gas which displaces air gently and gradually. If the gun cotton is fired by a detonator with great rapidity, it blows a hole in the board, the reason being that the air has not time to be displaced, and offers an immense resistance to the sudden upward explosion, so that nearly the whole effect of the explosion takes place downwards. In the electric experiment, if the two bodies connected by the iron or copper wire were brought up to difference of potential rather slowly, the effect would be to produce a current in the conductor; but if they are brought up with extreme rapidity the impedance of the conductor is so enormous that practically the whole discharge takes place across the air space between the conductors. To return to the peculiar case of iron. The non-magnetisability of iron to very sudden and very brief magnetising forces renders its inductance equal to or not greater than that of, say, copper. Its greater specific resistance then makes its time-constant less than that of an otherwise equal copper conductor, and therefore the *rate* at which the counter-electromotive force

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of self-induction dies away is greater in iron than in copper conductors of equal size and conformation; and hence the iron conductor is able to draw down faster to equality the potentials of the conductor to which the ends are attached, and therefore to reduce their tendency to spark across or discharge to one another through the air.

In Dr. Lodge's experiments the two conductors were the two outer coatings of two Leyden jars on the terminals of a Voss inducto-static machine. The inner coatings of these jars were in connection with the + and − terminals of the machine. The outer coatings of these jars were connected by a long wire and also to two discharging rods whose distance could be varied. When the handle of the machine was turned the jars became charged respectively with +E and −E. The outer coatings then possessed also oppositely-named charges, which in the language of palæozoic electricians would have been called "bound" electricity. If the inner coatings of the jars are connected these "bound" charges on the outer coatings become suddenly "free." Although, however, these outer coatings are connected together by a metallic circuit, viz., the long wire, the discharge prefers to take the route across the air space between the points or balls of the discharger rather than through the wire, because that wire offers such enormous impedance to sudden and brief currents.

In respect of the passage of electric currents we are bound now to recognise three well-marked differences in the behaviour of conductors. First, when the current is a steady current the phenomena of current flow is then regulated by the ohmic resistance; secondly, when the current is periodic or of moderate duration, when the phenomena is regulated in addition by the inductance of the circuits; third, when the conductor is submitted to discharges of very brief duration, when the inductance almost wholly determines the behaviour.

In those cases, therefore, such as lightning conductors, in which the very object of the arrangement is to conduct, inductance comes in as an opposing action, and renders a conductor virtually non-conductive for brief discharges. Hitherto it has been supposed that flat bands of copper formed the best arrangement for passing such instantaneous currents, and iron has been rejected because of its supposed greater inductance and less resistance. All these experiments of Dr. Lodge indicate, however, that this preference for copper has been founded on insufficient knowledge, and that for these rapid discharges iron is as non-magnetic as copper and possesses superior advantages in its greater specific resistance, higher melting point, and less cost. The only way in which the inductance of a circuit can be lessened or neutralised is by the addition of electrostatic capacity. If a condenser is arranged in series with a circuit, such as an electro-magnet, possessing large inductance, it is possible by a certain proportion between the inductance and capacity to neutralise the inductance of this circuit for periodic currents of given frequency; and in the same way a sufficiently large capacity bestowed upon an inductive circuit would enable it to transmit very brief discharges freely. In this case what we virtually do is to give the conductor a certain elasticity, and instead of resisting strongly a sudden electromotive impulse it yields to it, and permits the generation of a current. It may be that we have here a partial explanation of the fact that even if the terminals of the secondary wire of an induction coil are short-circuited by a wire of no very great resistance, yet a very sensible shock is experienced on touching with the two hands the ends of the secondary. The human body possesses a sensible *capacity*, although perhaps the origin of this may be found in the fact that the tissues are susceptible of electrolysis, and accordingly the human body possesses capacity only in the sense in which we may say a voltameter or secondary battery possesses capacity, and not a true electrostatic capacity to any great degree. The result, however, is to make the human body act like a non-inductive circuit, and very responsive, therefore, as a conductor to brief electromotive forces applied to its ends. Hence, when the two hands short-circuit a metallic circuit of very low resistance, yet sensible inductance, brief periodic electromotive forces applied to the ends of this conductor are yet felt as shocks, because the inductive metallic conductor is virtually more opaque to these than the more highly resisting yet less inductive circuit of the body. More is this apparent if a Leyden jar is discharged by a long copper wire, the ends of which are held in the bare hands. Hence the necessity for a glass handle to a discharging rod.

These researches of Dr. Lodge go far to upset current notions on the appropriate form to be given to lightning conductors, and they point to the fact that the right direction of modification is to give the conductor attachment, if possible, to a conductor or condenser of large electrical capacity. Hitherto it has been assumed that the ohmic conductance of a lightning conductor is the quality on which its preservative utility chiefly depends. Our eyes are now opened to the fact that the instantaneous impedance to rapid discharges may make even a thick copper rod virtually non-conductive.

The exceedingly interesting experiments of Dr. Lodge on artificial lightning strokes produced between metallic plates, and various objects placed on one of them make it evident that old notions of a protected area round a conductor must now be considered as obsolete. The only absolute protection is obtained when the object is entirely enclosed in a metal case kept in connection with the earth. A man in armour, standing on damp ground, may be probably considered as very perfectly protected from harm by lightning stroke; but for buildings the nearest approach to security is probably to be obtained by following Dr. Lodge's suggestion to place high lightning conductors on all exposed pinnacles, turrets, towers, &c., connecting all these conductors to one another, and to all metal roofs, water courses, leads, &c.; and to fit the edges and eaves of roofs, wall tops, and ridges with barbed galvanised iron wire connected to the conductor system generally.

Protection from lightning is evidently a subject on which the last word has by no means been said, and Dr. Lodge's contribution to it is one of the most important of recent additions to practical knowledge.

ON A NEW COMPOSITE ELECTRIC BALANCE.*

BY SIR WILLIAM THOMSON, F.R.S.

This instrument has been designed for the purpose of providing, in one instrument, the means of (*a*) measuring the difference of potential between two points of an electric circuit, as, for instance, the difference of potential between the supply conductors of an electric light installation, (*b*) the current flowing in such a circuit, and (*c*) the rate of working in the circuit. The instrument thus forms a combined voltmeter, ampere-meter and wattmeter. The general form of the instrument is similar to that of the standard centi-ampere or deci-ampere current balances, and it consists of (1) two coils of silk-covered copper wire fixed one above the other, with their planes horizontal on a slab of slate, (2) two coils of similar wire made up in the form of anchor rings and fixed to the ends of a balance beam, (3) two coils fixed similarly to (1) but capable of carrying currents up to 500 amperes. The beam of the balance is suspended by two flat ligaments of fine copper wire in such a position that one of the coils fixed to the ends of the beam is suspended midway between the fixed pair of fine-wire coils (1), while the other suspended coil is similarly placed relatively to the thick wire or current coils. When the instrument is used for the measurement of alternating currents, the current coils are made by two or three turns of a stranded conductor. Each wire of the stranded conductor is covered with silk, so as to insulate it from the others, and in order as far as possible to annul the effect of induction in causing the current to be different at different distances from the axis of the conductor the strand is given one turn of twist for each turn round the coil.

The arrangement of the connections in the instrument will be readily understood from the figure, which shows diagrammatically the arrangement of the coils. In this figure *a* and *b* represent the fixed fine-wire coils, *c* and *d* the suspended coils, and *g* and *h* the current coils. The instrument is joined in the circuit through a suitable anti-inductive resistance, R, through which the current passes to the terminal T, from

* Abstract of a Paper read before the Philosophical Society of Glasgow.

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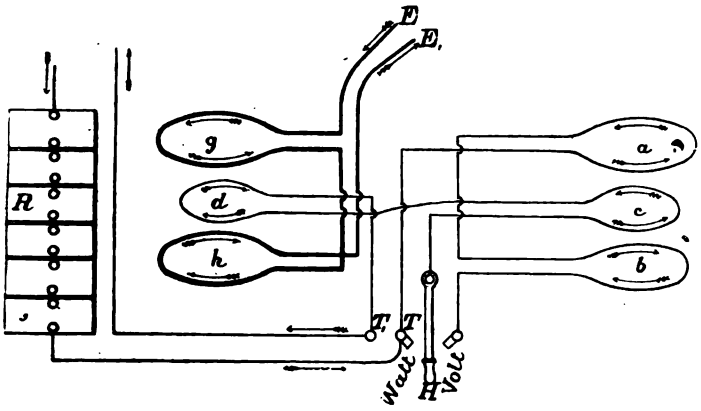
which the course of the current through the coils to T_1 is indicated by the arrows in the diagram, the switch handle H being in this case turned to "volt." For the measurement of amperes the switch is turned to "watt," the measured current passed through the suspended coils of the balance, and the currents to be measured passed through the coils *g*, *h* by introducing the electrodes E, E_1 into the circuit. The current through the suspended coils may sometimes be measured by means of the instrument itself, arranged for the measurement of volts. This may be done by first measuring the current which the difference of potential between the supply conductors of an electrical installation, or between the poles of a battery, causes to flow through the fine coils of the instrument and its external resistance, and then turning the switch to "watt," and, at the same time, introducing a resistance into the circuit equal to the resistance of the fixed coils. When the balance is used as a wattmeter the switch is turned to "watt," and the terminals T, T_1 joined to the supply-conductors, while the current through the circuit is passed through the coils *g*, *h*. When the rate of working in an alternate-current circuit is measured by such a balance, the anti-inductive resistance R must be so great that there is no sensible difference of phase



between the currents flowing through the fine-wire coils of the instrument and the electromotive force on the supply-conductors to which they are connected.

JUVENILE LECTURES.

THE APPLICATION OF ELECTRICITY TO LIGHTING AND WORKING.*

BY W. H. PREECE, F.R.S.

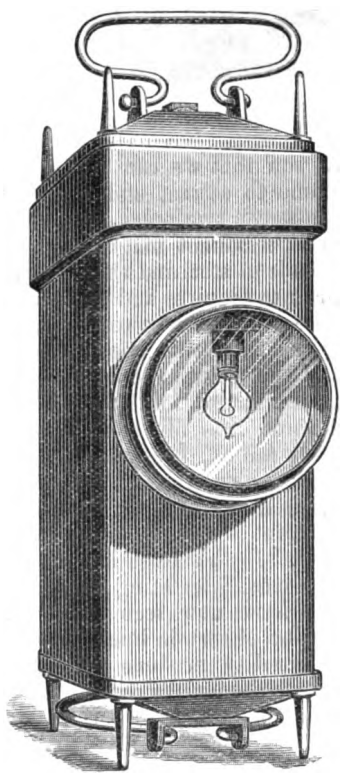
Lecture II.

(Continued from page 738, Vol. XX.)

Last Wednesday I had the pleasure of showing you how electricity was employed to produce heat, and how, by means of the heat resulting from the passage of electric currents, we obtained light. To-night I intend taking you in a different direction altogether. I want to disabuse your minds of the idea that electricity is a prime mover in the sense we generally consider prime movers to be. It is nothing of the sort; it is simply an agent or a medium by which energy, such as I showed and described to you last Wednesday, can be passed through one of its stages. The first form of energy that I am going to call your attention to to-night is of the character generally called work. It means something done; objects moved, resistance overcome.

In all these actions of electricity that I am going to show you—if an electric current, for instance, moves a magnet, a magnet moved will produce electricity; if an electric current, as I showed you last Wednesday, produces heat, heat in its turn will produce electricity, and so we have throughout the whole range of mechanics and of science this principle of reversibility introduced. For another instance, suppose we compress air or gas, the gas always reverses the action, and exercises a reaction precisely equal in amount to the action that caused the compression. Take a letter-weight. If you want to weigh a letter you do so simply by compressing a spring, and the weight of the letter is measured by the reverse action of the spring in pressing the letter upwards. If you take a weight and lift it, wherever it may be, that weight is in a position to produce the reverse action. If we take two magnets or two currents of electricity and forcibly separate them, there is also always this reaction between them.

PITKIN'S LAMP AND BATTERY. For description see preceding Lecture.



SCHANSCHIEFF BATTERY AND LAMP. For description see preceding Lecture.

I will first of all once more refer you to the hand-dynamo, which will work and produce currents of electricity that will enable me to produce on the table before you some effects. Last week I showed you how we could obtain heat. To-night, as some of the effects I want to show you are rather minute,

* A course of three Lectures delivered before the Society of Arts on January 4th, 11th and 18th.

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my friend, Mr. Lant Carpenter, has undertaken to assist me by throwing upon the screen behind me certain pictures conveying more vivid ideas of what I want to express than if I were to attempt to do so with the small apparatus that I have on the table.

I want, in the first place, to show you what is meant by a magnetic-field. We have now on the screen the projection of a steel magnet; it has been charged with magnetism, and as Mr. Carpenter now scatters over a glass placed above that magnet some very fine iron filings, you see that they arrange themselves in straight lines and curves, and when the glass is gently tapped, those lines all arrange themselves in a radial fashion, with beautiful symmetry, in the most wonderful way, every particle being directed by attraction towards the pole (Fig. 7). From that I want you to see how those lines picture to us the conditions of the space that surrounds every magnet, and in every single experiment that I am going to show you to-night the currents that we obtain are currents due to the fact that we can force copper conductors to pass through what is called a magnetic-field; the neighbourhood of a magnet, such as you saw just now on the screen, is called a magnetic-field. Whenever a copper conductor, such as the wire I now have in my hand, or a wire arranged in other forms, is caused to pass through a magnetic-field, it becomes electrified, it acquires that condition which enables us to obtain currents, and to use those currents.

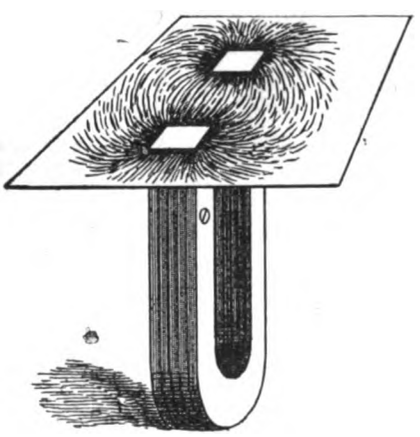

FIG. 7.

I will now show you that we can utilise currents produced by this hand-dynamo to attract and repel particles of iron. You now see on the screen two poles of an electro-magnet; the difference between a permanent magnet and an electro-magnet is that the one is made of steel and the other of soft iron. The permanent steel magnet acquires and retains its magnetism for a long time, whereas in an electro-magnet the magnetism only exists during the time that the current is passing round the soft iron core. The picture shows the two coils of copper wire which, with their cores, form the electro-magnet. Mr. Carpenter places some iron filings on that magnet, and on raising it they simply fall off, because there is no power present to attract them; I now cause a current to pass, and the iron filings being presented they are attracted, and continue so as long as the current is passing. The moment the current ceases the filings fall. In that experiment we have seen one of the simplest and most interesting elementary experiments in electricity. You have now seen that in a magnetic-field we have the production of certain lines of magnetic force, and that currents of electricity produce magnetic-fields. I want now to show you that whenever a conductor is passed through a magnetic-field, work is done upon the conductor, it receives a kind of reaction, currents of electricity are produced. Similarly, if the conductor be placed in the magnetic-field and the current from another source be passed through it, it is urged to move in a certain direction. I am going to show you the instrument itself if I can, but Mr. Carpenter has a similar instrument in the lantern, and the experiment will be repeated before you in another and different form on the screen.

The fact that I want you to understand is, that whenever we pass a current of electricity through a conductor in the neighbourhood of a magnet, or in a magnetic-field, it has a tendency to be moved or to rotate around that field in a definite direction. Here I have a horseshoe magnet; it is surrounded by a cage of copper wire, and through that cage I will cause a current of electricity to flow. You now see that the coils are rattling round at a rapid rate. I take the current off, and they stop; I put the current on again, and away they go. There you have an illustration of the fact that whenever you have a conductor in a magnetic-field, and the conductor is traversed by a current of electricity, it is always urged to move.

I ought to point out to you that here we have the basis of every single experiment I am going to show you to-night. A current of electricity produced rotation, as you saw, in that cage, and in this particular form that I want to show you on the screen you will see that rotation is produced in another way. You now see the apparatus on the screen. On the left and right hand side there are two upright columns, the poles of the magnet, exactly similar to the one I showed you on the table. Between those two poles there is an iron armature rotating on a centre point, and that armature is enveloped at each end by a small coil of copper wire. When a current of electricity passes through that copper wire it magnetises the iron bar, and the iron bar gets attracted and repelled by the two poles of the magnet, so that on my now putting the current on, you see, away it goes. The application of that principle has been carried out in the little apparatus I have here, called Froment's motor. This particular Froment's motor is used to wind a clock; in fact, it has only just been taken from a clock which, at twenty minutes past every hour, was wound up by a current of electricity actuating this motor. By its means the hand-winding of clocks is dispensed with, and, supposing a battery will last for years, so the clock will keep time for years without one being troubled by the necessity of going round the house and winding up the clocks. In order to show you, in a pretty way, one effect of this rotation, I have, through the kindness of Mr. Apps, brought here a motor which works a disc on the front of which some vacuum tubes have been fixed. Here is an induction coil which will produce currents of electricity that pass through these vacuum tubes and illuminate them, and when, by means of the motor, I cause the disc to rotate, you see what beautiful optical effects the persistence of vision produces when you look at electric sparks passing through vacuum tubes filled with a very slight proportion of different gases.

(To be continued.)

EFFECT OF CHLORINE ON THE ELECTROMOTIVE FORCE OF A VOLTAIC COUPLE.*

BY DR. G. GORE, F.R.S.

If the electromotive force of a small voltaic couple of unamalgamated magnesium and platinum in distilled water is balanced through the coil of a moderately sensitive galvanometer of about 100 ohms resistance, by means of that of a small Daniell's cell, plus that of a sufficient number of couples of iron and German silver of a suitable thermo-electric pile (see *Proceedings* Birmingham Philosophical Society, Vol. IV., p. 130), the degree of potential being noted, and sufficiently minute quantities of very dilute chlorine water are then added in succession to the distilled water, the degree of electromotive force of the couple is not affected until a certain definite proportion of chlorine has been added; the potential then suddenly commences to increase, and continues to do so with each further addition within a certain limit. Instead of making the experiment by adding chlorine water, it may be made by gradually diluting a very weak aqueous solution of chlorine.

The minimum proportion of chlorine necessary to cause this sudden change of electromotive force is extremely small; in my experiments it has been one part in 17,000 million parts of water,† or less than one 7,000th part of that required

* Paper read before the Royal Society, May 3, 1888.

† As one part of chlorine in 17,612 millions parts of water had no visible effect, and one in 17,000 millions had a distinct effect, the influence of the difference, or of one part in 500,000 millions, has been detected.

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to yield a barely perceptible opacity in ten times the bulk of a solution of sal ammoniac by means of nitrate of silver. The quantity of liquid required for acting upon the couple is small, and it would be easy to detect the effect of the above proportion, or of less than one ten thousand millionth part of a grain of chlorine in one-tenth of a cubic centimetre of distilled water by by this process. The same kind of action occurs with other electrolytes but requires larger proportions of dissolved substance.

As the degree of sensitiveness of the method appears extreme, I add the following remarks. The original solution of washed chlorine in distilled water was prepared in a dark place by the usual method from hydrochloric acid and manganic oxide, and was kept in an opaque well-stoppered bottle in the dark. The strength of this liquid was found by means of volumetric analysis with a standard solution of argentic nitrate in the usual manner, the accuracy of the silver solution being proved by means of a known weight of pure chloride of sodium. The chlorine liquid contained 2·3 milligrammes or ·03565 grain of chlorine per cubic centimetre, and was just about three-fourths saturated.

One-tenth of a cubic centimetre of this solution ("No. 1"), or ·003565 grain of chlorine, was added to 9·9 cubic centimetres of distilled water, and mixed. One cubic centimetre of this second liquid ("No. 2"), or ·0003565 grain of chlorine, was added to 99. cubic centimetres of water, and mixed; the resulting liquid ("No. 3") contained ·000003565 grain of chlorine per cubic centimetre. To make the solutions ("No. 4") for exciting the voltaic couple, successive portions of one-tenth or one-twentieth cubic centimetre of "No 3." liquid were added to 900. cubic centimetres of distilled water, and mixed.

I have employed the foregoing method for examining the states and degrees of combination of dissolved substances in electrolytes, and am also investigating its various relations.

THE SUBMARINE TELEGRAPH ACTS.

The following Order in Council was issued on the 3rd inst. :—

WHEREAS by the 2nd Section of "The Submarine Telegraph Act, 1885," it is enacted as follows :—

"The Convention of the fourteenth of March, one thousand eight hundred and eighty-four, mentioned in the schedule to this Act as set forth in that schedule is hereby confirmed and subject to the provisions of this Act the articles of such Convention (referred to in this Act as 'the Convention') shall be of the same force as if they were enacted in the body of this Act:"

And whereas by the 2nd section of "The Submarine Telegraph Act, 1886," which was passed on the 25th of September, 1886, it is enacted as follows :—

"It shall be lawful for Her Majesty in Council at any time after the passing of this Act, to order that the declaration mentioned in the schedule to this Act as set forth in that schedule shall be of the same force, and the same shall accordingly be of the same force, as the Articles of the Convention set forth in the schedule to the Submarine Telegraph Act, 1885:"

And whereas it has been made to appear to Her Majesty that it is expedient to give effect to the declaration set forth in the schedule to "The Submarine Telegraph Act, 1886:"

NOW, THEREFORE, Her Majesty, in exercise of the power vested in Her by the said Submarine Telegraph Act, 1886, and by and with the advice of Her Privy Council, is pleased to order, and doth hereby order, that the said Declaration mentioned in the schedule to that Act, as set forth in that schedule and in the schedule hereto, shall be of the same force as the Articles of the said Convention set forth in the schedule to the said Submarine Telegraph Act, 1885.

C. L. PEEL.

Schedule to the foregoing Order.

SUBMARINE TELEGRAPH DECLARATION.

Certain doubts having been raised as to the meaning of the word "wilfully," used in article two of the Convention of the fourteenth of March, one thousand eight hundred and eighty-four, it is understood that the provision in respect of penal responsibility contained in the said article does not apply to cases of breakage or injury caused accidentally or of necessity in the repair of a cable when all precautions have been taken to avoid such breakage or injury.

It is equally understood that article four of the Convention had no other object, and is to have no other effect, than to empower the competent tribunals of each country to decide in conformity with their laws and according to the circumstances the question of the civil responsibility of the owner of a cable who in laying or repairing his own cable breaks or injures another cable, as well as the consequences of such responsibility if it is recognised as existing.

MEETINGS OF SCIENTIFIC SOCIETIES.

(TO-NIGHT) FRIDAY, May 11th.

ROYAL INSTITUTION.

9 p.m. Lecture, "Building the New Tay Bridge." By Mr. W. H. BARLOW.

SATURDAY, May 12th.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Later Works of Richard Wagner" (5). By Mr. C. ARMBRUSTER.

PHYSICAL SOCIETY (LONDON).

3 p.m. Note on "The Condition of Self-Excitement in a Dynamo Machine," and Note on "The Conditions of Self-Regulation in a Constant Potential Dynamo Machine." By Prof. S. P. THOMPSON. Note on "The Electrical Action of Light." By Mrs. W. E. AYRTON. On "The Theory and Practice of Applying the Dynamometer to the Investigation of Transformers." By Mr. T. H. BLAKESLEY. On "Measuring the Electromotive Force of Dynamos and Motors." By Prof. W. E. AYRTON, F.R.S., and Prof. J. PERRY, F.R.S.

MONDAY, May 14th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture VI. "The Decoration and Illustration of Books" (3). By Mr. WALTER CRANE.

TUESDAY, May 15th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be discussed:—"The Tay Viaduct, Dundee." By Mr. PETER CRAWFORD BARLOW, B.A., M.Inst.C.E. "The Construction of the Tay Viaduct, Dundee." By Mr. W. INGLIS, Assoc.M.Inst.C.E. At this meeting the last ballot for members for the present session will take place.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Plant in the War of Nature" (3). By Mr. W. GARDINER, M.A.

SOCIETY OF ARTS.

8 p.m. Foreign and Colonial Section. "Emigration." By Mr. JAMES RANKIN, M.P.

ENGINEERING SOCIETY (King's College).

4:15 p.m. Paper on "High-Speed Engines." By Mr. LONG.

ROYAL VICTORIA HALL (Waterloo Bridge-road, S.E.).

8 p.m. Lecture, "William Harvey and his great Discovery of the Circulation of the Blood." By Mr. E. A. PARKYN.

WEDNESDAY, May 16th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "Electric Lighting from Central Stations." By Mr. R. E. B. CROMPTON. The ATTORNEY-GENERAL, M.P., will preside.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Meeting at the Institution of Civil Engineers. The following papers will be read:—"Report of the Wind Force Committee on Experiments with Anemometers conducted at Hersham." Drawn up by Mr. G. M. WHIPPLE, B.Sc., F.R.Met.Soc., and Mr. W. H. DINES, B.A., F.R.Met.Soc. "On the Measurement of the Increase of Humidity in Rooms by the Emission of Steam from the so-called Bronchitis Kettle." By Mr. WILLIAM MARCET, M.D., F.R.S., President.

THURSDAY, May 17th.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Chemical Arts" (6). By Prof. DEWAR, M.A., &c.

FRIDAY, May 18th.

ROYAL INSTITUTION.

9 p.m. Lecture, "La Reproduction Artificielle des Roches Volcaniques." By M. ALPHONSE RENARD.

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my friend, Mr. Lant Carpenter, has undertaken to assist me by throwing upon the screen behind me certain pictures conveying more vivid ideas of what I want to express than if I were to attempt to do so with the small apparatus that I have on the table.

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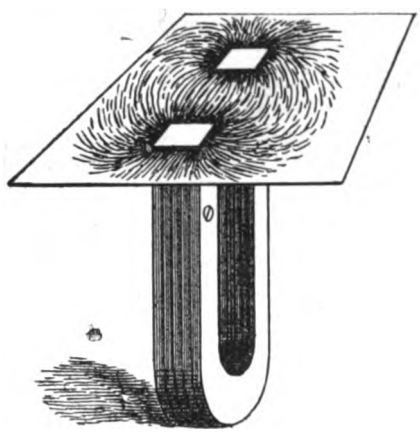

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The minimum proportion of chlorine necessary to cause this sudden change of electromotive force is extremely small; in my experiments it has been one part in 17,000 million parts of water,† or less than one 7,000th part of that required

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to yield a barely perceptible opacity in ten times the bulk of a solution of sal ammoniac by means of nitrate of silver. The quantity of liquid required for acting upon the couple is small, and it would be easy to detect the effect of the above proportion, or of less than one ten thousand millionth part of a grain of chlorine in one-tenth of a cubic centimetre of distilled water by by this process. The same kind of action occurs with other electrolytes but requires larger proportions of dissolved substance.

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NOW, THEREFORE, Her Majesty, in exercise of the power vested in Her by the said Submarine Telegraph Act, 1886, and by and with the advice of Her Privy Council, is pleased to order, and doth hereby order, that the said Declaration mentioned in the schedule to that Act, as set forth in that schedule and in the schedule hereto, shall be of the same force as the Articles of the said Convention set forth in the schedule to the said Submarine Telegraph Act, 1885.

C. L. PEEL.

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3 p.m. Lecture, "The Later Works of Richard Wagner" (5). By Mr. C. ARMBRUSTER.

PHYSICAL SOCIETY (LONDON).

3 p.m. Note on "The Condition of Self-Excitement in a Dynamo Machine," and Note on "The Conditions of Self-Regulation in a Constant Potential Dynamo Machine." By Prof. S. P. THOMPSON. Note on "The Electrical Action of Light." By Mrs. W. E. AYRTON. On "The Theory and Practice of Applying the Dynamometer to the Investigation of Transformers." By Mr. T. H. BLAKESLEY. On "Measuring the Electromotive Force of Dynamos and Motors." By Prof. W. E. AYRTON, F.R.S., and Prof. J. PERRY, F.R.S.

MONDAY, May 14th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture VI. "The Decoration and Illustration of Books" (3). By Mr. WALTER CRANE.

TUESDAY, May 15th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be discussed:—"The Tay Viaduct, Dundee." By Mr. PETER CRAWFORD BARLOW, B.A., M.Inst.C.E. "The Construction of the Tay Viaduct, Dundee." By Mr. W. INGLIS, Assoc.M.Inst.C.E. At this meeting the last ballot for members for the present session will take place.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Plant in the War of Nature" (3). By Mr. W. GARDINER, M.A.

SOCIETY OF ARTS.

8 p.m. Foreign and Colonial Section. "Emigration." By Mr. JAMES RANKIN, M.P.

ENGINEERING SOCIETY (King's College).

4:15 p.m. Paper on "High-Speed Engines." By Mr. LONG.

ROYAL VICTORIA HALL (Waterloo Bridge-road, S.E.).

8 p.m. Lecture, "William Harvey and his great Discovery of the Circulation of the Blood." By Mr. E. A. PARKYN.

WEDNESDAY, May 16th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "Electric Lighting from Central Stations." By Mr. R. E. B. CROMPTON. The ATTORNEY-GENERAL, M.P., will preside.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Meeting at the Institution of Civil Engineers. The following papers will be read:—"Report of the Wind Force Committee on Experiments with Anemometers conducted at Hersham." Drawn up by Mr. G. M. WHIPPLE, B.Sc., F.R.Met.Soc., and Mr. W. H. DINES, B.A., F.R.Met.Soc. "On the Measurement of the Increase of Humidity in Rooms by the Emission of Steam from the so-called Bronchitis Kettle." By Mr. WILLIAM MARCET, M.D., F.R.S., President.

THURSDAY, May 17th.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Chemical Arts" (6). By Prof. DEWAR, M.A., &c.

FRIDAY, May 18th.

ROYAL INSTITUTION.

9 p.m. Lecture, "La Reproduction Artificielle des Roches Volcaniques." By M. ALPHONSE RENARD.

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The Electrician.

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Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

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THE PROPRIETORS *of* "THE ELECTRICIAN" *beg to inform Electricians and Electric Light Engineers that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

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At the end of December in each year is issued THE ELECTRICIANS' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and has now attained considerable proportions. Every care is taken to make the names and addresses of all persons engaged in the Electrical Industries absolutely accurate. Useful Tables and Electrical Formulæ are given, together with popularly-written Biographical Notices of the leading Electricians, accompanied in many cases by Portraits.*

THE DIRECTORY FOR 1888 IS NOW READY.

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VOLUME XX. OF "THE ELECTRICIAN"

READY NEXT WEEK. Bound in cloth, price Ten Shillings and Sixpence. Also Cases for Binding, price Two Shillings.

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With this number a Supplement is issued (Gratis), containing the Index to Volume XX. This Supplement should be received with every copy of the paper. Complaints of non-receipt should be at once forwarded to the Publisher.

THE PORTRAIT OF SIR JOHN PENDER.

To meet the desire of those who wish to frame the Steel Plate Portrait of SIR JOHN PENDER, given with our issue of the 27th April, a limited number of impressions have been taken on large paper, and can be obtained in a neat black and gold or carved brown frame, price Four Shillings each.

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TELEPHONE AMALGAMATION.

If the first effect of the POSTMASTER-GENERAL'S declared intentions with regard to the Telephone Companies was to inspire some rather precipitate exultation, the effect of his later pronouncement has been to provoke some perhaps unreasonable resentment. Whatever may be the wishes of the managers of these companies, there can be little doubt that the feelings of the shareholders, as indicated on the market, were favourable to a Government purchase. And when subsequently Mr. RAIKES let it be known more explicitly what his policy really was, namely, to allow the business to go on until he could buy it, if so disposed, at an advantage, the fall in the value of telephone stock and the openly-expressed opinions of the financial press betrayed pretty plainly the angry disappointment it occasioned. It is no doubt in obedience to this sentiment that the companies have approached each other with a view to determine what measures of self-defence it will be wise for them to take. Some counterstroke of policy was in the first heat of the moment suggested in certain quarters; but as we pointed out at the time, any retaliatory measures would probably only result in exasperating the public, and would be really playing into the POSTMASTER-

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GENERAL'S hands. More reasonable councils we are glad to notice have prevailed, and what is now proposed to be done is no more than the companies are perfectly justified in doing in their own interests, and certainly not more than Mr. RAIKES might have anticipated they would do. Negotiations have already made some progress for the amalgamation of the companies; and in a few days' time a meeting of representatives of metropolitan and provincial telephone systems will be held in London, at which some definite resolution may probably be formulated.

Assuming that the POSTMASTER GENERAL will not interpose any obstacle in the way of this union—and we have no reason to suppose that he has either the wish or the power to do so—there is very little doubt that the companies will come to a satisfactory arrangement among themselves. Some outlines of the terms have been already foreshadowed in the press; but we have reason to believe that they have no official authority, and that in some particulars they are erroneous. We may, however, leave these matters to the parties whose interests are so closely bound up that a friendly settlement among them may be confidently predicted. That a working agreement of some kind would have to be entered upon has long been evident; and Mr. RAIKES' latest announcement has only had the effect of precipitating matters a little. With the object of strengthening their position in view of eventualities not far distant, the companies must have come together before very long; and the rapid development of long-distance telephony has rendered this step imperatively needful without any further delay. The rise and progress of this branch of their business has been almost as much a surprise as the rise and progress of telephony itself. Telephony, as originally designed, was merely what may be called a superior kind of speaking tube, far more flexible it is true, and of longer range, but still only local, urban and domestic in its application. It has grown to be not only something more than this, but something quite different. Besides serving the modest uses for which it was at first designed, though on a wider scale than had been imagined, the area of its operations has been immensely extended, and it is now to all intents and purposes a telegraph worked by telephony.

We revert to this important change in its character, because the fact that it was unforeseen explains the present situation better than anything else can. If this remarkable transformation had been anticipated, it is at least possible, and we think not improbable, that the Post Office would have been less willing to issue licenses to companies who are now its competitors for telegraphic business. And it is equally probable that the United Telephone Company, which may be called the parent of the provincial companies, would have acted somewhat differently also in the granting of their licenses. As matters stand, the country is cut up into various districts of unequal dimensions, and of greatly dissimilar service, some parts being very well serviced, others not so well, and some still not opened up at all; but the commercially-paying districts are pretty thoroughly covered, and within itself each one has its trunk lines in tolerably complete intercommunication. Some of these districts have gone a step further, and are connected one with the other, so that their customers have the advantage of speaking often far beyond the limits of the system to which they subscribe. To what extent this has been done already, and to what it is capable of, the information published in these pages recently has sufficiently testified.

Now it is obvious that all this is tending towards union in some form or other, and that it cannot long be delayed. The streams, since they have acquired strength by combining, are fast flowing towards London; and it is not possible for the parent company to hinder, even if it were inclined to do so, the strong desire to connect all the provincial systems through to the metropolis. By the time this is accomplished the several areas will probably every one of them be connected with each other, and consequently London with them all. This result, indeed, has been inevitable ever since the practicability of long-distance telephony was proved, and its practice taken up by the companies as part of their business. The local areas assigned under licenses could no more be kept separate and isolated than could a telegraph system under similar conditions. That the people of Derby may telephone to Nottingham, but not to Leeds, would be as absurd as to impose a like artificial restriction on the telegraph. Once admit that telephonic telegraphy is a business in which the telephone companies may legitimately engage, the public whom they are permitted and required to serve have a right to demand that it shall be universal. And for this reason, if for no other, we do not apprehend the least opposition on the part of the public to the proposed amalgamation of the companies. As there is no competition under the present arrangement, no reasonable exception can be taken to the creation of a big monopoly. Monopoly has been described as the slaughter of the prisoners when contrasted with competition which is civil war. But seeing that the State has elected to waive its rights to assume the monopoly of the telephonic branch of its telegraph business, neither the State nor the public has any cause to be alarmed by the companies combining to further their own interests. The State will still exercise a controlling influence over the monopoly; and perhaps it is better to have a semi-independent monopoly, efficiently regulated by the State—as was argued in connection with the proposed State purchase of the railways the other evening—than to augment the monopolies already owned by the State. Practically, if not avowedly, this is the attitude at present taken up by the Postmaster-General; and it rests very much with the Telephone Companies what their future will be.

OBITUARY.

SIR CHARLES BRIGHT, F.R.A.S., F.G.S., M. Inst. C.E.

It is with profound regret that we have to announce the sudden death of Sir Charles Bright, which took place at his residence, 78, Philbeach-gardens, on Thursday, the 3rd inst.

Charles Tilston Bright was born in 1832. His father, Mr. Brailsford Bright, represented the elder branch of an old Yorkshire stock, long settled in Hallamshire, a district near Sheffield. Sir Charles Tilston was the youngest son, and had several brothers. He first became connected with electro-telegraphy in 1847. In 1852 he became engineer to the Magnetic Telegraph Company, in which capacity he took part in the submersion of the first submarine telegraph cable between Great Britain and Ireland, from Port Patrick to Donaghadee, in 1853. He held this appointment for eight years—during which period the greater part of the company's lines were constructed under his superintendence—and in 1860 became their consulting engineer, a post which he held until the land telegraphs were taken over by the Government in 1870. In 1854 he engaged in an extended series of experiments upon the retardation experienced in subterranean and submarine conductors, and in the following year entered into a partnership with Messrs. Cyrus Field, John Watkins Brett, and Dr. Whitehouse, with a view of forming a company to lay a submarine cable across the Atlantic; having satisfied himself and them of the feasibility of working through so long a distance without the signals becoming blended together, a fact which, strange as it may seem to us now, was disbelieved by many at that date. In 1856 the time was considered ripe for putting the great project

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into a practical shape, the lines of the Magnetic Company being extended to the West of Ireland, and those of the New York and Newfoundland Company (of which Mr. Field was vice-president) being laid to Newfoundland. A company was accordingly formed, with 350 shares of £1,000 each, the subscribers being principally shareholders in the Magnetic Telegraph Company, among whom Sir Charles Bright was the first to enter his name for part of the capital. Mr. Brett became one of the directors of the company, Sir Charles Bright the engineer, Mr. Cyrus Field the manager, and Dr. Whitehouse the electrician. The cable was laid successfully in 1858, the end being landed by Sir Charles Bright in Valentia Bay on the 5th of August in that year. For this national service he received the honour of knighthood. In 1860 he laid a series of cables for the Spanish Government from Barcelona to Minorca, Majorca, Iviza, and back to Cape San Antonio on the mainland. In 1861 he entered into partnership with Mr. Latimer Clark, as the firm of Bright and Clark. He afterwards, in 1864, laid the first working cable to India, for the Government of India, from the head of the Persian Gulf to Kurrachee, a distance of nearly 1,600 miles. Sir Charles Bright was returned to Parliament as member for Greenwich in 1865, and sat until the election at the end of 1868, when he retired, being engaged in the Gulf of Florida laying a cable from the United States to Cuba, and his seat was transferred to Mr. Gladstone. While Sir Charles Bright was in Parliament he took an active part on the East India Communications Committee, part of the outcome of which was the formation of the Eastern Telegraph Company a few years later. In 1869 he was engineer to the Anglo-Mediterranean Company, by which a direct line was laid from Malta to Alexandria. In the following year he was joint engineer to the Falmouth, Gibraltar, and Malta Company, the Eastern Extension Company from India to Singapore, and to several other companies. In this and succeeding years he laid many cables between North, Central, and South America, connecting Cuba, Porto Rico, Jamaica, St. Thomas, St. Kitts, Antigua, Guadeloupe, Martinique, Dominica, St. Lucia, Barbadoes, St. Vincent, Grenada, Trinidad, Demerara, and Panama. In 1881 he was appointed by Her Majesty's Government as one of the British Commissioners to the French Electrical Exhibition. Sir Charles Bright was the inventor of many important improvements in telegraph apparatus, and the manufacture and laying of submarine cables, which are extensively used. He was a Past President of the Society of Telegraph-Engineers and Electricians, a member of the Institution of Civil Engineers, of which he was the Telford gold medallist in 1864, and a Fellow of various other learned societies, as well as an officer of the Legion of Honour.

The funeral took place on Monday last at Chiswick, the first part of the service being held at St. Cuthbert's Church, opposite Sir Charles's residence, and was attended by a large number of personal friends and professional men engaged in telegraph and submarine cable enterprise, with which Sir Charles Bright's name will always be honourably associated. Amongst those present were the following:—H.S.H. Prince Victor Hohenlohe-Schillingsfurst; Sir Francis Burdett, Bart.; Sir R. Jardine, Bart., M.P.; Sir W. Thomson, F.R.S.; Sir S. Canning, M.I.C.E.; Major-General Sir Frederick Goldsmid, C.B., K.C.S.I.; Mr. Edward Graves, President S.T.E. and E.; Mr. Latimer Clark, Past President S.T.E. and E.; Prof. Hughes, F.R.S., Past President S.T.E. and E.; Mr. Preece, F.R.S., Past President S.T.E. and E.; Mr. Benest, Mr. R. Collett, Mr. Clifford, Mr. H. C. Forde, Mr. R. K. Gray, Mr. John Muirhead, Mr. E. Stallibrass, Mr. E. March Webb, Mr. F. C. Webb, Mr. F. H. Webb. Many others were prevented by pressing engagements from attending. Sir D. Salomons's carriage was amongst those which followed in the *cortége*, Sir David being, much to his regret, unable to attend.

Dr. Werner Siemens.—The Berlin official *Gazette* publishes a list of the personal honours with which the Emperor Frederick has marked the opening of his reign. Among those who have been ennobled or dignified with the prefix "Von" are Prof. Gneist and Dr. Werner Siemens.

EDISON AND SWAN ELECTRIC LIGHT COMPANY v. HOLLAND AND OTHERS.

MONDAY, MAY 7TH.

The examination-in-chief of Prof. SILVANUS THOMSON was continued by Mr. FINLAY as follows:—

Have you anything further to say about exhibits J H 2 and J H 3?—I was about to say I could see no difference between J H 2 and J H 3, and I think I was further going to add that the joints appear to be made in a different manner from anything contemplated in Edison's specification.

Would you look at the series of exhibits marked I T, made by Mr. Gimingham?—I T 1 has a conductor made on a spiral, and the coils of the spiral are so open that they could not fulfil the requirement of offering only a small radiating surface. There is no appearance on the platinum wires indicating that they have been subjected to the process of carbonisation. The platinum wires attached to the carbon are not mounted to other platinum wires by clamps, and they are supported just below the joints by a little piece or disc of glass in the manner described in specification 539 of 1881. The wires themselves are sealed through the lower end of the bulb, after the manner described in specification 4,174 of 1881. The conductor in this case, as nearly as I can measure it from the outside, is 26-thousandths of an inch thick. There is considerable discoloration of the lower part of the bulb, which I should think is due to the incomplete driving off of the tar in the cemented joints or in the conductor itself.

[The witness proceeded to point out similar discrepancies in the other lamps of the series.]

Take the other exhibits produced by Mr. Gimingham marked E G 1 and following numbers?—E G 1 has a conductor looped but not coiled, there are no internal clamps, the bulb appears to be separately blown and joined on afterwards, and there is a yellow discoloration.

What about E G 2?—E G 2 has a coil of three turns wide apart from one another; there is an internal support of glass just below the mounting. The platinum wires show no trace of having been in the carbonising pot. The wires themselves are sealed direct to the lower end of the bulb, and the conductor is about 23-thousandths of an inch thick, or No. 24 Birmingham wire gauge.

Take E G 3?—E G 3 has a conductor that does not visibly vibrate when tapped. The bulb appears to have been separately joined on, and there is no appearance of the wires having been in the carbonising chamber. The conductor appears to be about 27 Birmingham wire gauge, or 16-thousandths of an inch.

Similar evidence was given with regard to the remaining lamps of the series.

With regard to these lamps of Mr. Gimingham's, are you able to say from your examination of them whether they would be commercial lamps?—I doubt if they would be durable lamps.

Take the two specimens produced by Mr. Crookes of filaments coated with non-carbonisable substances, marked W C 9 and 10, what do you say about them?—W C 9 is a lamp which was made at Mr. Crookes's, and it was tested in my presence.

The ATTORNEY-GENERAL: Did you see it made?—I saw the conclusion of the making process, and a portion of the operation of making. It was tested while still on the pump in my presence, and I saw the reaction taking place which ended in the destruction of the lamp.

There is one other exhibit produced by Mr. Crookes—W C 23—said to be Edison's bamboo lamp?—I think I have already seen this lamp, and it is not bamboo at all.

What do you say it is in your judgment?—Whatever it is it has been subjected to some process. Its surface is white and metallic, and it is not mounted in the way Edison's lamps are mounted at all.

How does it differ from them in the mode of mounting?—Every lamp that I have ever seen put into the market as an Edison lamp with bamboo conductor this differs from in several respects. The joining is made in a different way, the platinum wires are in one piece; in fact, it does not possess any of the peculiarities which I pointed out as characteristic of Edison's lamp so largely introduced about the year 1882. I never saw that lamp before this trial; it might have been made for the purpose.

Did you examine the filaments of tar putty put in during the cross-examination by the Attorney-General to Mr. Crookes?—Yes, I have examined these filaments.

What do you say about them?—A, B and C are about 40 or 41 thousandths of an inch thick. They are not quite uniform, though nearly so, but they exhibit a number of small cracks. The filament marked D is about half as thick, and is not so uniform; it is thinner in some places than in others. There is a spiral a good deal thicker than in any of the others, and it has been carbonised; it also presents inequalities in diameter.

Have you tried yourself to make tar putty filaments?—Yes, I have several times.

Have you got any specimens here of your work?—Yes. [Specimens produced.] I made these last Wednesday; that is the third occasion on which I have tried such experiments. Four years ago I tried tar putty on slate, and gave it up as an entirely hopeless job. The second occasion was at Mr. Crookes's, where I employed part of the same mixture which he was using, lampblack which had been in a crucible for some hours, mixed with tar and rolled out. The best results I got then were not so good as those I have here. The third time was last Wednesday evening, the results of which I have got here. I took lampblack, such as already was existing in my laboratory, and sent out for some tar, and having ignited the lampblack in the crucible, first of all for half an hour and then for three hours, I tried to roll out these strings of putty. I tried to roll them on a plate, on the palm of my hand, and on a porcelain plate, on a

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plate of glass, on paper, and, last of all, upon rather coarse pieces of cardboard. And the best results were got by rolling the stuff upon a clean piece of cardboard, using another clean piece of cardboard to roll it out. I consider the tar putty process, as a whole, quite an impracticable one for commercial use, on account of the contracting that goes on, and the liability to distortion and fracture. And the addition of camphor is simply fatal to the working process. I would only add, every one of those specimens I have had was complete when I laid it out on a sheet of paper, and of these two broke while the paper was resting on a rigid pedestal.

Were you present at the experiments made by Mr. Crookes with regard to infusible bodies, non-conductors of electricity, or non-conducting non-carbonisable substances?—I was present when they were coating some of those tar putty filaments with fireclay and trying them, and I also saw the results of burning lamps, the conductors of which had been coated with some other materials than fireclay.

You have heard the evidence given already on this point by Mr. Crookes?—I have.

Do you agree with it?—Entirely.

Is there anything you have to add?—Yes; that those lamps I saw tried were sealed to the pump when they were being tried, and that they were sealed by passing a current through them, first gently, then more strongly, and that I observed no depreciation in the gauge of the pump indicating that gases were being given off until the conductors had been raised to a full yellow heat; also that before the conductors had been raised to that degree the brilliancy and whiteness which is ordinary in running lamps before any arc has been formed at any part of the conductor gases began to be given off, producing a well-marked depression in the mercury of the gauge pump. It fell without doubt, and at the same time the bulb was more or less filled with faint glow, and portions of the conductor became by themselves more highly luminous. It was at this stage that the spectroscope showed lines indicating volatilisation, and of course the reduction of the materials of the non-carbonisable coating. The added materials did not require to be kept up to the same stage of incandescence before the phenomena took place; but every one of them I saw was in this way volatilised and destroyed long before they had been heated up to the ordinary degree of an incandescent lamp.

You have examined Mr. Cheesborough's specification?—Yes.

I would ask you what you have to say as to what is stated at page 15, line 49, regarding infusible substances, non-conductors of electricity—a tube of lime enclosing a pencil of carbon, through which a current is passed?—I witnessed the experiments made by Mr. Crookes, and I agree with him.

Have you examined the Paper by M. Deprez?—I have.

And have you also examined Sidot's papers?—Yes.

What do you say as to the substances yielded by Deprez, the Sidot process as compared with the substances in Cheesborough's process?—I regard the substances yielded by Cheesborough's process as absolutely identical with the substances which were produced by Deprez and Sidot processes.

So much with regard to the substances; have you compared the processes themselves?—Yes, I have. The processes themselves appear to me to be mere variations in detail of the same process, viz., that of heating, by means of an electrical current, a conductor, which becoming incandescent at the surface acts upon the surrounding fluid containing carbon, and dissociates the carbon from it, becoming coated thereby. In that sense Cheesborough has struck out of his first specifications the only two hydro-carbons that he ran.

With regard to the material yielded by the various processes, what do you say?—The material yielded by Sidot's process is the same as that yielded by Cheesborough or by Deprez.

How does the process differ?—The physical action is the same, *i.e.*, there is decomposition of the surrounding fluid containing carbon resulting from the contact of the surrounding fluid with a highly-incandescent surface. So far as the material is concerned the reaction is solely and purely consequent upon the high temperature of the surface that is brought into contact with the carbon or liquid containing gas.

Cross-examined by Mr. MOULTON, Q.C.: You say with reference to the processes of Sidot and Deprez that so far as substances are concerned they are the same. Do you say that Cheesborough's conductors could be got by Sidot's process?—What I said was the material was the same.

Do you say that the conductors described in the Cheesborough's specification could be obtained by Sidot's process?—Some of them may not.

Could any of them be so obtained?—Yes, I think so.

Please understand me. Can they be obtained as conductors of the same regularity as by Cheesborough's process?—The carbon would be deposited in perfectly regular layers wherever the incandescent surface was in contact with the gas.

I ask you whether you could obtain these conductors with the same regularity in them as by Cheesborough's process?—Do you refer to regularity of form or regularity of material?

I talk about regularity in everything.—Well, I can only talk about it in two stages. So far as regularity of material is concerned, I think the two processes would produce exactly the same results. With regard to regularity of form, I do not think that Sidot's process would, without modification, produce as great a uniformity of form as Cheesborough's.

In making electric conductors, regularity of material and form are both important, are they not?—They are not necessarily. Regularity of material and form are not respectively important for a lamp conductor. My reason for saying that is that in modern lamps the process of flashing does not produce uniformity of diameter.

What is important, I understand, is uniformity of electrical resistance?—No, not even that.

Will you kindly tell his lordship what is important?—It is of importance that the conductor should be so built or so shaped as to glow at every point of its surface with an equal degree of incandescence.

Do you suggest you would get that by Sidot's process?—By a modification of Sidot.

Do you suggest you could get that by Sidot?—No, not by Sidot alone.

Is it not a fact that you can get that by Cheesborough and by no other process that is known?—I do not know that.

First of all, can it be got by Cheesborough?—By applying a portion of Cheesborough's patent.

Then it can be obtained by Cheesborough, but Cheesborough gives you some other method?—Cheesborough does not tell you how to do it.

But, by the process Cheesborough describes it can be done?—Oh, yes.

I put it to you that by no other known process can it be done. Is that so?—Oh, no.

Tell me all the known processes by which it can be done?—I think I can do so. Specification 562 of 1881.

Did you ever try that?—No, I never tried that, nor Cheesborough's either.

Can you say of your own knowledge whether this would succeed?—It would certainly deposit carbon. It is a question of care, time, and patience.

Do you suggest that this would make the carbons glow uniformly throughout, as Cheesborough's will?—Undoubtedly, if properly applied.

You say so in practice?—I have no doubt, though it is not in practice yet.

Have you ever heard of a single lamp being made in this way?—No.

This would not do it automatically, would it?—I think not.

Have you any doubt about it?

Mr. JUSTICE KAY: That depends on what you mean by automatically.

Mr. MOULTON: I mean if it would find out the weak places for itself?

Witness: Certainly not.

Would there be anything automatic in the connection?—I think so.

It not only finds out the weak spot, but the connection is proportional to the weakness?—Undoubtedly.

Any defect in the inside which you suggest should be remedied?—I do not think either process corrects the inside satisfactorily.

You have never tried Cheesborough, and you do not know whether it affects the interior or not?—I have seen the process.

But you have never examined to see whether Cheesborough does affect the interior?—No; I have never seen that.

Supposing Sidot's filaments formed of little balls touching one another, would that be regularity suitable for a conductor?—Not at all.

I understand you to say that the Deprez and Cheesborough processes are merely variations of the same process?—Cheesborough is a variation of Deprez.

In the first place, how do you suppose Deprez placed his carbons?—Between two clamps in some cases.

And, how with regard to the electric current?—So that the electric current would go through them.

Where do you get that?—All through the description.

That is your interpretation of the Paper?—Yes.

We know what the objects of these experiments were, they were the fusion and volatilisation of carbon?—That was the title of the Paper.

In every one of these experiments did not he get either fusion, volatilisation or rupture of carbon?—I think in almost every case he claimed something of the kind.

This being the uniform result of his experiments, when he comes to experiment in hydro-carbon he does not say the result is different, excepting so far as there was a deposit besides?—It is utterly unsuitable for softening.

He calls attention to difference in the result. Is there any portion which calls attention to any difference in the effect so far as fusion and ruptures are concerned?—He does not even mention fusion or rupture.

But in all the other experiments he mentions one or the other?—Yes.

Have you tried the experiment of putting this enormous current through a hydro-carbon rod?—He was only dealing with small currents.

I am asking you if you tried the passing of these enormous currents through the carbon?—Certainly not.

I understand you to say that taking into consideration the size of the carbon conductor the currents which Deprez used were not enormous?—I should not think they were.

Do you remember Mr. Preece giving a lecture at the Society of Arts on the electric lighting at the Paris Exhibition?—I do not think I was there; but I may have read it afterwards.

I think you take *The Electrician*?—Yes.

Did you read the lecture in that journal?—Probably I did.

Were you on the jury of the Paris Exhibition?—No.

Mr. Preece, in his lecture, says, "There were several incandescent lamps; that which possessed the greatest novelty and was decidedly the most efficient was that of Edison. Its distinctive character was the remarkable uniformity of its texture and light-giving powers." Are you prepared to say that is not a correct description of what was shown in Edison's exhibit?—Contrasting them, I should differ in detail from the description of the lamp. I should entirely doubt the right to use the word efficiency, because my recollection is that the lamps were not so efficient as some of the other lamps shown at the Exhibition. As to their being a novelty, I think that is right, for nobody had seen them before that day.

You are not prepared to say that the Edison lamp was not the most efficient?—I am, judging by the way in which these lamps themselves were then shown. Doubtless the owners did not wish to burn them brightly; my inference from that was that they might break down.

The Electrician, in a description of the electric lighting apparatus, 22nd October, 1881, says, "The lamps numbered 160, and two rooms were lighted with Edison's exhibits." Is not that a correct description?—Yes, that is correct.

Then I put it to you, were there 160 lamps?—I cannot say.

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Did you take any notice of them?—I do not think I took any particular notice. I am speaking from general recollection.

This was published 22nd October, 1881; are you prepared to say it was incorrect?—No, I am not prepared to say so, I did not see the lamps. I remember seeing a number of Swan's festooned all round the hall, and they made a great impression. I felt disappointed at seeing so few lamps lighting Edison's show cases.

Was it the small number of lamps that struck you?—Yes, and the lower degree of incandescence at which they were running. The lights were much redder.

You have been asked several questions about a lamp put in of the Edison type—W C 23; will you kindly tell me what difference there was between what you saw at Paris and W C 23?—My recollection of the Paris lamps is that they were like that produced by Prof Frankland, E F I, and not like this.

Leaving out the question of attachment of the carbon conductors to the wires, do you say that either of these is not made in accordance with Edison's specification?—It is made in accordance with a number of subsequent specifications. It is not made in accordance with Edison's specifications.

Is there a carbon filament in E F 1?—Yes.

Within a receiver made entirely of glass?—Yes.

Through which the leading wires pass?—Yes.

And from which receiver the air is exhausted?—I have no doubt of it.

Take now W C 23, and answer the same question?—Yes.

Do you say that C F 1 is not made according to Edison's specification?—It is not.

Is not the conductor there of fibres made of vegetable substances?—I have no doubt it was.

Which would leave a carbon residue after heating in a close chamber?—That would depend.

Do you suppose it has been heated in a close chamber?—I think it has.

Mr. JUSTICE KAY: This is all argument.

Mr. MOULTON next referred to "Chambers's Encyclopædia" for certain definitions, and asked witness if it was a rare or unrecognised book?

Witness: I do not happen to possess it.

You have heard of people doing so?—I have.

I have a copy here dated 1851, and in an article on carbon it is said "carbon was used for electrical purposes, mainly referring to Bunsen's carbonisation for batteries." They were well known, were they not?—Oh, yes.

Do you know how these were made?—I know the process in general.

After what I have read from "Chambers's Encyclopædia" do you tell his lordship that it was not well known that in carbonising charcoal, if you did not wish them destroyed, you packed them with charcoal dust?—All I can say is that it was not known to me.

Mr. JUSTICE KAY: He says that it was not known to him, and the inference would be that it would not be known to an ordinary workman. That is all this evidence goes to show.

Mr. MOULTON (to witness): Do you know a common manual called "Brand and Taylor's Chemistry," published in 1863?—I do. I have read it. I have referred to it, but not often,

In it there is a passage: "Charcoal may be obtained from either vegetable or animal substances. In order to procure it it is necessary that the organic matter should be heated to a high temperature out of contact with air."—I did not know that. I never read that passage. I knew it could be made that way.

But did you know that in order to procure charcoal it is necessary that the organic matter should be heated to a high temperature out of contact with air?—I knew that carbonising was a process of imperfect combustion.

Can you find me any book or treatise in which carbonisation is said to be a process of imperfect combustion?—I do not recollect. When heated in the chamber I call this destructive distillation.

Do you think that was what was referred to by whatever it may be called, in the phrase "having fibrous vegetable substances after heating in a close chamber"? Do you suppose that what I have been talking about was what you call destructive distillation?—I am not sure. It looks very like it.

If it was destructive distillation you would keep the air from contact with the organic body?—Yes; as far as possible.

[Shown lamp G I 3.] You said that was a machine-made bulb?—I said my impression was that it was a machine-made bulb.

What has that got to do with it?

Mr. JUSTICE KAY: I understood witness to mean that it was not blown over the hole, but was made separately by machinery and then attached?—Witness: Yes.

Mr. MOULTON: (To witness). Do you suggest that it makes any difference whatever as to whether it is blown before or after, whether it is ready made or blown out afterwards?—I suggest it is a different process of manufacture, and it would be a very difficult thing, commercially, to try and blow a bulb over such an arrangement as this.

What meaning do you attach to the words to have a "bulb blown over it"?—That you put it there and blow it.

May I ask whether your knowledge of glass blowing is extensive?—I have seen bulbs blown many times.

In glass blowing you have a little blob of glass; you blow into that and it will expand into a bulb?—That is one way. The other way is to take a piece of glass tube hot on a blow pipe, and then blow it so that the tube expands. I supposed it was one or other of these two methods which was meant.

How would the second method differ from the statement of the specification?—The process is completely different. I would not have thought it worth mentioning if Mr. Edison had not used these words.

You do not mean to say that the glass being blown over it would make any difference?—On the contrary, there would be a difference. It would be a great source of trouble.

Would any practical person have any difficulty in understanding what was meant by the glass globe being blown over it?—I think they would take it that the globe was to be blown over the filament.

Mr. JUSTICE KAY: You think it would be much more difficult than making the bulb separately?—Yes.

Mr. MOULTON: Do you suggest that there would be the least difficulty in understanding what Mr. Edison meant?—No, I think not. I think it was clear. He meant it was to be blown over, and not to be blown from the thing; that he was not to put the filament in the tube, and by blowing expand the tube.

You do not suggest that while blowing it into a bulb you had the filament inside?—Certainly.

Mr. JUSTICE KAY: Really all this is a matter of construction; whether material or not is quite another matter.

Mr. MOULTON: You have called attention to the descriptions of Mr. Edison in his specification of the then state of electric lighting by incandescence, and you say they were incorrect, because of the three specifications of Mr. Lane-Fox, among other things?—I think I referred to them.

You never knew of any lamp being made in accordance with these three specifications, did you?—They were made; they were not sold.

Did you know of one made before 1879?—I think I did.

Are you prepared to swear you did?—I think I saw some.

Are you prepared to swear you saw them before the date of Edison's patent?—I cannot tell you the date.

Mr. JUSTICE KAY: Is it not admitted that the lamp F G B 1 was made before the patent?

Mr MOULTON: Yes.

Mr. JUSTICE KAY: And this does not accurately describe the Swan lamp?

Mr. MOULTON: No.

Mr. JUSTICE KAY: It has been admitted frankly that Edison did not describe the actual knowledge at that time. As to what you said as to Sidot's light. Can you tell me of a single installation on Sidot's principle of incandescence?—Yes, at Wittlesborough. I think that was on that principle. I will not swear it.

With regard to the lamps that were made with carbon and not carbonisable material, I understood your evidence in regard to that was that these were heated to full yellow incandescence. Your view is that you had got to the temperature at which carbon would unite with non-carbonisable substances?—At that pressure. We had got to that temperature at which the carbon would unite with the oxygen and non-carbonisable matter.

That must necessarily be the limit of the temperature which such a lamp, composed of whatever substance it was, could stand?—Yes, it must be.

Mr. JUSTICE KAY: And did they give light?—They were not heated to the height that they should have been had they been commercial lamps. Destruction took place before that heat was arrived at.

Mr. MOULTON: Had they been carbon lamps you could have raised them to a much higher incandescence?—If purely carbon lamps undoubtedly.

As to the filaments which were made, look at E F 2. How do you suggest these were made?—I do not know.

Take W C 25; you say you never saw such an Edison lamp before, and that it is not bamboo. How do you say that?—Because it is quite different in appearance; it looks like twisted thread.

Are you prepared to say the original filament is not bamboo?—I do not think it is.

Prof. JOHN PERRY, examined by Mr. GRAHAM, deposed as follows: I remember a meeting of the Telegraph Engineers, at the Institute of Civil Engineers, November, 1880. Swan's lamps were exhibited there. They were incandescent lamps, very much like the lamps in use at the present day. There were twelve lamps. On that occasion Mr. Swan delivered a lecture about his former experiences. Going to the British Association meeting, in August, 1881, at York, I remember Swan's lamps being exhibited, lighting up the picture gallery. I made a number of measurements of the efficiency of Swan's lamp in May, 1881. I believe Prof. Ayrton and myself were the first to measure the efficiency of the lamps. Compared with the best lamps now known, the Swan lamps in 1881 were exceedingly good in respect of efficiency. Again, I measured the efficiency of the Swan and Maxim lamps in October, 1881. Those measurements were made at Finsbury Technical College, with Prof. Ayrton. At that time we obtained very much higher electrical efficiency from lamps than is ever obtained now from incandescent lamps in regular working, because at that time it was not sufficiently well known that lamps may be made to give out too much light for their lives. Now with regard to the lamps exhibited by Mr. Swan to the Society of Telegraph-Engineers, I am in a position to say, from their bright appearance, that they must have been burning with much the same efficiency as lamps of the present day. They burned for several hours. Those lamps exhibited by Mr. Swan must have undergone a considerable amount of testing before he would have dared to exhibit them on such an occasion. I remember the auditorium of the Savoy Theatre being lighted in 1881 with over a thousand Swan lamps. At the Paris Exhibition of 1881 the Swan lamps had the appearance which lamps now generally have, the Edison lamp had a reddish orange appearance, and from my knowledge I should say it was burning very inefficiently. A Gramme dynamo was shown at the British Association meeting in 1874, when I explained its construction to many electricians. Before that time electricians in this country were almost ignorant of its construction I have heard the evidence of Prof. Thompson about the advantage of high resistance, and I agree with him. I have seen F I B 1—the Swan lamp put in by Sir Frederick Bramwell. Having regard to the sort of dynamos in existence in 1879, I think you

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have there nearly the minimum thickness for dynamos at that time, taking into account that running with pumps was unknown. I think it was very much better able to resist shocks than anything which could have been made under Edison's patent. Going to Cheeseborough's specification, he probably was using a producer of electrical force, and, in that case the current would automatically increase, the temperature would slightly increase if left to itself, unless the battery was frightfully bad. If you use a dynamo machine the temperature would certainly increase, and it would be necessary to adopt some means for increasing rather than diminishing the resistance. When the section increases two per cent. the current has only to be increased one per cent. to keep it at the same temperature. It is not necessary to make any provision for increasing the current when using the dynamo. The total output from the 600 cells—the largest battery used by Deprez—was probably considerably less than half a horse-power. And that is exceedingly small.

Cross-examined by the ATTORNEY-GENERAL: Swan certainly had much the better of Edison at the Paris Exhibition in 1881.

If you had been asked to describe the Swan lamp would you not have said it was a vessel of glass, platinum leading-wires, a filament of carbon, and a complete vacuum?—Certainly not. He used the same combination in 1878.

Will you kindly tell us what you say was the novelty of the Swan lamp as exhibited in 1881?—That he had manufactured them in exceedingly large numbers and had made a great commercial success.

Any other novelty?—No; I do not know of any other.

Look at that lamp [handing up lamp], does that not represent Swan's lamp of to-day? It comes, I may say, from Her Majesty's Royal Courts of Justice?—Yes.

Speaking of its leading features, does it not consist of a vessel of glass, leading-wires sealed in it, and a carbon filament, the vessel being exhausted?—Yes, I think so.

Sir HORACE DAVEY applied for leave to have the examination of Mr. Carré taken in Paris, as he was unable to attend the court in England and give evidence through an interpreter.

The ATTORNEY-GENERAL asked for evidence of the inability of the witness to attend.

It was agreed to delay the matter, and the Court adjourned at four o'clock.

TUESDAY, MAY 8TH.

Sir HORACE DAVEY: I mentioned yesterday afternoon that we were disappointed in believing that M. Carré, as he led us to believe, would be here to give evidence before your lordship, and the application I have to make is that he should he examined in Paris. We wish to prove that he made his carbons; that those produced were made by him; if necessary, the mode in which he made them, and probably if they were received in that particular shape for carbonisation. Secondly, we wish to prove that he sold similar carbons which had received that shape before they were carbonised, after they had been made into those rods or pencils, and that he supplied those to Swan before November, 1879. I should also, if he had been here, have asked him to look at the carbon in the Swan lamp, and say whether that was one of those carbons he had supplied to Mr. Swan. I regret that the affidavit which was sworn is not in court; it appears to have gone astray between two gentlemen, and has been mislaid. Directly before it was sworn, General Webber, manager of one of the departments, saw M. Carré in Paris, and was told by that gentleman that it was not convenient for him to come to England. Under these circumstances, we ask your lordship to allow him to be examined on Friday or Saturday in Paris.

The ATTORNEY-GENERAL: I wish to facilitate matters as far as I possibly can, and I asked your lordship last night to allow my learned friend to point out the grounds on which he was going to make this application, because it is impossible, unless we have something definite, that this application can be acceded to. Of course it is important to avoid expense. The granting of this application means sending over to Paris Mr. Moulton and a skilled chemist. So far as Sir Horace Davey has indicated what M. Carré will prove, and in regard to the fact that the lamp F I B 1 has a carbon made by M. Carré, I admit that at once. And I should think it makes no difference to my purpose that somebody may have had more pieces like that in the lamp than the one in the lamp itself. I am quite prepared to consent that he got indirectly from Carré the carbon which is in the lamp F I B 1, and I admit, if it must be so, that it was made by Carré's process.

Mr. JUSTICE KAY: It may be material to prove that M. Carré's carbon was formed in that shape before being carbonised.

The ATTORNEY-GENERAL: Not for the purpose in view. I am prepared to submit to your lordship that it would be immaterial.

Sir HORACE DAVEY: There are some details of the process, but all I wished to establish by M. Carré was that the carbon received the shape and form in which it appears in Swan's lamp before it was carbonised.

The ATTORNEY-GENERAL: As to that I must make some inquiry.

Mr. JUSTICE KAY: Do you admit that Swan got many of these carbons?

The ATTORNEY-GENERAL: No, I just admit the fact.

Mr. JUSTICE KAY: The only admission is that F I B 1 contains a carbon made by M. Carré, and that Swan got that from Carré.

The ATTORNEY-GENERAL: I further admit that the things in the green case were purchased from Carré.

Sir HORACE DAVEY: I will prove that.

Mr. JUSTICE KAY: What I have put on my notes is:—Admits that F I B 1 contains carbon made by Carré, and admits that Swan got that from Carré; will consider if he can admit that it was carbonised after it received its present shape.

Sir HORACE DAVEY: After the very fair way in which I have been met by the Attorney-General I will not press the application to have M. Carré examined in Paris.

The cross-examination of Prof. PERRY was then continued by the ATTORNEY-GENERAL.

Was not the first publication of electrical measurement in the *Telegraphic Journal and Electrical Review* of May, 1881, by Henry Madden, Alfred Meyer, and Prof. Thomas?—No, I do not think it was.

Will you produce an earlier one?—If I hunted for it I have no doubt I could.

Will you produce at any time an earlier publication of the electrical measurements of these lamps than May, 1880?—I am quite sure I could if I had time.

You shall have lots of time—days. You began in May, 1881, and on November 25th, 1881, there was published in the *Engineer* an account of the Paris Exhibition. Have you any earlier publications than those I have mentioned dealing with the same subject matter as the Paper of 1880?—It dealt with the subject of electric measurement.

Mr. JAMES SWINBURNE, examined by Sir HORACE DAVEY, said: I have had very great experience in the practical manufacture of lamps. I first saw Edison's lamp in the Paris Exhibition buildings, in December, 1881. I examined that lamp; it was the same as Dr. Frankland's exhibit—E F 1. As a practical lamp maker, I would say that was not made in accordance with the directions in Edison's specification. I have heard the evidence of Prof. Frankland and others on that point, and do not think there is anything to add. In my opinion that lamp certainly could not have been made from the directions in Edison's specification. I was first employed as a practical lamp maker at the Swan Works, at Gateshead, in the September of 1881. I stayed about a month or five weeks, then went to Paris to take charge of the works there, where I remained four or five months; after that I went to organise or start a very large incandescent lamp works in the United States, and since then I have been manager of the incandescent department of the Hammond Company. I am now scientific manager to Messrs. Crompton and Co. I am acquainted with all the processes in the making of incandescent lamps. When I was at Swan's I saw the process of carbonisation. They employed a particular mode of packing, which was secret then, but is not so now. The process was packing each filament in charcoal powder, with a little lampblack in it—a little division of a thing like a water-colour pallet. These pallets were then packed in the same powder in a large crucible or flagon, whose lid was carefully luted, and then carbonised by a very gradual raising to a high temperature. Several precautions are necessary in order to produce carbon for a practical lamp. There is the exclusion of the air. The carbons are liable to distortion. I was present when Mr. Gimingham gave his evidence. The frame produced by him and finally adopted I recognised having seen at the Swan Works. It was in use at the Swan Works, having taken about three months to work out. Mr. Alfred Swan, brother of Mr. Swan, did a large number of experiments. The difficulty was the distortion of the filaments during carbonisation. As you carbonise the wood slowly it gives off large volumes of protecting gases, and these prevent the consumption of the filaments. Swan tried a large number of experiments, some of which were under my eye. Filaments contract very much during carbonisation; if left loose they are very much distorted, and so you have to make a frame which contracts at the same rate and at the same time as the filaments themselves. The frame described by Mr. Gimingham was exactly the same as the frame we used. So far as I know, those appliances, in the way of surmounting the difficulties I have referred to, were certainly not known in November, 1879. Lane-Fox took out a patent to obviate those difficulties. Mr. Swan took out two patents for charcoal packing, and Edison I need hardly mention. Swan's is 5,014 of 1880. The necessity for precautions such as I have described is very great. A practical filament could not be made without using some of those precautions. I have tried to make a good filament of them. I made a number of such experiments in 1883, not for the purposes of this action or any other action. I made the experiments because I wanted, if possible, to bring out a lamp which had filaments made of some material not parchmentised. In 1883 I knew the advantage of having the thread parchmentised before being carbonised. The result of a large number of experiments was that I could not make a reasonably good filament. In 1883 I had been about two years engaged in work of that kind. I had acquired some experience in manipulating. I renewed those attempts in 1884 or 1885. The result was in these experiments I used every modern improvement I knew of, and I could not make commercial lamps of cotton thread not parchmentised. I used the most improved methods I knew of carbonising. At that time I was a lamp maker but wanted to simplify the manufacture. Putty or oxide of zinc I did not try. I never heard of anybody using them for practical purposes for making a useful lamp. I once tried packing the crucible with fireclay. That was in 1883; but the filaments were destroyed. I took every precaution known to me. I tried that experiment for the same reason as the parchmentising. Having been with Mr. Swan, I did not like to start on my own account with anything. This was Mr. Swan's invention. I did not wish the imputation of an old servant using his master's process. The reasons why this fine sand did not succeed were, first, that no luting is perfectly airtight, and oxygen gets into the cells; second, that there is a quantity of oxygen in the interstices of the powder which attacks the carbon of the filament; and, third, there is probably water in the fine sand. A filament may look perfectly right, and you do not find out its defects till it is put into a lamp. I have made experiments within a day or two as to carbonising in sand. I heated some red sand in a glass retort [retort produced] to low redness; air and water came off. I calculated that there was enough water given off to consume completely some hundreds of modern filaments. I made a second experiment with another kind of sand, which gave off enough to consume some

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twenty-five to fifty modern filaments. The second sand was silver sand. I tried a third sand, grey coloured, and it gave off more water than the first. I weighed it, and found the volume of water vapour 27,000 centimetres. As to the practical result for the purpose of manufacture of filaments, I do not think packing with any kind of sand is a practical way. The copper spiral described in Edison's patent I do not think a practical way of making them. The copper would expand whilst the filament was contracting, and probably the filament would break for that reason. If the filament did expand so as to come out of the crucible whole, I think the workman would break it in manipulation. I made some experiments with regard to carbons mounted on platinum wires in 1881. I wanted, if possible, to avoid the necessity of making the large ends of the Swan filament. The result was the platinum was acted on by the carbon. The effect on the quality of the platinum was to make it very brittle, and I should think it was porous. I made a large number of other experiments in 1883 with a view to starting a Swinburne lamp. Some of the platinums were made like frosted silver, and others were quite black. I have examined the lamps which Mr. Gimingham produced. I agree substantially with everything Prof. Thompson said about those lamps. I have had some experience of flashing, and am acquainted with the process carried on at the Brush works. There are several necessary precautions observed—that the current does not increase unduly, that the filaments do not increase in diameter unduly, the less the better. In Cheesborough's process the precautions were not necessary. The purpose was to increase the diameter. As the carbon increased in size in Cheesborough's process the current would increase too. More current is required because there is a larger surface to heat. If you kept the current constant the temperature would fall as the carbon increased in size.

If I understand you rightly, as the carbon increases in size the current would itself increase?—It would of its own accord.

Examination continued: I have read Deprez's paper. Assuming the experiment on page 80 was an incandescent experiment, exactly the same thing would occur as Cheesborough mentions. Cheesborough does not add anything to Deprez. In flashing it is necessary to take precautions to prevent the current increasing, as it would if left to itself. I find no directions for that purpose in Cheesborough. Assuming the purpose of Cheesborough to be to cut sticks or pencils of carbon, the precautions I have just mentioned would not be necessary.

Would the directions in Cheesborough be sufficient to enable a workman to perform the process of flashing for the purpose you have told us?—Oh, no.

For the purpose of making carbons it would be sufficient?—Yes

I do not know whether you formed your judgment from reading Deprez's Paper as to whether he was using an incandescent experiment, on page 80?—I feel sure he was referring to an incandescent experiment.

Cross-examined by Mr. MOULTON: Do you say that in all cases, whatever be the source of your electricity, the temperature of the carbon will always increase during flashing?—Not if the resistance of the other part of the circuit is greater than that of the carbon; but that is an extreme case that I do not think Cheesborough could have contemplated.

Whether or not the temperature would fall if the carbon was left to itself would depend on the source of electricity, would it not?—It depends in a way on the source of the electricity.

In a case in which the carbon was of the same size and of low resistance, and the batteries of fairly high resistance, the temperature would fall very rapidly, would it not?—I find no mention in Cheesborough of batteries, but if Cheesborough used batteries and arranged them badly, what you say might take place.

Supposing Cheesborough was operating on a carbon of low resistance, and the batteries were of fairly high resistance, the temperature would fall very rapidly, would it not?—If you mean a whole set of batteries, it would.

In that case it would be necessary to take means to keep the temperature of the carbon up?—Certainly, it would.

You have been suggesting to his lordship that the resistance of the circuit of Deprez's batteries was high?—Certainly not.

What do you say it was?—Anything he chose. He could arrange in any way he liked.

Do you suggest if you were working a chain of batteries of ordinary pencil carbon the temperature would not fall rapidly?—Before answering the question you must tell me what you mean by a chain of batteries.

Supposing M. Deprez tried the experiment of passing electricity through carbon, as you suggest he did, in a hydro-carbon case with 100 cells arranged like that, do you suggest the temperature of the carbon would not rapidly fall as the flashing went on?—In the case of the carbon thread mentioned by him I think it would not.

In the case of either?—If he took a thick carbon and 100 single cells, arranged in series, I have no doubt the temperature would fall very quickly.

In Cheesborough's time those who used carbon in lamps used pencils of more or less considerable diameter?—I think so.

In the case of making a pencil of that diameter, or making a pencil from which other pencils could be cut, it would be necessary to take means to secure that the temperature would be kept up?—No, I think not.

I am putting to you the case of using batteries in which the interior resistance is considerably greater than the carbon?—If Deprez used batteries with the interior resistance of the whole battery greater than the resistance of the carbon he was treating, the temperature of the carbon would fall.

And so if they were equal?—If they were equal to start with they would fall.

Under these circumstances it would be necessary, would it not, to take means to keep up the temperature?—It would.

You state that Deprez was in this particular experiment on page 80 trying incandescence?—Yes.

Have you ever made a lamp like Cheesborough's?—Yes, to a certain extent like it.

Have you ever made a nitrogen lamp?—No, I have not.

Can you point to any paper which speaks of any such lamp being run at any such expenditure as 15 watts per candle-power lasting?—I cannot think of any one at the moment. I do not know whether there are any.

And you have made no experiments as to whether it is so?—No, I have not.

Do you suggest to his lordship that in 1879 it was not known that in order to conduct carbonisation carefully without destruction of the carbon, you must put carbon powder or something of that kind in the crucible?—From recent knowledge I cannot speak, as I was not in the trade then. I should think it was not known.

I am asking you whether it was common knowledge amongst chemists?—Oh, yes, amongst chemists it was common knowledge.

Do you mean to tell me anybody of ordinary chemical knowledge in 1879 would have any difficulty in understanding this question. "The whole is placed in a closed vessel free from air, and subjected to heat sufficiently to fully carbonise the fibre?"—I think they would.

Mr. JUSTICE KAY: They would have great difficulty in making the crucible free from air.

Examination resumed: Was it not well known that in the performance of such an operation carbon powder was the best way to keep it from the air?

Mr. JUSTICE KAY: No, it was not the best way of keeping it from the air; it was the best way of dealing with the air which was in it.

Examination continued: The two processes which you say were taken at Swan's factory in carbonisation were packing with charcoal powder and lampblack, and luting down carefully. In using these frames parchmentised the thread was wrapped up in long lengths?—It was.

So that the contraction of the thread in those long lengths would require some shrinkage of the wood that kept the carbon rods apart?—It would.

If the filaments were made singly—in other words, if cut before carbonised, there would be no need of that wood?—Do you mean putting the cut filament on the frame?

Cut filaments packed in charcoal in a crucible.—Cut filaments packed in charcoal in a crucible would get all sorts of queer shapes.

I would ask you whether or not the need for the wood was that you were making many filaments of continuous length?—In that particular case I should say it was.

Therefore, so far as the wood is concerned, if you were making filaments separately you would not want the wood at all? Would it not be useless?—Not necessarily.

If they were cut the wood would be of no good?—Not unless they were supported at the ends.

The Court adjourned at half-past one o'clock until the following day.

WEDNESDAY, MAY 9TH.

The ATTORNEY-GENERAL said: I desire to mention to your lordship that I have consulted my clients, and will now admit that the conductor F I B 1 received its present shape before carbonisation. I would ask my learned friend to admit—I think he has practically done so—that it came from France.

Sir HORACE DAVEY: It came from M. Carré.

The ATTORNEY-GENERAL: And Carré never was in England.

Sir HORACE DAVEY: I do not know that he never was in England. He carried on the business of manufacturing carbons, and sold them in France.

The ATTORNEY-GENERAL: I will also admit that, so far as we know, F I B 1 is made according to the description in *La Fontaine*, the translation of which was published in England in 1878.

The cross-examination of Mr. SWINBURNE was continued by Mr. MOULTON, as follows:—I refer you to articles published in *The Electrician* in the early part of last year. In the article published on February 18th, 1887, you began by saying, "Carbonising is simply raising the prepared manufacture to a high temperature out of contact with the air." That in your opinion was an accurate definition of carbonisation?—Of carbonising filaments, yes.

You go on to say, "The prepared threads or splints are placed in a closed vessel, and in a suitable furnace raised to a red or white heat?"—Yes.

You give a very long description of the exact working details of all this, and I take it that the process you describe is in your opinion a process of carbonising within the meaning of that definition?—Yes, I think so.

May I take it broadly that the methods are either to put carbon dust into the crucible itself, or to pack the crucible with carbon dust?—I think I described various other methods.

You have described an experiment of carbonising with kaolin. You say it did not succeed, first, because no luting is perfectly airtight?—I said that was one of the reasons why it did not succeed.

What kind of crucible was it?—It was either what is sometimes known as a carbon crucible or a little fireclay crucible. You might call it a fireclay crucible, I think.

Are such crucibles notoriously porous?—I do not think so.

Is it not a fact that danger arises from the oxygen which comes in through the cracks in the luting, not from that present in the crucible at first?—That is not quite the case. If your sand contains clayey matter there will be water coming off from it. Apart from the oxygen coming off the packing the destruction in long carbonisation is generally due to the oxygen getting in through the luting.

Therefore, if either outside or inside, the luting by packing charcoal dust will prevent destruction?—Yes; in a large measure.

Cross-examination resumed by Mr. MOULTON: In 1883 you applied

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for a patent, and I will read to you the last sentence of the specification, as follows:—"For joining carbons to the terminal wires I propose to employ a cement wherein the carbonaceous matter is the basis, it being incorporated with a substance, which, on being heated, itself carbonises and cements the whole into a hard mass." Was not that a proposition on your part to use that very method for the purpose of uniting it to the terminal wires?—It is not the method of Edison. I have made lamps according to that.

I think lampblack would be called carbonaceous matter?—I tried lampblack, but it would not do.

"Incorporated with a substance, which on being heated carbonises," that would be tar?—What I was prospecting at the time was fuchnia or aniline dye.

Therefore you intended to take this cement and put it on the platinum wire. You did not mean to use clamps?—No.

You intended to use the platinum wire hot?—Yes, it was put through the glass before the cement was applied.

And then you intended to carbonise them?—Not in the sense in which you have used the word carbonise.

What is your operation in carbonising?—The ones I wanted to carbonise I held on the top of a piece of biscuit box with a gas flame underneath.

Heated them in the air?—Yes. I put something on which gave off some sort of gas; many of them were spoiled, some came out right.

I may take it that in 1883 you prepared a method of joining filaments on with the cement to the glass, which were carbonised upon a platinum wire?—I have made thousands of lamps in that way.

I asked you several questions on the subject of efficiency with regard to Cheesborough's process, and you told me Cheesborough's process did not increase the life of the lamp?—I told you flashing did not.

You were writing at the beginning of last year about modern filaments?—I was writing about every sort of filament I could think of.

You were only writing about filaments which were being commercially used?—Filaments that were being commercially used, or that I thought might be so.

Well, now, I will read you a passage from a Paper which you read February 25th, 1887, and is reported in *The Electrician*, p. 346. It is as follows:—"Flashing then tends to make a carbon that will run at the same surface temperature all over, which is not of necessity a carbon of uniform resistance. This is really what is wanted in a lamp, as durability of a carbon depends upon its temperature, or rather on the temperature of its hottest or weakest part." When you wrote that you meant to say that the flashing would greatly increase the durability of the lamp?—No; I meant that flashing would greatly increase the durability of the lamp if the filament is not uniform to begin with.

You told us that you were only writing about filaments that either were or might be commercially used?—I was.

Therefore I take it, at that date, February 25th, 1887, you thought that on such filaments flashing would have that effect?—With many of the filaments I have described here flashing would be very useful in increasing the durability of the lamp.

And according to your definition that would be increasing the efficiency of the lamp?—No. Efficiency of the lamp itself means nothing.

You would have to take into consideration the life of the lamp?—Yes.

But do you mean to say if it lengthens the life of a lamp according to your own definition it would increase its efficiency?—In the popular meaning of the word efficiency it would, but in the technical meaning it would not.

What do you say of the following:—"In a lamp it is required that the carbon should be all of the same temperature, and that that temperature should be the highest the carbon can safely stand, for the higher the temperature the higher the efficiency of the lamp?"—Yes.

Therefore, when you wrote that you meant it would, with many of those filaments, increase the efficiency?—No.

Comparing the efficiency of lamps in 1879 and 1887 there are improvements which greatly increase the efficiency in respect of the higher temperature which the carbons will stand?—For a long time, yes.

Has it not been shown that the use of this very method increases the actual brilliancy at the same amount of heat of a carbon by 30 per cent.?—I may explain that several lamp makers hold some opinion of that sort, but I believe no lamp makers who are aware of the great work done on the question of radiation would differ from me.

What works do you refer to?—Kirchhoff, for one.

Re-examined by Sir HORACE DAVEY: What do you mean by efficiency?—By efficiency I mean the ratio between the power absorbed and the light given out, or, in other words, the light-giving capacity of lamps at a given temperature.

You were not speaking of durability?—No.

Why do you say that flashing would not increase the durability of the lamp if the filament were uniform to begin with?—I say, from my own experience, a uniform filament is injured by flashing. I have made experiments with lamps having filaments, flashed and unflashed, and found a lamp with an unflashed filament more durable.

Mr. ALEXANDER BERNSTEIN, examined by Sir HORACE DAVEY, said: I am an electrical engineer, and have been engaged in electric light working for about 10 years. I have been a manufacturer of incandescent lamps for the last six years, and there is a lamp which bears my name and has been largely sold in the United States, Germany, and England. My lamps are essentially low-resistance lamps. The burner in my lamp is a straight rod of carbon. The rod is supported between two leading-wires, which leading-wires are sealed into the glass. The carbon rods made at the the present time vary in length between three-quarters of an inch and two and a-half inches, and the diameter is usually ·04 of an inch, or $\frac{1}{25}$th of an inch. I have sold as commercial lamps similar to that now shown me, A B 1. They have only lately been made, and I suppose about 1,000 are in use at the present time. There are installations of these lamps working in series, not only in England, but a far larger number in the United States, where there are about 80,000 now in use in circuit. That lamp has a carbon conductor attached to leading-wires, which are sealed to the glass, and the glass exhausted of air. I went to the United States in December, 1880. I was then interested in the subject of electric lighting, and had been for two years carrying on installations. I was exceedingly anxious to see the incandescent lamps in the market, and made repeated inquiries as to the Edison lamp, of which I had seen so much in the papers, but could not find any in the market or elsewhere. I first saw an Edison lamp in February, 1881, when Edison was giving an exhibition of his lamps at Menlo Park. People were invited. I went and saw the lamps. I examined the lamp, and made inquiries regarding it. [Shown E F 1.] Edison's lamp was a lamp of this kind. The leading-wires were attached to the filament in Edison's lamp by electro-plating. They were certainly not made by carbonising putty on the platinum leading-wires. The platinum leading-wires were continuous, as in this lamp. The filament was not made in the form of a spiral, but in the form of a loop, as this one is. I am quite certain the filaments were made out of carbonised bamboo fibre. The lamp was almost identical with E F 1; of that I am certain. In my experience I have never seen a lamp made simply from the directions in Edison's patent of 1879, and, from my knowledge, I think it would be impossible to make a lamp simply from the directions in Mr. Edison's specification.

Cross-examined by Mr. ASTON: When did you see any lamps like A B 1 which are now working in series in England?—In England the first lamp of this kind was in either August or September, 1886.

Where did you see them?—I am not in a position to give such information without injuring other people's business affairs.

I do not wish to press this witness, my lord, but I would like to know where these lamps were?—They are in use in works near Northwich.

Can you tell me whether there are any of these lamps within reach of this court?—There is one here.

I am serious; can you tell me whether there are any working in an installation within a reasonable distance of this court?—Certainly, there are quite a number at Commercial-road, Pimlico.

And they may be seen there?—Certainly, I will be happy to let you see them.

Is that your factory?—Yes.

I want to know whether they are in use in any other place than in your factory in London?—I do not think there is any installation at the present time in London. There was one, but the lamps are not in use now, as the lamps are not required.

Any other places?—It would be against the business interest of those connected with me to make any publication in which we put up our installations.

Mr. JUSTICE KAY: The witness tells you he has some objection to give further information on the point. I daresay he is afraid some persons interested may come against him.

Mr. ASTON said he would not press the point.

Mr. BERNARD PROCTOR, examined by Sir HORACE DAVEY, said: I am a chemist at Newcastle-on-Tyne. I have known Mr. J. W. Swan about 40 years. In 1878-79 Mr. Swan was carrying on business in Newcastle. I was not in any way professionally connected with him. At this time, besides his ordinary business, he was engaged in electric light, photographic light, and matters of that kind. He was engaged in the construction of incandescent lamps. I met Mr. Swan almost every day. I took an interest in the construction of incandescent lamps, and frequently assisted Mr. Swan in little matters connected with the lamps. Mr. Swan showed me every step in the progress he made about the time we speak of. I was secretary of the Newcastle Chemical Society, and President some years afterwards. I was present at a meeting on the 19th December, 1878. Mr. Swan exhibited a lamp which had broken down. He explained the construction of it to the meeting. He gave me the lamp, which I broke to get at the smoky deposit inside; I then sealed it together and now produce it. [Lamp produced.] That is the glass of the identical lamp produced by Mr. Swan, but does not contain the platinum or the carbon. That lamp has never been here before. The conductor was like F I B 1. The general construction was exactly the same. I remember being present at Mr. Swan's lecture at the Literary and Philanthropic Institute at Newcastle on 3rd February, 1879. He then exhibited a lamp and explained its construction. It was like F I B 1 now shown to me. My impression is that the lamp at the lecture had a thinner leading wire and a thinner carbon conductor. I produce wires which according to my recollection represent what was exhibited on that occasion. At that lecture the lamp was lighted with a dynamo machine. The lamp burned steadily from the time of lighting till it was put out by turning off the electricity. It could scarcely be called a good light compared with the lamps made now in 1888. There was an audience of 20 or 30 persons at the meeting of the Chemical Society in December, 1878. At the lecture in February, 1879, there was an audience of 600 to 800. On the 27th of March, 1879, I read a Paper on the smoke of an electric lamp before the Newcastle Chemical Society. The lamp I used then was this very broken lamp now produced. After the lecture in February, 1879, I continued to assist Mr. Swan in his researches. The examination of the smoke was made to assist him. I saw other lamps besides those used at the lectures, both before and after. I saw them in the various establishments of Mr. Swan. After the lecture of 3rd February, 1879, and before November, 1879, Mr. Swan made many improvements on his incandescent lamps. Within a day or two of the lecture Mr. Swan pointed out to me that the lamp could not be permanently a satisfactory one; he was aware that it took a large current. He also pointed out that the rigid connection of platinum, carbon, and glass were a source of weakness. I set to work to improve the lamp in these respects.

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He endeavoured to remedy those defects by thinner carbons, and by making arched carbon, so as not to have leading wires at opposite ends of the lamp. During the period to which my attention has been directed I saw many other lamps besides those I have spoken of made by Mr. Swan, amounting probably to hundreds.

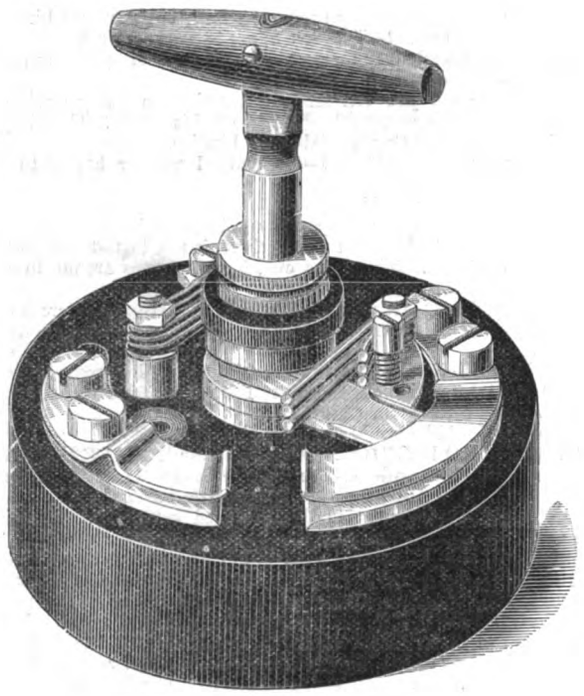
The ATTORNEY-GENERAL said he would submit that the seeing of those lamps by the witness at Mr. Swan's was not within the particulars of the case.

[Mr. BERNARD PROCTOR'S examination was continued at some length. Mr. A. W. HEAVISIDE was the next witness called, and the Court rose before his evidence was completed. On Thursday Mr. A. W. HEAVISIDE'S examination was concluded, and after some further evidence the Court again adjourned.

We are, however, unable to find room for the whole of the evidence down to the time of our going to press, preferring to stop short at Wednesday's proceedings rather than curtail the verbatim report, which we shall continue next week.]

SWITCHES FOR CONNECTING AND DISCONNECTING LAMPS AT VARIOUS POINTS IN THE CIRCUIT.

In our issue of the 20th January we described a simple method of arranging the wiring of incandescent lamps so that the same



lamp or group of lamps might be turned on or off from two different points. In the succeeding issue Mr. R. H. Neville pointed out that the device might be extended so that the same lamp or lamps might be turned on or off from as many different points as might be desired. A similar arrangement of 2-way switches has frequently been used in telephone work, in which the wits of the engineer are sometimes hard tested to provide subscribers with simple arrangements for all the combinations of circuit they require to be able to effect. For electric lighting purposes, however, we believe that the device was not in use before we drew attention to it.

The United Electrical Engineering Company inform us that they are now making switches of this design for a large retail establishment in London. They are to be used in the "furnishing" department. The attendant enters at one end of the gallery with a customer, and reverses the switch, thus lighting up; as he passes through the door at the other end he reverses the switch fitted there, and thus extinguishes the light. The switch is mounted upon a substantial slate base, and cannot be left in a neutral position; this, of course, is essential.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY.—The directors recommend a dividend at the rate of £5. 7s. per cent. per annum for the year ending the 31st March, inclusive of the interim dividend paid in November last. A year ago the dividend was at the rate of 5 per cent., and there was a payment of 1s. per share by way of return of capital.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED) v. LA COMPAGNIE FRANCAISE DU TELÉGRAPHE DE PARIS À NEW YORK.

In our issue of the 13th January last we gave some particulars of this action, which was commenced in the Tribunal of Commerce of the Seine, and the judgment of that Court is given at length in our issue of the 27th January. The French Company appealed against the judgment to the Court of Appeal in Paris, and the appeal was heard on the 10th, 11th, 12th, and 27th April. The appellants were represented by M. Durier and M. Rodolphe Rousseau, and the Anglo-American Company by MM. Barboux and Nerot.

The arguments took place on the first three days, and on the 17th April the Advocate-General (M. Manuel), who appeared on behalf of the State, addressed the Court in a very able and comprehensive speech, which sets out all the facts of the case, and renders it unnecessary to report the speeches of the advocates on either side.

In the course of the discussion the appellants denied the competence of the Tribunal of Commerce to deal with the case, and repudiated the admission made by their counsel before that Tribunal that M. Cochery, the Minister of Posts and Telegraphs, in 1881 told M. Pouyer-Quertier, the President of the French Company, that his consent to the joint-purse agreement with the English Companies was unnecessary.

By the terms of the Concession held by the French Company all questions between the concessionnaire or the Company and the Government in relation to the Concession are to be decided "administratively by the Council of the Prefecture of the Department of the Seine, with appeal to the Council of State."

It will be seen from the report now given that the Court of Appeal has decided in favour of the Anglo-American Company upon the question of the competence of the Tribunal of Commerce, but has directed that the proceedings be stayed and final judgment postponed until the Administrative tribunals have decided the question whether the joint-purse agreement did or did not require the consent of the Government.

We understand that the case will be brought before the Administrative Tribunals as early as practicable.

The ADVOCATE-GENERAL expressed himself as follows:—Gentlemen, I think I may say without any exaggeration that the matter which has been submitted to the consideration of the Court presents itself under circumstances of fact rather exceptional, and which the Court will allow me to recall to it. It was in 1865 that the first transatlantic cable which was to connect Europe with North America was laid by an English Company, called the Anglo-American Telegraph Company—the respondent in the present action. Three years later, in 1868, the French Government granted Messrs. Erlanger and Reuter the exclusive right for twenty years of laying cables between France and the United States. Messrs. Erlanger and Reuter, in order to work this concession, had to, and in fact did, form with the aid of French capital a Company of the English kind. This Company necessarily entered into active competition with the Anglo-American Telegraph Company. This competition becoming disastrous to both Companies, they thought of amalgamating, and in 1873 the amalgamation between the two Companies was carried out with the consent of the French Government, which, however, made it a condition of giving its consent that it should resume its liberty of action, and that in future it should have the power of granting other cable concessions. The Anglo-American Telegraph Company consequently completely absorbed that which Messrs. Erlanger and Reuter had formed, and thus remained the only Company possessing transatlantic cables.

In 1875 another Company was formed in London for the working of a transatlantic cable—the Direct United States Cable Company. This new Company also entering into competition with the Anglo-American Telegraph Company, an agreement was brought about between them—a *modus vivendi*—which it has been agreed upon to call "the joint-purse arrangement." Making use of the liberty which it had recovered when it gave its consent to the amalgamation of the Anglo-American Telegraph Company with that formed by Mr. Erlanger, the French Government, represented by the Minister of Finance of the day, M. Léon Say, on the 7th January, 1879, granted to M. Pouyer-Quertier for himself and for the Company which he was about to form, the permission to land upon the French coast one or more cables for the purpose of connecting France with the United States. A schedule of conditions was annexed to this Concession, and in this schedule of conditions there is an Article 9 which plays an important part in the present contest, and which runs as follows:—

"The grantee, or the Company which may be formed by him, shall neither transfer any of the rights conferred by these presents, nor lease its lines, nor amalgamate its interests with those of any other Company, whether French or foreign, which is the concessionary of submarine transatlantic cables, without the express and written consent of the Government."

Beside this article, there are several others about which I must say a word. The first is Article 13, which runs as follows:—

"The authorisations conferred by these presents would become legally null and void, firstly, . . . secondly, . . . and thirdly, in the event of

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failure to carry out the other essential clauses of the present Concession, and specially those formulated in Articles 9 and 11, as above."

As regards Article 14, it stipulated that in the event of the interpretation of the Concession giving rise to any differences between the Government and the concessionary, these differences should be submitted to the Council of Préfecture of the Department of the Seine, with the right of appeal to the Council of State.

The day after the Concession had been granted to M. Pouyer-Quertier—that is to say, on the 8th January, 1879—M. Pouyer-Quertier formed a joint-stock company under the title of "*Compagnie Francaise du Télégraphe de Paris à New York*," with an authorised capital of 42 million francs. It is this Company which is the appellant in the present suit. From that time there were three Companies in possession of transatlantic cables connecting Europe and America—the Anglo American, the Direct, and the French Company. There arose, as was bound to be the case, a war of rates between the two allied English Companies and the French Company. It is superfluous to say that this war of rates was injurious to all three Companies, but it was more particularly ruinous to the French Company. This war of rates was terminated by an arrangement, which was embodied in the Convention of the 24th September, 1880, which forms one of the main elements of the contest, and on which, therefore, I shall be obliged to dwell.

What, then, is the sum and substance of the Convention of the 24th September, 1880?

This Convention comprises several Articles. First of all, a word upon Article 1. This Article, which I will not read again, but only summarise, sets forth that the agreement—the subsequent Articles of which make known the scope—shall only become definitively binding after being ratified by the shareholders of the French Company assembled in general meeting, and provided that the Government authorisations which might be necessary shall have been obtained. Agreeably to the terms of Articles 2 and 3 of the same Convention, the receipts of each of the Companies for all the traffic traversing the Atlantic Ocean, after first deducting certain amounts due to the French and English Governments, shall be paid into a joint purse, and then the product of the joint purse shall ultimately be divided in the following proportions:—84 per cent. for the English Companies and 16 per cent. for the French Company. I shall shortly have occasion to give the explanation of these figures. The Court knows the working of this joint-purse arrangement. The product of the despatches forwarded to the other side of the ocean is always collected in France by the French Government. When a private individual hands in at a telegraph office a despatch, which despatch is to be forwarded to America, he pays the cost of the message, indicating the Company over whose line he wishes his telegram to be transmitted to its destination. Every three months an *employé* of the Government makes up a statement of the amounts received on account of each of the Cable Companies by the telegraph *employés*. After certain deductions have been made in favour of the French Government the balance is paid into the joint purse, where it swells the amounts paid in by the other Companies. At fixed periods the contents of the joint purse are ascertained, and distributed in the proportions mentioned. Thus much as regards the constitution of the joint purse. I must now say a word on Article 8 of the Convention. This Article is not without some importance in the case. It runs as follows:—

"The share capital of the Companies, and all properties, Concessions, authorisations, risks and perils respectively of the companies, shall remain entirely separate, independent, and distinct. . . . The results, good or bad, of their respective undertakings shall continue to belong each to their respective account. Lastly, it is expressly agreed and declared that there is neither amalgamation nor fusion of interests between them, but simply a *working arrangement* or agreement, leaving each Company its administration, direction, and particular *employés* and agents, who remain under the conditions of the present Convention entirely independent as regards the traffic, and free from all control or interference on the part of any one of the other Companies whatever."

Again, Article 10, which it is important to recall here, has for its object the fixing of the conditions of what has been called the Interruption Convention. It is an Article agreeably to the terms of which, when one of the Companies shall find its cable temporarily defective or broken, it may apply to another Company to forward its messages over that Company's cable. To this Convention of the 24th September, 1880, is annexed another Convention which the English documents term "Schedule," and which relates to the tariffs and regulations. Agreeably to the terms of the 1st Article, paragraph 1, of this schedule it is stated:—

"The charge for all telegrams between London and Paris and New York, forwarded over the lines of the three Companies, shall be such rate as shall from time to time be agreed upon between them."

Then, in paragraph 2 of this same Article, which in the printed copies has only two paragraphs, but which in reality in the original text must have had three, it is stated that until a new agreement is made the French Company shall receive 2s. per word as a minimum, and shall have the power of raising the tariff per word up to the maximum allowed by the Deed of Concession. The third paragraph of this Article 1 sets forth that the English Companies may at any time fix their tariffs as they like, but they shall not go below 2s. without the consent of the French Company. Then the same day the allied Companies entered into a subsequent Agreement, in which it was stipulated that the French Company should submit the Convention which had been entered into to the French Government, and should do its best to obtain its approval within a certain time.

On the 12th January, 1881, the shareholders of the French Company, assembled at an extraordinary general meeting, ratified by an imposing majority the Convention of the 24th September, 1880, together with the schedule annexed to it. On the 14th January this Convention was also ratified by the English Companies. A few days afterwards, on the 17th January, 1881, a further Convention was entered into between the French Company and the English Companies, the Convention which has been called "secret." I will shortly explain the relevancy of this word. What was this secret Convention? It is of great importance in the present contest.

The general meetings of the three Companies (it is stated in this Convention) duly ratified the original Convention. The French Company having submitted the said Convention to the French Government was assured that, agreeably to the true interpretation of its Concession dated the 7th January, 1879, this Convention did not require any approval of the French Government. The Convention of the 24th September, 1880, became definitely binding and was put into force.

On the 12th May, 1882, another Convention was entered into, that between the Anglo-American, the Direct and the French Company of the one part, and an American Company called the American Cable Company of the other part. The object of this Convention of the 12th May, 1882, was to admit the American Company to the benefits of the joint-purse arrangement, only the proportions in which the joint-purse was to be divided were altered. Agreeably to the Convention of the 24th September, 1880, the French Company took 16 per cent. of the total product of the joint-purse. By the terms of the Convention of the 12th May, 1882, it would not take more than 12½ per cent. The Convention of the 12th May, 1882, effected another modification in the Convention of the 24th September, 1880. The Court will remember the provisions of Article 1 of the annexed Schedule. Agreeably to the terms of paragraphs 2 and 3 of this Article the English Companies had a certain right relative to the fixing of their tariffs; but the paragraph states that the English Companies should never lower the tariff below 2s. per word, without the consent of the French Company. By the Convention of 12th May, 1882, paragraphs 2 and 3 of Article 1 of the schedule annexed are simply entirely suppressed.

For the present this is all I need remind you of respecting the Convention of 12th May, 1882. But this is not the only Convention entered into at that date. On the same day the four Companies which had just made the preceding Convention treat with four land line Companies, at the head of which is a Company called the Western Union. In this second Convention the contracting Companies undertook to hand over to each other the messages which had to be forwarded over each other's lines, and the American Companies undertook to establish at New York a central office as a terminus for all the telegrams. It was a sort of traffic arrangement, on which there is no occasion to dwell at any length, since it presents no difficulty as regards the present suit. It is desirable, however, to call the attention of the Court to a special point of this second Convention of the 12th May, 1882.

In addition to its cable connecting France with the United States, the French Company possessed on the American soil land lines extending from Cape Cod, the landing point of its cable, to New York. Now, the second Convention of the 12th May, 1882, contains, relative to these land lines, the following stipulation:—

"The land lines of the French Company between New York and Cape Cod, Taunton and Boston, and between Louisberg and North Sydney, shall be considered as a portion of the system of the parties of the second part (these were the American Companies) during the term of the present Agreement, but the French Company shall preserve not the less intact the full and entire ownership of the said lines, as stipulated in Article 12 of the present Agreement."

And in this Article 12 it is stated that the Western Union Company shall, at its own cost, maintain the lines in question in good working order. This is the only point to bear in mind in this second Convention of the 12th May, 1882. The land lines belonging to the French Company upon the American Continent shall be considered as forming part of the system of the American lines; but their ownership is nevertheless vested absolutely in the French Company. The maintenance and management, however, of these land lines shall devolve on a Company called the Western Union. This clause it seems has given rise to great disputes between the French Company and the Western Union—disputes which have been brought before the American tribunals, but with which the Court has no concern whatever in the present suit. All these Conventions were carried out up to the end of the year 1886, and as regards the principal one—that of the 24th September, 1880—it was carried out for nearly six years. But on the 30th December, 1886, the Minister of Posts and Telegraphs wrote a letter to the Managing Director of the French Company, which is worded as follows:—

"I have received the documents which I had asked you for by letter of the 23rd October last. Their examination shows that your Company, by amalgamating its interests with those of the Foreign Companies, is no longer under the conditions provided for by the cahier des charges (schedule of conditions) of the 7th January, 1879."

The very next day the Managing Director of the French Company acknowledged the receipt of this letter in the following terms:—

"Monsieur le Ministre. I acknowledge the receipt of your letter, &c., and I hasten to inform you that the Board of my Company, summoned as as of urgency, has just taken the necessary steps to put an end to the position the irregularity of which you point out."

We may do the Managing Director the justice to say that he acted with unprecedented rapidity, for the same day, December 31st, he not only assembled his Board, he not only replied to the Minister, but he also wrote to each of the Companies, parties to the Convention of the 12th May, 1882, communicating to them the Ministerial letter, and adding to it as follows:—"I have therefore the honour to inform you that, beginning from this day—December 31st—which closes the 1886 accounts, terminates the community of interests in which, according to the declaration of the Minister, we find that we have irregularly existed from the first of our Conventions up to the present time."

On the 17th January, 1887, the Minister acknowledged the receipt from the Managing Director of the French Company of the letter of the 31st December, saying:—

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"By your letter of the 31st December you informed me that your Company's Board, summoned as of urgency, had just taken the necessary steps for putting an end to the position the irregularity of which I had pointed out to you. These steps can only be the denunciation of the agreements entered into between your Company and the foreign companies. I take note of your notification."

The allied Companies were not willing to admit that Conventions which had been in operation for six consecutive years should thus be suppressed by a stroke of the pen. This is why the Anglo-American Company summoned before the Tribunal of Commerce the French Company to have it declared that this Company should be made to resume the execution of these Conventions, under a penalty of 5,000 francs for each day's delay; and to have it condemned, in addition, to pay damages representing as many times 5,000 francs as there should be days elapsed between the 31st December, 1886, and that on which the execution of the Conventions should be resumed.

On the 9th January, 1888, was given the judgment appealed against. There is in this judgment a hiatus which is evidently attributable to an omission on the part of the copyist. The judgment mentions the Convention of the 12th May, 1882, only, and not that of the 24th September, 1880, which is the more important of the two. The grounds of the judgment are substantially the following:—If the Conventions entered into between the Companies, says the judgment, were only to take effect after obtaining the Government approval which might be necessary, it is acknowledged at the Bar of the Tribunal, and not denied:—1st, that the approval was asked for by the French Company; 2nd, that the Minister then in office declared his approval unnecessary because the Conventions did not fall within the scope of Article 9 of the Schedule of Conditions of the Concession granted to M. Pouyer-Quertier; 3rd, that upon the faith of this declaration the Conventions entered into between the parties were carried out during six consecutive years. The Ministerial letter of the 30th December, 1886, is therefore at variance with the preceding declaration. The mode in which it interprets the Conventions is new and unexpected. It cannot, under these circumstances of fact, constitute a case of "*force majeure*," for it is not even a command. Besides Article 14 of the Schedule of Conditions reserved to the French Company, in the event of any difficulties arising respecting the interpretation of its Schedule of Conditions, recourse to the Administrative jurisdiction. By failing to exercise this right, the French Company violated Conventions the maintenance of which was confided to its good faith, and gives ground for thinking that it was to its interest not to carry them out.

These, summed up in a few words, are the grounds of the judgment appealed against. As regards the decision itself, it is to the effect that the French Company shall resume the execution of the Conventions of 1880 and of 1882, until such time as the competent judicial authorities shall have definitively decreed as to the value of the Ministerial declaration of the 30th December, 1886, and this under a penalty of 5,000 francs damages for each day's delay. Then the judgment concludes with a condemnation to pay 2,000 francs for each day which may have elapsed from the 30th December, 1886, up to the day of the carrying out of the Conventions being resumed.

In the face of this judgment we have to examine two questions. First of all, we have to ask ourselves if the judgment has made a sound appreciation of the facts of the case? And afterwards, whether the judicial solution which it has given to them is acceptable to the Court? The first question which is raised by this dispute is this. Did the Convention of the 24th September, 1880, come within the provisions of Article 9 of the Schedule of Conditions, and was the Government approval necessary to make the Convention of the 24th September, 1880, possible, in order, and executory? No; say the English Companies. The approval was not necessary, because in Article 8 of the Convention of the 24th September, 1880, it had been expressly stated that there was no amalgamation—no fusion of interests—between the three contracting Companies. On behalf of the French Company it was replied to this that it was impossible to fail to acknowledge that on account of the creation of the joint purse there was at least a fusion of interests between the three Companies.

We are not required to give our opinion upon the first point. The solution of the difficulty can only appertain to the competent Minister. In 1881 three courses were open to the competent Minister—either to have authorised the execution of the Convention of the 24th September, 1880; or to have said that he refused to give his approval to the execution of this Convention; or to have said that there was no ground either for approval, or for its refusal, because the approval was not necessary seeing that the Convention of the 24th September, 1880, did not come within the prohibition of Article 9 of the Schedule of Conditions. It is certain that the competent Minister did not give any express and written approval. It is equally certain that he did not give any refusal of his approval. But the first judges say, that if the competent Minister neither granted nor refused his approval, it is because he deemed such approval was not necessary. The first judges add that certainly there was no document expressly stating this decision of the Minister; but that it was shown by matters of fact absolutely certain, and which were of a character to bring conviction to their minds. Is this estimate of the first judges correct? We believe so. It is based upon the acknowledgment at the bar by the two parties to the suit, that the Minister had declared that the Convention which was submitted to him did not come within the prohibitions of Article 9. That is what the tribunal expressly says, commenting upon what passed at its bar.

Observe that not the slightest attempt has been made to allege that the tribunal has misunderstood, and that it has given any other than their proper meaning to the words of the Agréé who had the honour of addressing it. Only before this Court the Appellant Company comes and says that if the tribunal made no mistake, the Agréé, to make amends, spoke with lamentable carelessness, that he made an incorrect statement which he had received no authority from his clients to make, and that if he had kept to his instructions he would have made an absolutely contrary statement. Is there ground for now admitting the disavowal thus thrust upon the Agréé? First of all, then, who conducted the defence of the French Company before the Tribunal of Commerce? It was Maitre Lignereux. The Court knows that he is one of the busiest and most experienced, as well as one of the most careful, Agréés of the Tribunal of Commerce. It seems to me utterly inadmissible that, making a speech in an affair of the importance this is, Maitre Lignereux should have lightly made this most material and most important statement, for the whole case lay in this statement. Admitting, which is impossible, however, that he did make this grave mistake, as his statement was most material, and would form the basis of the judgment, the final consideration having lasted a month, a letter of correction would have been received on this point, either from the French Company or from Maitre Lignereux himself, who would have had his mistake pointed out to him. Having stated this, Now can we doubt that the language of Maitre Lignereux was that which the first judges retained and recorded? How can we doubt it, in the face of the stubborn facts which we must now review?

On the 9th October, in execution of the Supplementary Convention, the French Company had at once applied to the competent Minister, the Minister of Posts and Telegraphs, for approval, foreseen by the Convention of the 24th September, 1880, and under date of the 22nd October, the Minister replied to M. Pouyer-Quertier:—

"By your letter of the 9th October instant, you submitted for my examination the agreement entered into between the Anglo-American Company, the Direct United States Cable Company, and the 'Compagnie Française du Télégraphe de Paris à New York' for the working of their cables. In order to complete the study which my department is making of the subject, I shall require to be in possession of various documents which are connected with this agreement., viz.":—[Here follows a list of the documents asked for].

The French Company immediately placed itself in communication with the Anglo American in London, which alone was able to forward some of the documents asked for by the Minister. It was in consequence of these communications that the general meeting of the shareholders of the French Company of the 12th January, 1881, was held, a meeting convened specially to consider the import of the Convention of the 24th September, 1880. And the Court will not have forgotten that at this meeting an important personage was present—we mean the delegate of the Minister. It is five days after this that we have the Convention of the 17th of January, 1881, in which it is stated that the French Company, having assured itself that, according to the correct interpretation of its Concession, dated the 7th January, 1879, this Convention did not require any approval of the French Government, it had been decided and agreed, &c., &c.

In the face of the facts which we have just brought out, has not this Convention of the 17th January, 1881, a special bearing and significance? It has been said that this Convention was a secret one. But for whom? For the public? Perhaps so; but there is no provision of the law requiring that this Convention should be made public. Secret as regards the parties interested? Yes, it has been said this Convention was kept secret from the shareholders of the French Company, by whom it should have been ratified. The answer to this is simple. There was not the slightest reason for getting the shareholders of the French Company to ratify a Convention entered into in order to show they were agreed that the Minister had declared that the Convention did not need to be approved. But is it really true that the Convention of the 17th January was a secret one as regards the shareholders of the French Company? The reverse is certain. For in the report which was submitted to them by the Board at the ordinary general meeting of the 11th May following we read as follows:—

"We will simply say to-day that we are glad that we proposed this Convention to you, and that the results are of a character not to make you regret having approved it. . . . Anxious at once to reap the benefit of it, we satisfied ourselves that the Government authorisations mentioned in Article 1 of the Convention were not necessary for us. From that time, nothing further preventing the Convention coming into operation, we agreed with the English Companies to put it into force forthwith."

It is therefore certain that it is somewhat to meet the requirements of the case that the Convention of the 17th January, 1881, has been termed a secret one. On the contrary, this Convention was not secret to anyone; it was known to all whom it could concern. What is the sum and substance of what is said respecting this Convention? It is said that the language attributed to the Minister of Posts was not held by him, and that the Directors of the French Company then in office deceived the Directors of the English Companies when they came to them, saying: We have satisfied ouselves by application to the Minister that his approval was not necessary. Who, then, is it that says that? It is the French Company itself, represented, it is true, by other Directors, but still it is the French Company, which for six consecutive years reaped the benefit of the Convention.

Now, who are they who are thus alleged to have played upon the credulity of the English Directors? They are honourable men, most of them very well known. They had at their head M. Pouyer-Quertier, Senator, formerly Minister of Finance and Minister Plenipotentiary, and who, in virtue of his position, necessarily found easy access to the Minister of Posts and Telegraphs. And these are the men who it is alleged banded themselves together to deceive the good faith of the English Directors! It is very difficult to believe this. Granting, however, for the moment that M. Pouyer-Quertier lied—for it was he who on behalf of the Board signed the Convention of the 17th January, 1881. Granting that he condescended to what has been characterised at the Bar as a trick of legerdemain. What *rôle* would they make then the Minister play? This high functionary

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must then substantially have replied :—"I will not give you my approval —I will not refuse to give you the approval which you apply for either. Do what you like. Go! Make contracts, involve the most important interests. And if by chance I should happen to leave the Ministry, well, I shall be replaced by another Minister who will enjoy the same power as myself, and you will always be at the mercy of the caprice of the Administration!"

On such an assumption what opinion should we form of the good faith and justice of the Minister of the time, particularly when it is certain that he knew everything before the Convention was concluded, at the moment of the general meeting which ratified it, and subsequently to this ratification. The Court will remember that letter of the 24th August, 1882, which was read to it by the worthy Counsel of the Anglo-American Telegraph Company—a letter emanating from M. Pouyer-Quertier, and which was addressed to the Minister of Posts and Telegraphs. This letter related to questions of modifications of tariffs. The approval of the Minister was necessary in order to make these modifications. And M. Pouyer-Quertier, reminding the Minister of the interview which had taken place between them, says to him :—"I cannot agree to such and such of your demands because I must (first) have the assent of the parties who are interested with me."

Who were these parties interested with him? They were the Anglo-American, the Direct and the American Company—in a word, the parties to the Convention of the 12th May, 1882. And when M. Pouyer-Quertier thus spoke of the co-operation and approval necessary from the parties interested with him, it is obvious that the Minister of that time was perfectly aware of the Conventions of 1880 and 1882, particularly those of 1880, which had formed the object of special study on his part. Here there is a document which has a certain importance, and which has not been read to the Court. It is a letter dated the 2nd March, 1885, addressed by M. Riant, one of the Directors of the French Company who replaced the Chairman, to Mr. Weaver, Managing Director of the Anglo-American Telegraph Company, relative to the establishment, in the interests of both Companies, of a special wire from Brest to Havre. It is thus worded :—

"Dear Sir: By invitation given him by M. Cochery, M. Pouyer-Quertier this morning called at the Ministry of Posts, where he met your representative, who had also been summoned by the Minister. At this interview the following proposals were made. . . . Their object is to enable us to compete as advantageously as possible with the Commercial Cable Company."

And thereupon a long correspondence ensued, not only between the two Companies, but also between them and the Minister. In the face of all these facts, we declare that we entirely share the opinion of the Tribunal of Commerce.

The approval of the Minister was asked for in 1880, and at a date corresponding to that of the Convention of the 17th January, 1881, the Minister replied that his approval was not necessary. It is now that intervenes this Convention, which became the starting point of the execution of the Convention of the 24th September, 1880. But here an objection arises, which does not seem to have been submitted to the first judges, and to which the attention of the Court must be called; and all the more as in the note which has been circulated since the last sitting, on behalf of the French Company, this objection is taken up with much force. Let us examine it. The French Company says there is not only the Convention of the 24th September, 1880, there is also that of the 12th May, 1882. Now, if it may be considered that approval was asked for the Convention of the 24th September, 1880, and if it may be granted that the Minister replied that his approval was not necessary, it is certain that approval was not asked for the two subsequent Conventions of the 12th May, 1882, and that consequently the Minister could not have replied as to these that his approval was not necessary. Now, adds the French Company, the approval was all the more indispensable for these two Conventions of the 12th May, 1882, as they made the position of the French Company considerably worse than it was made by the Convention of the 24th September, 1880. In point of fact, it is said, the French Company, agreeably to the first of the two Conventions of the 12th May, 1882, took no more than 12½ per cent. of the product of the joint-purse. It lost its right of veto to the reduction of the tariff by the English Companies below 2s. per word. Then, agreeably to the Second Convention of the 12th May, 1882, the French Company leased its land lines on the American Continent to an American Company. Here was a veritable transfer of rights to which most certainly Article 9 of the schedule of conditions should be applied.

On behalf of the respondent Company it had been answered, and the answer is true in point of fact, that the Government approval was not explicitly stipulated in the first Convention of the 12th May, 1882, as it was in the Convention of the 24th September, 1880; that it was merely stated that the necessary authorisations should be obtained, and beyond the Government approval there were other authorisations to be obtained; that from the moment the Minister declared that his approval was not necessary for the Convention of the 24th September, 1880, it was not so either for that of the 12th May, 1882, because in fact it is a mistake to allege that this Convention, as well as that of the same day with the Western Union, changed for the worse the position which had been made for the French Company by the Convention of the 24th September, 1880.

The last estimate seems to us correct. And on this point the Court will allow me to enter into a few details which are not devoid of interest. First, agreeably to the terms of the Convention of the 24th September, 1880, the French Company took 16 per cent. of the product of the joint-purse. Under the Convention of the 12th May, 1882, it only took 12½ per cent. This question of proportion, when once the principle of the joint-purse is admitted, is of no importance. There is, however, one explanation which it is desirable to give the Court. When the Convention of the 24th September, 1880, was entered into, the contracting Companies possessed six cables amongst them, of which only one belonged to the French Company. One-sixth of the joint-purse was apportioned to it. When the Convention of the 12th May, 1882, with the American Company was entered into, the four contracting companies possessed eight cables amongst them. The French Company still had but one, and an eighth was allotted to it. It is unnecessary to dwell any longer on this first point.

Now, as to the allegation that by the Convention of the 12th May, 1882, the French Company lost the right of opposing the reduction of the tariff below 2s. per word, it is perfectly true that by the suppression of the two last paragraphs of Article 1 of the schedule annexed to the Convention of the 24th September, 1880, it is no longer stated that the English Companies shall not have the power of reducing the tariff below 2s. without the approval of the French Company. But it is not the less a fact that this reduction cannot take place without its consent. The Court will remember, indeed, the terms of Article 1 of the schedule. It is worded as follows :—

"The rate for all telegrams between London, Paris, and New York, forwarded over the lines of the three Companies, shall be such rate as may from time to time be agreed upon between the Companies."

This assumes the agreement of the contracting Companies.

Here, now, is Article 4 of the Convention of the 12th May, 1882 :—

"The tariff arrangements in pursuance of the present agreement shall remain the same as those borne on the schedule annexed to the agreement of the 24th September, 1880, which schedule, with the exception of the last two paragraphs of Article 1, and with the exception of the changes introduced into it by the present agreement, is hereby adopted by the contracting parties. But the rate for the transmission of cable messages between Europe and America, with the exception of those referred to in paragraph 2 of the said schedule, and of the service messages, shall, as soon as the necessary arrangements can be made, be raised to 2s. per word. It shall be maintained at this until it may be otherwise agreed by the contracting parties."

The tariff, therefore, cannot be lowered without the assent of the contracting parties. It has been argued, however, that the French Company might find itself in the minority, and that it would then be obliged to support the decisions of the majority. This, in our view, is a wrong interpretation both of Article 1 of the schedule, and of Article 4 of the Convention of the 12th May, 1882. It is obvious that, in order to modify the tariff rate, the four Companies must be in accord. It is thus that the French Company itself, as represented by the present Board, understands the matter. Here in fact is what was said to the shareholders at the general meeting held on the 25th May, 1887 :—

"Before making this concession (reducing the tariff to 60c.), had all the means of resistance conferred by the Conventions been exhausted?—We think not; and we persist in affirming that in virtue of Article 1 of this Convention, an absolute veto could be opposed to any reduction of tariff."

From this point of view, therefore, no alteration has been effected in the rights of the French Company by the Convention of the 12th May, 1882. But there remains a last point, the leasing of the land lines by the French Company. In the note which has been put in since the last sitting, this point is insisted on, and it is said the leasing of the land lines is unquestionably a transfer of rights, and so irrefutable is this proposition that even the opposite side has found nothing to reply to it. For our part we cannot admit the argument. The leasing of the land lines has nothing to do with the question. The French Company doubtless established them in virtue of a concession from the American Government. No doubt when the French Company came to take part in the second Convention of the 12th May, 1832, it was stipulated that these land lines should be in a certain measure abandoned by it from the point of view of actual possession. But it was stated at the same time that it would retain the ownership of them, and that only the management and maintenance of them would devolve on the Western Union Company. On what ground, then, should this special arrangement have been submitted for the approval of the Minister? Did it come under the application of Article 9? Was the Western Union Company the concessionary of submarine transatlantic cables? No; it was the concessionary of land lines. It follows as a consequence that the alleged leasing of land lines cannot be considered as coming under the prohibition of Article 9.

To sum up this part of the case, which has remained entirely outside the grounds of the judgment, it is true to say that if the Government approval was not necessary for the Convention of the 24th September, 1880, neither was it for the Conventions of the 12th May, 1882, since they did not alter the position of the French Company, as created by the preceding Conventions.

Let us now return to the consideration of the opinions of the first judges on the facts. After having established the fact that the Minister of Posts and Telegraphs of 1881 had deemed his approval unnecessary, they say that the interpretation arising out of the letter of the 30th December, 1886, was new and unexpected. New, it certainly was. No discussion is possible on this point. One might have even added "contradictory." Unexpected, there is no doubt about it, at least as regards the English Companies.

It must be admitted that the first judges characterised with some severity the conduct of the French Company in saying that it was wanting in good faith, and that it was permissible to assume that it was to that Company's interest that the Convention which it had voluntarily entered into with the English Companies should not be carried out. A few words only upon these two points. The Court is aware that in December, 1885, a new Transatlantic Cable Company was formed called "The Commercial." It is an American Company also known under the name of "The Mackay-Bennett Company." The Court knows that Mr. Mackay is a rich American, and that Mr. Bennett is the proprietor of a well-known American journal, the *New York Herald*. The Managing Director of the Commercial Com-

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"By your letter of the 31st December you informed me that your Company's Board, summoned as of urgency, had just taken the necessary steps for putting an end to the position the irregularity of which I had pointed out to you. These steps can only be the denunciation of the agreements entered into between your Company and the foreign companies. I take note of your notification."

The allied Companies were not willing to admit that Conventions which had been in operation for six consecutive years should thus be suppressed by a stroke of the pen. This is why the Anglo-American Company summoned before the Tribunal of Commerce the French Company to have it declared that this Company should be made to resume the execution of these Conventions, under a penalty of 5,000 francs for each day's delay; and to have it condemned, in addition, to pay damages representing as many times 5,000 francs as there should be days elapsed between the 31st December, 1886, and that on which the execution of the Conventions should be resumed.

On the 9th January, 1888, was given the judgment appealed against. There is in this judgment a hiatus which is evidently attributable to an omission on the part of the copyist. The judgment mentions the Convention of the 12th May, 1882, only, and not that of the 24th September, 1880, which is the more important of the two. The grounds of the judgment are substantially the following:—If the Conventions entered into between the Companies, says the judgment, were only to take effect after obtaining the Government approval which might be necessary, it is acknowledged at the Bar of the Tribunal, and not denied:—1st, that the approval was asked for by the French Company; 2nd, that the Minister then in office declared his approval unnecessary because the Conventions did not fall within the scope of Article 9 of the Schedule of Conditions of the Concession granted to M. Pouyer-Quertier; 3rd, that upon the faith of this declaration the Conventions entered into between the parties were carried out during six consecutive years. The Ministerial letter of the 30th December, 1886, is therefore at variance with the preceding declaration. The mode in which it interprets the Conventions is new and unexpected. It cannot, under these circumstances of fact, constitute a case of "*force majeure*," for it is not even a command. Besides Article 14 of the Schedule of Conditions reserved to the French Company, in the event of any difficulties arising respecting the interpretation of its Schedule of Conditions, recourse to the Administrative jurisdiction. By failing to exercise this right, the French Company violated Conventions the maintenance of which was confided to its good faith, and gives ground for thinking that it was to its interest not to carry them out.

These, summed up in a few words, are the grounds of the judgment appealed against. As regards the decision itself, it is to the effect that the French Company shall resume the execution of the Conventions of 1880 and of 1882, until such time as the competent judicial authorities shall have definitively decreed as to the value of the Ministerial declaration of the 30th December, 1886, and this under a penalty of 5,000 francs damages for each day's delay. Then the judgment concludes with a condemnation to pay 2,000 francs for each day which may have elapsed from the 30th December, 1886, up to the day of the carrying out of the Conventions being resumed.

In the face of this judgment we have to examine two questions. First of all, we have to ask ourselves if the judgment has made a sound appreciation of the facts of the case? And afterwards, whether the judicial solution which it has given to them is acceptable to the Court? The first question which is raised by this dispute is this, Did the Convention of the 24th September, 1880, come within the provisions of Article 9 of the Schedule of Conditions, and was the Government approval necessary to make the Convention of the 24th September, 1880, possible, in order, and executory? No; say the English Companies. The approval was not necessary, because in Article 8 of the Convention of the 24th September, 1880, it had been expressly stated that there was no amalgamation—no fusion of interests—between the three contracting Companies. On behalf of the French Company it was replied to this that it was impossible to fail to acknowledge that on account of the creation of the joint purse there was at least a fusion of interests between the three Companies.

We are not required to give our opinion upon the first point. The solution of the difficulty can only appertain to the competent Minister. In 1881 three courses were open to the competent Minister—either to have authorised the execution of the Convention of the 24th September, 1880; or to have said that he refused to give his approval to the execution of this Convention; or to have said that there was no ground either for approval, or for its refusal, because the approval was not necessary seeing that the Convention of the 24th September, 1880, did not come within the prohibition of Article 9 of the Schedule of Conditions. It is certain that the competent Minister did not give any express and written approval. It is equally certain that he did not give any refusal of his approval. But the first judges say, that if the competent Minister neither granted nor refused his approval, it is because he deemed such approval was not necessary. The first judges add that certainly there was no document expressly stating this decision of the Minister; but that it was shown by matters of fact absolutely certain, and which were of a character to bring conviction to their minds. Is this estimate of the first judges correct? We believe so. It is based upon the acknowledgment at the bar by the two parties to the suit, that the Minister had declared that the Convention which was submitted to him did not come within the prohibitions of Article 9. That is what the tribunal expressly says, commenting upon what passed at its bar.

Observe that not the slightest attempt has been made to allege that the tribunal has misunderstood, and that it has given any other than their proper meaning to the words of the Agréé who had the honour of addressing it. Only before this Court the Appellant Company comes and says that if the tribunal made no mistake, the Agréé, to make amends, spoke with lamentable carelessness, that he made an incorrect statement which he had received no authority from his clients to make, and that if he had kept to his instructions he would have made an absolutely contrary statement. Is there ground for now admitting the disavowal thus thrust upon the Agréé? First of all, then, who conducted the defence of the French Company before the Tribunal of Commerce? It was Maitre Lignereux. The Court knows that he is one of the busiest and most experienced, as well as one of the most careful, Agréés of the Tribunal of Commerce. It seems to me utterly inadmissible that, making a speech in an affair of the importance this is, Maitre Lignereux should have lightly made this most material and most important statement, for the whole case lay in this statement. Admitting, which is impossible, however, that he did make this grave mistake, as his statement was most material, and would form the basis of the judgment, the final consideration having lasted a month, a letter of correction would have been received on this point, either from the French Company or from Maitre Lignereux himself, who would have had his mistake pointed out to him. Having stated this, Now can we doubt that the language of Maitre Lignereux was that which the first judges retained and recorded? How can we doubt it, in the face of the stubborn facts which we must now review?

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"By your letter of the 9th October instant, you submitted for my examination the agreement entered into between the Anglo-American Company, the Direct United States Cable Company, and the 'Compagnie Française du Télégraphe de Paris à New York' for the working of their cables. In order to complete the study which my department is making of the subject, I shall require to be in possession of various documents which are connected with this agreement., viz.":—[Here follows a list of the documents asked for].

The French Company immediately placed itself in communication with the Anglo American in London, which alone was able to forward some of the documents asked for by the Minister. It was in consequence of these communications that the general meeting of the shareholders of the French Company of the 12th January, 1881, was held, a meeting convened specially to consider the import of the Convention of the 24th September, 1880. And the Court will not have forgotten that at this meeting an important personage was present—we mean the delegate of the Minister. It is five days after this that we have the Convention of the 17th of January, 1881, in which it is stated that the French Company, having assured itself that, according to the correct interpretation of its Concession, dated the 7th January, 1879, this Convention did not require any approval of the French Government, it had been decided and agreed, &c., &c.

In the face of the facts which we have just brought out, has not this Convention of the 17th January, 1881, a special bearing and significance? It has been said that this Convention was a secret one. But for whom? For the public? Perhaps so; but there is no provision of the law requiring that this Convention should be made public. Secret as regards the parties interested? Yes, it has been said this Convention was kept secret from the shareholders of the French Company, by whom it should have been ratified. The answer to this is simple. There was not the slightest reason for getting the shareholders of the French Company to ratify a Convention entered into in order to show they were agreed that the Minister had declared that the Convention did not need to be approved. But is it really true that the Convention of the 17th January was a secret one as regards the shareholders of the French Company? The reverse is certain. For in the report which was submitted to them by the Board at the ordinary general meeting of the 11th May following we read as follows:—

"We will simply say to-day that we are glad that we proposed this Convention to you, and that the results are of a character not to make you regret having approved it. . . . Anxious at once to reap the benefit of it, we satisfied ourselves that the Government authorisations mentioned in Article 1 of the Convention were not necessary for us. From that time, nothing further preventing the Convention coming into operation, we agreed with the English Companies to put it into force forthwith."

It is therefore certain that it is somewhat to meet the requirements of the case that the Convention of the 17th January, 1881, has been termed a secret one. On the contrary, this Convention was not secret to anyone; it was known to all whom it could concern. What is the sum and substance of what is said respecting this Convention? It is said that the language attributed to the Minister of Posts was not held by him, and that the Directors of the French Company then in office deceived the Directors of the English Companies when they came to them, saying: We have satisfied ouselves by application to the Minister that his approval was not necessary. Who, then, is it that says that? It is the French Company itself, represented, it is true, by other Directors, but still it is the French Company, which for six consecutive years reaped the benefit of the Convention.

Now, who are they who are thus alleged to have played upon the credulity of the English Directors? They are honourable men, most of them very well known. They had at their head M. Pouyer-Quertier, Senator, formerly Minister of Finance and Minister Plenipotentiary, and who, in virtue of his position, necessarily found easy access to the Minister of Posts and Telegraphs. And these are the men who it is alleged banded themselves together to deceive the good faith of the English Directors! It is very difficult to believe this. Granting, however, for the moment that M. Pouyer-Quertier lied—for it was he who on behalf of the Board signed the Convention of the 17th January, 1881. Granting that he condescended to what has been characterised at the Bar as a trick of legerdemain. What *rôle* would they make then the Minister play? This high functionary

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must then substantially have replied :—"I will not give you my approval —I will not refuse to give you the approval which you apply for either. Do what you like. Go! Make contracts, involve the most important interests. And if by chance I should happen to leave the Ministry, well, I shall be replaced by another Minister who will enjoy the same power as myself, and you will always be at the mercy of the caprice of the Administration!"

On such an assumption what opinion should we form of the good faith and justice of the Minister of the time, particularly when it is certain that he knew everything before the Convention was concluded, at the moment of the general meeting which ratified it, and subsequently to this ratification. The Court will remember that letter of the 24th August, 1882, which was read to it by the worthy Counsel of the Anglo-American Telegraph Company—a letter emanating from M. Pouyer-Quertier, and which was addressed to the Minister of Posts and Telegraphs. This letter related to questions of modifications of tariffs. The approval of the Minister was necessary in order to make these modifications. And M. Pouyer-Quertier, reminding the Minister of the interview which had taken place between them, says to him :—"I cannot agree to such and such of your demands because I must (first) have the assent of the parties who are interested with me."

Who were these parties interested with him? They were the Anglo-American, the Direct and the American Company—in a word, the parties to the Convention of the 12th May, 1882. And when M. Pouyer-Quertier thus spoke of the co-operation and approval necessary from the parties interested with him, it is obvious that the Minister of that time was perfectly aware of the Conventions of 1880 and 1882, particularly those of 1880, which had formed the object of special study on his part. Here there is a document which has a certain importance, and which has not been read to the Court. It is a letter dated the 2nd March, 1885, addressed by M. Riant, one of the Directors of the French Company who replaced the Chairman, to Mr. Weaver, Managing Director of the Anglo-American Telegraph Company, relative to the establishment, in the interests of both Companies, of a special wire from Brest to Havre. It is thus worded :—

"Dear Sir: By invitation given him by M. Cochery, M. Pouyer-Quertier this morning called at the Ministry of Posts, where he met your representative, who had also been summoned by the Minister. At this interview the following proposals were made. . . . Their object is to enable us to compete as advantageously as possible with the Commercial Cable Company."

And thereupon a long correspondence ensued, not only between the two Companies, but also between them and the Minister. In the face of all these facts, we declare that we entirely share the opinion of the Tribunal of Commerce.

The approval of the Minister was asked for in 1880, and at a date corresponding to that of the Convention of the 17th January, 1881, the Minister replied that his approval was not necessary. It is now that intervenes this Convention, which became the starting point of the execution of the Convention of the 24th September, 1880. But here an objection arises, which does not seem to have been submitted to the first judges, and to which the attention of the Court must be called; and all the more as in the note which has been circulated since the last sitting, on behalf of the French Company, this objection is taken up with much force. Let us examine it. The French Company says there is not only the Convention of the 24th September, 1880, there is also that of the 12th May, 1882. Now, if it may be considered that approval was asked for the Convention of the 24th September, 1880, and if it may be granted that the Minister replied that his approval was not necessary, it is certain that approval was not asked for the two subsequent Conventions of the 12th May, 1882, and that consequently the Minister could not have replied as to these that his approval was not necessary. Now, adds the French Company, the approval was all the more indispensable for these two Conventions of the 12th May, 1882, as they made the position of the French Company considerably worse than it was made by the Convention of the 24th September, 1880. In point of fact, it is said, the French Company, agreeably to the first of the two Conventions of the 12th May, 1882, took no more than 12½ per cent. of the product of the joint-purse. It lost its right of veto to the reduction of the tariff by the English Companies below 2s. per word. Then, agreeably to the Second Convention of the 12th May, 1882, the French Company leased its land lines on the American Continent to an American Company. Here was a veritable transfer of rights to which most certainly Article 9 of the schedule of conditions should be applied.

On behalf of the respondent Company it had been answered, and the answer is true in point of fact, that the Government approval was not explicitly stipulated in the first Convention of the 12th May, 1882, as it was in the Convention of the 24th September, 1880; that it was merely stated that the necessary authorisations should be obtained, and beyond the Government approval there were other authorisations to be obtained; that from the moment the Minister declared that his approval was not necessary for the Convention of the 24th September, 1880, it was not so either for that of the 12th May, 1882, because in fact it is a mistake to allege that this Convention, as well as that of the same day with the Western Union, changed for the worse the position which had been made for the French Company by the Convention of the 24th September, 1880.

The last estimate seems to us correct. And on this point the Court will allow me to enter into a few details which are not devoid of interest. First, agreeably to the terms of the Convention of the 24th September, 1880, the French Company took 16 per cent. of the product of the joint-purse. Under the Convention of the 12th May, 1882, it only took 12½ per cent. This question of proportion, when once the principle of the joint-purse is admitted, is of no importance. There is, however, one explanation which it is desirable to give the Court. When the Convention of the 24th September, 1880, was entered into, the contracting Companies possessed six cables amongst them, of which only one belonged to the French Company. One-sixth of the joint-purse was apportioned to it. When the Convention of the 12th May, 1882, with the American Company was entered into, the four contracting companies possessed eight cables amongst them. The French Company still had but one, and an eighth was allotted to it. It is unnecessary to dwell any longer on this first point.

Now, as to the allegation that by the Convention of the 12th May, 1882, the French Company lost the right of opposing the reduction of the tariff below 2s. per word, it is perfectly true that by the suppression of the two last paragraphs of Article 1 of the schedule annexed to the Convention of the 24th September, 1880, it is no longer stated that the English Companies shall not have the power of reducing the tariff below 2s. without the approval of the French Company. But it is not the less a fact that this reduction cannot take place without its consent. The Court will remember, indeed, the terms of Article 1 of the schedule. It is worded as follows :—

"The rate for all telegrams between London, Paris, and New York, forwarded over the lines of the three Companies, shall be such rate as may from time to time be agreed upon between the Companies."

This assumes the agreement of the contracting Companies.

Here, now, is Article 4 of the Convention of the 12th May, 1882 :—

"The tariff arrangements in pursuance of the present agreement shall remain the same as those borne on the schedule annexed to the agreement of the 24th September, 1880, which schedule, with the exception of the last two paragraphs of Article 1, and with the exception of the changes introduced into it by the present agreement, is hereby adopted by the contracting parties. But the rate for the transmission of cable messages between Europe and America, with the exception of those referred to in paragraph 2 of the said schedule, and of the service messages, shall, as soon as the necessary arrangements can be made, be raised to 2s. per word. It shall be maintained at this until it may be otherwise agreed by the contracting parties."

The tariff, therefore, cannot be lowered without the assent of the contracting parties. It has been argued, however, that the French Company might find itself in the minority, and that it would then be obliged to support the decisions of the majority. This, in our view, is a wrong interpretation both of Article 1 of the schedule, and of Article 4 of the Convention of the 12th May, 1882. It is obvious that, in order to modify the tariff rate, the four Companies must be in accord. It is thus that the French Company itself, as represented by the present Board, understands the matter. Here in fact is what was said to the shareholders at the general meeting held on the 25th May, 1887 :—

"Before making this concession (reducing the tariff to 60c.), had all the means of resistance conferred by the Conventions been exhausted?—We think not; and we persist in affirming that in virtue of Article 1 of this Convention, an absolute veto could be opposed to any reduction of tariff."

From this point of view, therefore, no alteration has been effected in the rights of the French Company by the Convention of the 12th May, 1882. But there remains a last point, the leasing of the land lines by the French Company. In the note which has been put in since the last sitting, this point is insisted on, and it is said the leasing of the land lines is unquestionably a transfer of rights, and so irrefutable is this proposition that even the opposite side has found nothing to reply to it. For our part we cannot admit the argument. The leasing of the land lines has nothing to do with the question. The French Company doubtless established them in virtue of a concession from the American Government. No doubt when the French Company came to take part in the second Convention of the 12th May, 1832, it was stipulated that these land lines should be in a certain measure abandoned by it from the point of view of actual possession. But it was stated at the same time that it would retain the ownership of them, and that only the management and maintenance of them would devolve on the Western Union Company. On what ground, then, should this special arrangement have been submitted for the approval of the Minister? Did it come under the application of Article 9? Was the Western Union Company the concessionary of submarine transatlantic cables? No; it was the concessionary of land lines. It follows as a consequence that the alleged leasing of land lines cannot be considered as coming under the prohibition of Article 9.

To sum up this part of the case, which has remained entirely outside the grounds of the judgment, it is true to say that if the Government approval was not necessary for the Convention of the 24th September, 1880, neither was it for the Conventions of the 12th May, 1882, since they did not alter the position of the French Company, as created by the preceding Conventions.

Let us now return to the consideration of the opinions of the first judges on the facts. After having established the fact that the Minister of Posts and Telegraphs of 1881 had deemed his approval unnecessary, they say that the interpretation arising out of the letter of the 30th December, 1886, was new and unexpected. New, it certainly was. No discussion is possible on this point. One might have even added "contradictory." Unexpected, there is no doubt about it, at least as regards the English Companies.

It must be admitted that the first judges characterised with some severity the conduct of the French Company in saying that it was wanting in good faith, and that it was permissible to assume that it was to that Company's interest that the Convention which it had voluntarily entered into with the English Companies should not be carried out. A few words only upon these two points. The Court is aware that in December, 1885, a new Transatlantic Cable Company was formed called "The Commercial." It is an American Company also known under the name of "The Mackay-Bennett Company." The Court knows that Mr. Mackay is a rich American, and that Mr. Bennett is the proprietor of a well-known American journal, the *New York Herald*. The Managing Director of the Commercial Com-

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pany was Count Dillon, the same who in 1881 was the Managing Director of the French Company, but who was dismissed from his office in consequence of disputes relative to the ratification of the Conventions of September, 1880. The Commercial Company, this new comer, made a severe competition with the allied Companies. The latter would have very willingly made alliance with it, but the requirements of the Commercial Company were excessive. For its adhesion to the joint-purse arrangement it demanded that it should be guaranteed gross receipts of five million francs (per annum). The French Company, like the English Companies, would not agree to such conditions. It was thought that there was no other way of fighting the Commercial Company than by lowering the tariff to such a point as to render it impossible for that Company to continue the struggle. A decision was then came to by the allied Companies, under date of the 16th April, 1886, reducing the rate of transmission to 60 centimes per word. In order to induce the French Company to consent to this reduction, the other Companies had been obliged to guarantee it its working expenses, to the extent of one million francs *per annum*. The amounts paid in carrying out this guarantee were to be refunded without interest by annual payments extending over five years, and then only if the tariff should have been raised again. It was in fact the "déversoir" agreement, a Convention which is often made between the Government and companies for the execution of railway works. It was not a loan, neither was it a gift, but this matters little. The French Company had agreed to the reduction of the tariff to 60 centimes per word.

At the general meeting of the shareholders of the French Company held on the 23rd June, 1886, the members of the Board, after having reported the position of the Company, and particularly the Convention for the reduction to 60 centimes per word, proposed to the shareholders to pay a dividend of 5 francs per share. The amount was considered very small by certain shareholders. There were complaints and recriminations. It has been said that amongst the shareholders there were some who had only just become such, those created only for the formation of a general meeting. We have not to ask ourselves the question, is this true or false? As a matter of fact, the shareholders by a majority of 567 votes against 442 refused to approve the accounts. The old Board, composed of very distinguished men, was obliged to resign. It was replaced by a new Board, one of the members of which, M. Belleville, accepted the position of Managing Director. His first act was to demand of the English Companies the raising of the tariff. They replied that doing this would be playing the game of the Commercial Company, and renouncing at a dead loss advantages which had been obtained at the cost of considerable sacrifices. It is in the course of this correspondence that the Minister of Posts and Telegraphs wrote to the Chairman of the French Company, under date of the 23rd October, 1886, the following important letter:—

"By your letter of the 3d October instant (says the Minister) you have kindly informed me of the reconstruction of the Board. . . . I have the honour to acknowledge the receipt of this communication. I have been unwilling during the course of the difficulties which your Company has just passed through, particularly as regards the reconstruction of its Board, to ask you for information as to the rumours which were then circulated as regards the position of your Company *vis-à-vis* the English Companies. But now, in the face of the persistence and multiplicity of the allegations which daily appear in the newspapers, and according to which, contrary to the formal provisions of Article 9 of the Schedule of Conditions, the French Company is said to have amalgamated its interests with those of the Anglo-American Telegraph Company, I find myself compelled to ask you what foundation there may be for such allegations. I beg you, therefore, to give me very definite information, and, in case of need, that you will forward me copies of the agreements which may have been entered into between your Company and the Foreign Companies."

The next day M. Belleville sent the Minister everything which the latter had asked him for—without one word of explanation, without one word of protest. He said to him purely and simply:—"Monsieur le Ministre, I have the honour to send you the documents which you ask me for." No doubt M. Belleville will inform the allied Companies of what is going on. Here, in fact, is the Minister notifying that the position of the French Company is irregular—that it is not in conformity with Article 9 of its Schedule of Conditions, and that he will be compelled to take steps to put an end to this state of things. The commonest good faith required that M. Belleville should say to the allied Companies:—"You know our position is getting precarious. It is seriously threatened. Here is a letter which I have received from the Minister of Posts, dated the 23rd October." Well, it is acknowledged that this letter was not in any way communicated to the allied Companies.

Two months elapse, and on the 30th December, 1886, there arrives a letter from the Minister, in which he says:—"The examination of the documents which you forwarded me has shown me that your Company was irregularly constituted. I beg you therefore to take the necessary steps, &c., &c." And the next day, without one word of protestation—without any demand for explanations, without even applying for an audience—M. Belleville writes to the Minister:—"I have done what you wished. I summoned the Board as of urgency. Everything is finished, for I have written to the companies concerned that for the future the agreements would no longer exist." On the 27th January, 1887, an agreement was entered into between the French Company and the Commercial, by which the latter Company, in case of interruption, placed its cables at the disposal of the French Company, in consideration of the payment of the rate charged to the public by it, the Commercial Company. Here is an Agreement very speedily concluded, for it is dated the 27th January, and the Minister's letter the 30th December previous.

But it has been said on behalf of the French Company that the making of this agreement was imperative, and that it was not made at all under conditions indicating any complaisance whatever on the part of the Commercial for the French Company, for whilst the French Company was obliged to pay 1f. 25c. per word to the Commercial for the transmission of messages, it only received from the public 60 centimes. If things had indeed happened in this manner the French Company's position would have been a profoundly disastrous one, but happily for it the Minister intervened to lower the tariff in its interests. Here is, in fact, an extract from a circular from the International Office of Telegraph Administrations at Berne, bearing date the 1st March, 1887, and in which the manager of that office thus expresses himself:—

"Confirming my telegraphic circular of the 10th February last, I remind you that agreeably to a notification of the French Minister of Posts telegrams bearing the indication *vià P. Q.* during the interruption of the French Company's cable will be transmitted without any increase of charge (that is to say, for 60 centimes per word by the Havre route, Commercial Cable Company)."

We see then that this agreement with the Commercial Company entered into just after the letter of the 31st December, 1886, did not and could not have the disastrous result for the French Company which we have just pointed out as the necessary result of the difference of the tariffs (60c. and 1fr. 25c. per word). These are the facts. Do they justify the opinions of the Tribunal? In our view we must answer in the affirmative. Now do they justify the final provisions of the judgment? No; at least this is our opinion. It has been pleaded before the Court, and it had been previously summed up, that the Tribunal of Commerce was incompetent. This is a mistake.

The Conventions in litigation are essentially commercial Conventions, entered into between commercial Companies. One of these Companies, for some reason or other, refuses to carry out these Conventions. The other contracting Companies allege that it is without reason that it acts thus. They invoke the principle that agreements are the law of the parties to them. A dispute arises. Before whom should this dispute be carried? Unquestionably before the jurisdiction of common law, and in this particular case before the commercial jurisdiction. It was therefore properly brought before the Tribunal of Commerce.

But what will be done if the Company which refused to carry out the Convention maintains that it is released from carrying it out by the fact of Administrative acts which cannot be properly estimated by the Tribunal? The Tribunal will have to ask itself whether the Acts are so clear and so precise that one ought from the present moment to assert their execution, and if the reply is in the affirmative, it will decide in favour of the French Company, because the Administrative acts in question constitute a case of "*force majeure*" for it. If, on the other hand, any difficulty arises relative to the validity, the import, and the interpretation of the Administrative acts which are invoked before it, the Court should suspend its decision. The Tribunal of Commerce has manifestly exceeded its power. It violated the grand principle of the separation of powers when it ordered the French Company, under a penalty of 5,000 francs per day, to resume the execution of the Conventions of 1880 and 1882, and condemned it to pay damages on account of the non-execution of the Conventions in the interval comprised between the 30th December and the day they shall be resumed.

If, then, we admit the opinions of the first judges as to facts, we regret, on the other hand, the juridical consequences which they have drawn from them. What should the Court do? It ought either entirely to revoke the sentence of the first judges, on the ground that the Administrative acts invoked by the French Company having nothing doubtful in their character, that Company should not be held responsible for having interrupted the execution of the Conventions in litigation, since it was a case "*force majeure*" for it. Or, on the other hand, it should suspend judgment and send back the parties to the suit to apply before the competent jurisdiction for the interpretation of the Administrative acts produced in the contest.

We hold that there is ground for the Court to pronounce suspension of judgment, and for these reasons:—We have said that the Minister of Posts was the sole judge upon the point of knowing as to whether the Convention of 1880 and that of 1832 came within the prohibition of Article 9 of the Schedule of Conditions. If, therefore, only the Ministerial letters of the 30th December, 1885, and 17th January, 1887, were in question, as they are clear and precise, there would be ground for the Court to make the application of them, and to declare the resistance of the French Company well founded. But these letters are in contradiction with a preceding Ministerial decision, a decision revealed by a series of acts and decisive facts confirmed by the execution of the Conventions in litigation during six consecutive years, with the knowledge and privity of the competent Minister, and without either opposition, protest, or even objection on his part.

But we now come to the main objection raised by the French Company. Yes, it says, if there were a written decision of the Minister of 1881, stating that his approval was unnecessary, then we might admit the contradiction invoked. But such a decision does not in fact exist. It cannot either be deduced from circumstances, facts and acts, however plain, precise and clear their character. The decision, therefore, must be held as non-existent. This, in a few words, is the question. The Court, be it well understood, would not have the power to base an administrative decision on facts and acts possessing even the precision and clearness of those with which we have intentionally so long occupied its attention. But would not the administrative jurisdiction have this power? This certainly is a delicate question, which we are not called upon to decide. It is precisely for this reason, therefore, that we demand suspension of judgment, so that this question may be decided by the proper authority.

Suspension of judgment—such, in our opinion, is the proper juridical solution which the present suit admits of. In confirming this solution by making a suspension order, the Court will give another proof that it knows how to respect the great principle of the separation of powers, whilst at the same time giving to interests worthy of respect the legitimate satisfaction which in the name of equity they have a right to demand.

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On the 24th April the Court (M. Perivvier, the First President of the Court, presiding) pronounced interlocutory judgment as follows:—

"Deciding upon the Appeal lodged by the *Compagnie Française du Télégraphe de Paris à New York* against the judgment given by the *Tribunal de Commerce de la Seine* under date of the 9th January, 1888.

"Upon the plea of incompetence propounded by the Appellant Company;

"Whereas the proceedings brought before the *Tribunal de Commerce de la Seine* had for object to make the *Compagnie Française du Télégraphe de Paris à New York* to carry out, under penalty of damages to be hereafter settled, the agreements entered into between that Company and the Anglo-American Telegraph Company (Limited) under the dates of the 24th September, 1880, and 12th May, 1882:

"Whereas these agreements both relate to the working of telegraph lines, of which the two parties to the suit are owners:

"Whereas these agreements belong directly to the domain of the Commercial operations which form the sole object of the said Companies:

"Whereas the questions to which they have given rise are agreeably to the terms of Article 631 of the 'Code de Commerce' within the competence of the Consular Tribunals.

"On the main question—

"Whereas in order to withdraw itself from the execution of the said agreements claimed of it and to justify the denunciation which it made of them under date of the 31st December, 1886, to the Anglo-American Telegraph Company, the appellant Company pleads a case of *force majeure*, which, according to it, would result from the injunction notified to it by Ministerial letter dated the 30th December of the same year, to return as of urgency to the conditions provided for and specified by Articles 9 and 13 of the Schedule of Conditions of the Concession prohibiting any fusion of interest with foreign companies without the express sanction in writing of the French Government:

"Whereas, if one puts against the above-mentioned Ministerial letter the execution during six consecutive years, with the knowledge and privity of the French Government, of the agreements of the 24th September, 1880, and 12th May, 1882, a serious doubt arises as to the precise meaning, character, and import of the despatch of the 30th December, 1886, from the point of view of the interpretation of the above-stated articles of the Schedule of Conditions of the Concession granted in 1879 to the French Company, and of the application which the Administration of Posts and Telegraphs claimed and claims to make of them, to the said agreements of the 24th September, 1880, and the 12th May, 1882:

"Under these circumstances there is ground for granting a stay of proceedings before definitively deciding, until the competent administrative authority shall have proceeded to the interpretation of the instruments and documents above mentioned.

"On these grounds,

"Without dwelling upon or recognising the plea of incompetence propounded, which is rejected as ill-founded,

"The Court suspends deciding upon the substance of the case until the competent administrative authority shall, on the proceedings of the most active party, have determined the interpretation of the Ministerial letter of the 30th December, 1886, from the point of view of the application which it intended and intends making to the agreements of the 24th September, 1880, and 12th May, 1882, of Articles 9 and 13 of the Schedule of Conditions of the Concession granted to the Compagnie Française du Télégraphe de Paris à New York, and reserves the costs for the purpose of their being decided upon at the same time as the substance of the contention."

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *April 28th*, 1888.

In one of my recent letters I made reference to the readiness and rapidity with which gas companies in all parts of the country were adopting the electric light as an adjunct to their present plant, or were consolidating with electric light companies, finding greater profit to lie in consolidation than in competition. Another feature of the present rapid extension of electric lighting is its union in the South and West with enterprises other than gas. In some parts of the South electric lighting plants are being run in conjunction with ice factories, which, serving as they do for refrigerating purposes, give a new extension and meaning to the well-worn old phrase, "sweetness and light." Just at present, too, a favourite enterprise is the combination of electric light plant with waterworks, and in some places, as at Hutchinson, Kansas, a telephone system is added, furnishing, it will be admitted, a peculiar diversification of industries under one roof. At Hutchinson, I am informed, the local company operates the Holly system of waterworks, a Thomson-Houston arc light plant, an Edison plant of incandescent light, and a large telephone exchange, the whole being under one ownership and management. In the waterworks department the company has a capacity of 5,000,000 gallons per day, with ten miles of mains and 108 double fire hydrants in service. The Thomson-Houston plant comprises a 50-light dynamo, and the incandescent branch includes six Edison machines of 2,400 light capacity. The electric light service is growing, and a fourth Armington-Sims engine is to be added to give the necessary power. The Telephone Exchange, it is interesting to notice, is equipped on the Cushman system, which is practically the only one left in the field to-day to contend with the Bell Company. The exchange has a capacity for about 200 subscribers, and nearly all the lines are rented. The whole plant cost about £45,000, and is regarded by the company as a very satisfactory investment. It is not at all unlikely that before long the station will be supplying current for an electric street railway; in fact, it is hard to say just where the limit to its usefulness will be found. The idea thus put into practice of combining several plants may not commend itself to your readers, but it has many advantages in point of economy and concentration.

Another idea, however, which is more likely to meet with favour is that carried out last week at Meriden, Ct., where the Street Railway Company, which is about to substitute electricity for animal power, invited Mr. Leo Daft to give a lecture on electricity, under the auspices of the Local Scientific Association. So much interest was taken in the lecture that the town hall of that busy city was crowded on the occasion with an audience of about 1,500 of the best people of the place. In order to illustrate his experiments Mr. Daft had a dynamo installed in a building near by, and thus had command of all the current necessary, and was enabled to deliver what is described as one of the most thorough and enjoyable dissertations on the subject ever given in New England. Mr. Daft, whose system has been adopted by the street railway company, paid special attention to motors in his lecture, and had on the stage with him a printing press from a local newspaper office, which was shown in operation, to the delight of the large gathering. It is evident that such a lecture must be beneficial in a variety of ways, not only in advertising the new power but in teaching correct ideas as to its nature and use.

Speaking of electric railways reminds me that Baltimore was last week the scene of another experiment in the way of storage battery cars. The Viaduct Manufacturing Company of that city has long been making experiments with the Faure battery, and as far back as the year 1885 had a car running at its works on a one-eighth of a mile track. The result of these experiments encouraged the gentlemen interested to construct a new car, and during the past winter, it has been equipped with Sprague motors. According to the newspaper accounts for that city the runs made last week were very successful. Over 150 miles of the worst track that could be found in that hilly city have been travelled, the car carrying a crowd of passengers at each trip without a single hitch, and the promoters of the enterprise are greatly encouraged. These experiments, it will be seen, have extended from first to last over a period of about five years, and therefore no want of persistence can be complained of. But the conditions were very different in 1883 from what they are now, and from what they will be in 1893. Five years ago there were no motors to be had in this country that were fit for street car work, and the storage batteries themselves were altogether crude. Now, with the motor in an advanced stage of improvement, and with the storage battery daily becoming cheaper and more efficient, it looks as if the sanguine expectations which have buoyed many enthusiasts up through weary years are very near realisation. There can be no question of the fact that the electric car has done enough to be accepted as an accomplished fact, and is the best for city street service that could possibly be desired. The leading newspapers in all our largest cities are emphatic in their demands for electric power. The committee of the Real Estate Exchange, which has been holding sessions here on the subject of rapid transit, has just reported to the effect that all rapid transit roads hereafter built shall be required not to use steam, but to put in either cable or electricity. They also

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recommend that all the existing surface roads should be allowed to change over at once from animal power to cable traction or electric motor. Another significant utterance on the subject is that of Colonel Flad, not long since President of the American Society of Civil Engineers, and now President of the Board of Public Improvements in St. Louis. Being asked to give his views on the subject of street railway enterprises in Chicago, he has expressed his firm belief that while the introduction of cable railroads was naturally hailed as a great step in advance over the old system, its application will very soon be confined to the operation of lines on which heavy grades occur, and that the electric motor, in combination with the storage battery, will be used almost exclusively for the propulsion of street cars in cities.

The work for the current year of the New York Subway Board has at last been mapped out, and as it will begin in another week, it may be worth while to note one or two of the particulars. No fewer than 5,000 men are to be put to work at once on several sections, including the unfinished work of the last year and the completion as far as possible of the intermediate sections between the down town and up town districts. The work authorised, exclusive of Edison ducts in subway trenches, is 626,235ft. This work will occupy some three or four months. The construction company which carries out the work also recommends a new field for occupancy, which will require 615,000ft. of single duct. If all this work is done during the present year, New York will have one of the largest electric subway systems in the world. This activity is commendable, but it will also be more promising of the desired results to see greater willingness on the part of the electric companies to occupy the accommodation so liberally provided.

The New York Electric Club has just had its annual meeting. Mr. Hy. C. Davis has been re-elected president. Mr. Thos. A. Edison has retired from the management, and among those who have been added is Mr. T. N. Vail. From the statement made by Mr. Davis it appears that the total receipts from all sources for the year have been about $24,000. Of the $25,000 of bonds authorised about $16,000 have been subscribed for. The club is still in debt, however, to the extent of about $8,000 for furniture, &c., and another call by bonds has been made to the extent of $9,000, the subscription to which, together with the hoped-for payment of about $3,000 of back dues, and the addition of 150 new members in the year, will place the club on solid financial ground and free from debt. The club has proved a valuable addition to the social features of New York, and if managed on the right basis promises to be increasingly useful as a means of promoting kindly intercourse among men who are otherwise antagonistic, or not likely to meet.

Attention has been called this week to a new and interesting form of meter, designed by Prof. Elihu Thomson, in which the heating property of the current is employed as a means of effecting motion in the registering train. The apparatus consists essentially of two bulbs, which are attached to each other by a tube of narrow bore, or so arranged as to resist the rapid flow of liquid through it. Two small resistances are sealed into the bulbs; these bulbs are partly filled with alcohol, which is boiled, and the whole is sealed when the alcohol vapour has completely filled the interior space. At the top of a central pillar is a knife-edge support carrying the frame to which the bulbs and tube are attached. The suspension is so arranged that the centre of gravity is above the point of support, thus putting the arrangement in unstable equilibrium, tipping either way according to the excess of weight on either side. Mercury cups receive the ends of wires leading to the small coils in the bulbs, and according to the number of lamps in circuit the coils will be fed and heated, thus warming the liquid. This will result in evaporating the alcohol, in depressing the level of the liquid in the bulb, and cause the flow from one bulb to the other. The flow of the liquid into the one bulb from the other tips the apparatus and throws the current through the coil in the other bulb, when the action is repeated. Thus oscillation is set up and the register is moved, and a definite amount of current is shown to have been consumed.

Attention is called by the New York *Electrical Review* this week to the manner in which Mr. Wood, the President of the Sandusky Gaslight Company, recommended the Ohio Gasmen's Association recently to take up incandescent as well as arc lighting. Mr. Wood has advocated this change of front before, and now repeats his recommendations and endorsements. He referred to the incandescent lamp as the ideal domestic burner for illumination purposes, whose adoption by the public could not be prevented by the gas companies; and, "if that be true," said he, "to my mind the wisest course to pursue is to admit what we know to be true, and decide at once to supply the demand, increase our revenue, push it into the suburbs of our cities, sell it as cheaply as possible, and do not let others come in and take away what rightly belongs to us." This is notable language, and worthy the prominence given to it. That Mr. Wood's foresight is appreciated is shown by the fact that he has been elected to the presidency of the association.

Many of your readers will no doubt be interested to learn that the D'Humy battery is to be introduced on this side of the water. It has been taken up by a number of capitalists at Albany, the capital of this State, and I am told that the announcements in regard to it in the local papers there have provoked quite a sensation, as well as wordy warfare, among the local electricians, many of whom characterise the battery in terms more forcible than polite. I do not think we shall see much done with primary batteries in the lighting field just yet, but I know of two other experiments being made, one in Brooklyn by a young Englishman named Mason, who has just organised a company, and the other by a well-known and careful worker in this department, who has progressed so far as to light up the house of one of our leading electric light presidents.

CORRESPONDENCE.

THE LATE SIR CHARLES BRIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was much surprised and grieved to read in *The Times* of the 5th inst. the announcement of the death of Sir Charles Bright, and much regret that my absence from home will prevent my adding my humble wreath to the many which are sure to surround the last resting place of one so respected by all who knew him. Instead thereof perhaps you will allow me to place upon record through your columns my great appreciation of the many good qualities he possessed.

I first became acquainted with Charles Bright in Manchester in 1851, and since that time it has often been my privilege to be associated with him in many works. In 1853 subterranean wires were being laid from London to Manchester for the Magnetic Telegraph Company, Charles Bright as their engineer having to certify the completion of the sections of the same; and many are the instances known to me personally that I could quote of his great kindness of heart and goodness to all those with whom he was brought into contact on those occasions. I could speak in the same strain of him during the manufacture of the first Atlantic cables of 1857 and 1858, also of the Persian Gulf cables of 1863 and 1864.

In 1868 a cable was laid from Malta direct to Alexandria, of which I had the charge on behalf of the company who manufactured it, while Sir Charles Bright represented the company for whom it was laid. The same system of testing and of working was adopted in this case as in the Atlantic cables of '66, and I have a vivid recollection of the delight of Sir Charles when our first message was sent and correctly received, at what in those days was considered the high speed of 21 words per minute.

On that occasion I was fortunate in securing him as a companion to Marseilles, Messina, Catania, Syracuse, Malta, Alexandria, and the Pyramids, and a more congenial one it would be difficult to find, his good spirits and generosity being unbounded.

I have every reason to believe that the friendship thus

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formed was as enduring on his side as on mine, and that our frequent meetings on the Council of the "Telegraph-Engineers" only served to cement it.

Trusting that his family, with whom personally I am not acquainted, will not consider this small tribute of respect to the memory of one whom I sincerely mourn intrusive.—Yours, &c., WILLOUGHBY SMITH.

May 8th, 1888.

"MAGNETIC RELUCTANCE."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There is a tendency at the present time amongst some writers to greatly extend the application of the word resistance in electro-magnetism so as to signify cause/effect. This seems a pity, because the term resistance has already become thoroughly specialised in electro-magnetism in strict relationship to frictional dissipation of energy. What the popular meaning of resistance may be is beside the point, ditto dimensions, &c.

I would suggest that what is now called magnetic resistance be called the magnetic reluctance; and per unit volumes the reluctancy.—Yours, &c., OLIVER HEAVISIDE.

May 6th, 1888.

THE PAPERS OF FLEEMING JENKIN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Permit me to suggest that the word "touch," which puzzles my friend Mr. Willoughby Smith, may be a typographical error for "hitch," due to indistinct manuscript. The substitution will make sense of the original.—Yours, &c.,

Valentia, May 7, 1888. J. GRAVES.

THE TELEPHONE INFRINGEMENT ACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It having come to the knowledge of the Equitable Telephone Association that the agents of the United Telephone Company are circulating reports to the effect that the association have not the intention or the means of defending the action for infringement of patent that the United Telephone Company have thought fit to commence against them, the association ask the favour of your space to give these most unwarranted reports an unqualified contradiction. They also take the opportunity of stating that not only have they the fullest intention of contesting the action to the utmost, but have also every confidence that they will be successful in upholding the freedom of their telephone.—Yours, &c.,

A. A. C. SWINTON, Director.

(For the Equitable Telephone Association, Lim.)

London, E.C., May 4, 1888.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

THE DEATH OF MR. THOMAS RUSSELL CRAMPTON.

At the commencement of the proceedings at the meeting held on Thursday, the 26th ult., the PRESIDENT said he had to announce the death of Mr. Thomas Russell Crampton, who had been a member for many years of the Society, and for some years a member of their Council, and who was so eminent as an engineer and contractor for railways that he need hardly say much about him, but merely call attention to the fact that he was one of the earliest pioneers of submarine telegraphy; and it was to his exertions that they were indebted for the present type of submarine cables throughout the world. The president then called upon Sir Douglas Galton to move a vote of condolence to the widow and family of Mr. Crampton.

Sir DOUGLAS GALTON said he was a very old friend of Mr. Crampton, and he felt satisfaction at having been called upon to move the resolution:—

That the members of this Society have learned with deep regret the decease of their much esteemed member Mr. T. R. Crampton, who was intimately connected with the establishment and laying of the first successful submarine cable, and they desire to express their sincere sympathy with his widow and with the other members of his family at the loss they have sustained.

Mr. Crampton, by his energy, his great science, and his great skill, was the person to whom the first submarine cable between Dover and Calais was due. An earlier line had been laid, which consisted of merely a wire covered with insulating material that very soon was destroyed. Mr. Crampton then came forward, and both raised the money and devised the cable which was subsequently laid in 1851, and that cable was really the origin of all the submarine cables which had been since laid. He (Sir Douglas) said the origin, because this form had been copied in every cable which had been successfully laid and successfully maintained until this day. He concluded by moving the resolution.

Prof. FORBES, in seconding the vote of condolence, said he endorsed everything that had been said by Sir Douglas Galton, having been intimately acquainted with the late Mr. Crampton.

The vote of condolence was unanimously accorded. The remainder of the proceedings was reported in our last issue.

[ERRATUM.—In our last week's report of the discussion on Mr. Crompton's Paper, page 751, 53rd line from the top, by an unfortunate printer's error the name of Mr. BERNARD DRAKE was omitted at the commencement of the paragraph containing his speech.]

PHYSICAL SOCIETY.

At the meeting of this Society held on the 28th ult., Mr. C. V. BURTON, B.Sc., read a Paper on

"Electromotive Force by Contact."

The author endeavoured to show by mathematical reasoning that there is not, as usually supposed, a definite and considerable E.M.F. produced by contact of two dissimilar substances, but that there is only a small E.M.F. due to gas effects at the separating surface, and depending either on chemical action or on absorption of heat.

Prof. AYRTON observed that there was no doubt of the existence of a marked potential difference when measured inductively. No experiments in which the quantity of gas present had been diminished as far as possible gave any indication of a diminution in the E.M.F. The evidence as far as it went was therefore in favour of the existence of a real contact E.M.F. of considerable amount, that is to say comparable to a volt. He did not consider that any process of reasoning apart from experiments would enable us to infer what would be the case in a perfect vacuum.

Prof. SCHUSTER referred to Prof. Lodge's Paper on "The Seat of the E.M.F. in a Voltaic Cell," and thought he had treated the air sometimes as a conductor and sometimes as a non-conductor, just as was most convenient.

Prof. S. P. THOMPSON observed that much of the discussion of this point had really arisen from different definitions of potential being taken. He did not agree with Prof. Ayrton that the gas plays no part, and referred to the experiments made by Mr. Brown, of Belfast, according to which the contact E.M.F. between two conductors was found to depend on the gas in which they were immersed.

Prof. AYRTON did not consider that Brown's experiment showed that the gas had any influence. The gases he used caused a visible oxidisation in the metallic surfaces, and this alteration of surface was sufficient to account for the observed differences in the E.M.F.

Prof. PERRY thought that the difference of opinion on the question arose entirely from the adoption of different definitions of potential.

Prof. SCHUSTER combated this statement, and pointed out that the question was, what would actually happen if two different conductors could be brought into contact in a space entirely free from air or other gas? And this did not depend on whether we adopted Sir William Thomson's definition of the potential of a conductor as the amount of work which would have to be done on a unit of electricity to bring it from an infinite distance to a point in the air infinitely near to the conductor; or MAXWELL's definition, which amounted to defining it as the amount of work which would have to be done on a unit of electricity to bring it from an infinite distance to a point within the conductor. He stated that by making some plausible hypotheses he had arrived at the conclusion that the amount of work done in bringing the unit of electricity within the conductor would be double the amount done in bringing it to a point in the air infinitely near to the conductor.

Mr. BURTON stated that he had adopted Sir William Thomson's definition of potential. He pointed out that Brown had obtained a series of successive reversals in the direction of the E.M.F. of contact by increasing the conductors alternately in air and in sulphuretted hydrogen, and this he considered showed that the difference in the effect in the two gases was not due to oxidisation.

Mr. H. TOMLINSON then read a Paper on

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"A Theory Concerning the Sudden Loss of Magnetic Properties of Iron and Nickel."

Experiments by himself and other observers have shown that the temperatures at which iron and nickel lose their magnetic properties depend on the specimens used and the magnetising forces employed; but the temperature at which they *begin to lose* these properties is definite, for nickel about 300° C., and iron about 680° C. The author's own experiments on "recalescence of iron" show two critical temperatures, and Pinchon has shown by calorimetric measurement that between 660 and 720° C. and between 1,000 and 1,050° C. heat becomes latent. All these facts seem to indicate a molecular re-arrangement about these temperatures.

In his proposed theory he assumes that the molecules of iron, say, contain magnetic atoms capable of motions of translation and of rotation. These tend to form closed magnetic circuits, but at ordinary temperature are unable to do so, on account of the close proximity of their centres. On raising the temperature their centres are further separated, till at about 680° C. their polar extremities rush together, forming complete circuits, and exhibiting no external magnetic properties. On cooling down, the centres approach until the gravitation attraction overcomes the magnetic attraction of their poles, when the magnetic properties reappear.

Prof. AYRTON pointed out that iron had been shown to regain its magnetic susceptibility to a certain extent at a bright white heat, and lost it again when the temperature was increased beyond this point. He thought it would be of interest to endeavour to determine whether it would regain it again at a still higher temperature.

"Note on the Graphic Treatment of the Lamont-Frolich Formula for Induced Magnetism."

BY PROF. S. P. THOMPSON, D.Sc.

The formula referred to is $N = \overline{N} \frac{Si}{Si+b}$, where $\overline{N}$ = total induction when saturated, N = induction due to Si ampere turns, and b = value of Si, which makes $N = \frac{1}{2}\overline{N}$. Simple geometrical constructions are given for plotting the curve when $\overline{N}$ and b are known, and for finding $\overline{N}$ and b when two pairs of values of N and Si have been determined.

The use of the formula is shown to be justified in practice, for, as pointed out to the author by Prof. Perry, the curves connecting permeability, u, and induction B, are straight lines from B = 7,000 to B = 16,000, between which dynamos are usually worked. A method of pre-determining $\overline{N}$ and b is given for magnetic circuits of known form and materials, thus removing the objection often urged against the above formula, viz., that it involves two constants which had to be determined after the magnet was made. Two other "Notes" by the same author were postponed till next meeting.

COMPANIES' MEETINGS & REPORTS.

The Brazilian Submarine Telegraph Company (Limited).

The twenty-ninth ordinary general meeting of the shareholders of the Brazilian Submarine Telegraph Company (Limited) was held at Winchester House, 50, Old Broad-street, on Wednesday last, under the presidency of the Right Hon. Viscount Monck.

The SECRETARY (Mr. Richard Collett) read the notice convening the meeting, and the minutes of the last meeting, which were confirmed and signed by the chairman as correct.

The report of the Directors was taken as read.

The CHAIRMAN said that that was the twenty-ninth half-yearly meeting of the Company, and on every occasion on which he had met them he had been able to give a satisfactory account of the state of the Company's affairs. He was happy to say that on the present occasion there was no exception to that rule. Their plant was in excellent condition, their revenue was increasing every week, their expenses were diminishing, and they were paying off the debenture debt which they had been obliged to contract in order to complete the payment for the duplication of the cables. The expenses of the past half-year had been £449 less than for the previous half-year, which showed that the Board were doing all in their power to save money for the benefit of the shareholders. The amount of the debentures paid off and drawn for redemption—which, of course, would also benefit the shareholders—was £51,000, leaving a balance of £99,000 on the first issue. He had said that their plant was in good order, but there was one qualification to that statement, a small fault having developed itself a few miles from Pernambuco close in shore, which did not, however, in any degree interfere with the working of that cable, and which could be removed without much difficulty. They had entered into arrangements by which they would now obtain a repairing ship, and the fault would be removed as soon as possible. A fault had for some time shown itself in one of their cables off Madeira, and in repairing that during the past half year they had rather a curious experience. It seemed that at Madeira the two cables were conducted up the face of a precipitous rock into the cable house at the top. There was a tremendous hurricane at Madeira last winter, which blew those cables about to such a degree that the covering was destroyed, the two cables becoming so mixed, that in testing they thought there was a fault in the new duplicate cable instead of the old; they, however, discovered where the fault was, and had no difficulty in setting the matter right. It was satisfactory to know that, after the repair of the old cable, which had been submerged 14 years, it tested as well as it did when first laid, and that the portions picked up in order to effect the repair were in perfect order.

He then moved the adoption of the report and accounts.

The VICE-CHAIRMAN (Sir James Anderson) seconded the motion.

Mr. CUFF suggested that it would be a convenience to the shareholders if the Directors printed in the accounts the figures of the corresponding half year.

The CHAIRMAN said that they would consider the suggestion, but at the first blush he saw certain objections to it, not in regard to the shareholders knowing everything which the Directors could tell them as to the Company, but with reference to the general public.

Dr. TREWHELLA proposed a vote of thanks to the Chairman and Directors, and said that it was very gratifying to have the noble Chairman's assurance that their property continued in excellent condition.

Mr. CUFF seconded the motion, which was carried unanimously.

The CHAIRMAN, in reply, said that on the part of his colleagues and himself he thanked them for the confidence they had shown in the Board, and they would endeavour to deserve it.

The proceedings then terminated.

West Coast of America Telegraph Company (Limited).

The eleventh ordinary general meeting of this Company was held on Wednesday, at Winchester House, 50, Old Broad-street, Mr. Alfred Marshall presiding.

The SECRETARY (Mr. Fred. L. Robinson) read the notice convening the meeting and the minutes of the previous meeting, which were signed by the Chairman as correctly entered.

The report of the Directors and statement of accounts were taken as read.

The CHAIRMAN: Gentlemen—It is always a pleasure for the Directors to meet the shareholders and to be able to present a favourable report. I can congratulate you to-day upon the fact that the West Coast of America Telegraph Company has done a more satisfactory and profitable business during 1887 than in any previous year of its existence. In moving the adoption of the report and accounts I have to draw your attention to a few figures contained therein. The most prominent item on the income side is the gross earnings of the Company for the year 1887, which amount to £57,060. 15s. 8d., as compared with £42,340. 18s. 6d. for the previous twelve months. This is a very satisfactory increase of business, and, as mentioned in the report, it is almost entirely due to the larger number of messages transmitted by the company. We have also been favoured by a rise in the exchange. We charge for messages according to the currency of the country, and we find the exchange frequently varies to a considerable extent. In 1886 we were losers by its going down; but this year we have benefited by its rising in our favour. Those shareholders who have followed the published statements of the Company may be astonished at seeing the sum represented as earned in our report considerably higher than the figures which appeared in the newspapers indicated. This requires some explanation on our part. Up to the autumn of last year we were in the habit of publishing our gross earnings, which included the amount earned by the repairing steamer, but since that time we have adopted the principle acted upon by other cable companies of publishing merely the traffic returns, so that as our steamer has during the last year earned £500 a month, we have apparently done less business, but we thought it fairer to publish what we earned by our messages, as it might happen that this extra income of £500 a month might disappear in future in case the Company had to employ the steamer. For the present year we have secured the same earnings as the year before, and we are not without hopes that in the future we may continue in the same satisfactory position. There is an increase in interest account, which is due to our having had a larger amount of reserve to invest, and I hope to see this item grow very much year by year. The expenses which we have incurred during the year vary very little from those of the previous twelve months. One item was nearly £1,000 larger, namely, salaries and wages. The reason for that is that we have done more work, and we have required more clerks. We have a number of old clerks in our employment who have done their duty faithfully to the Company, and their salaries had been to a certain extent increased. And here let me remark that they have well earned that increase, because it has been owing to their careful attention to their work that the Company has been able to maintain its high reputation. The working expenses of the steamer have been virtually the same as they were the year before, so also are the office charges in London. We have had to spend about £1,700 more in repairing our cables—not a very large amount when you come to consider that we have to deal with over 1,700 miles of cable, and that breakages will occasionally occur. The only thing we can do in such cases is to make the repairs as rapidly as possible. I am happy to say that although we have had several interruptions to our cables, we were fortunate in being able to keep them down to a very short time, and sometimes with the assistance of the land lines we have been able to work during part of the time there were interruptions. After deducting all the expenses and the amount which we have to pay on our debentures regularly on the 1st of January and the 1st of July, there remained a net profit of £23,114. 18s. 1d., or adding the amount brought forward from last year, namely, £776. 16s. 5d., the total sum to be dealt with was £23,891. 14s. 6d.; out of this sum you have received in dividend £15,000, and we now ask you to sanction our proposal to write off from the

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repairing steamer £1,557. 15s. 3d., reducing her value in the books of the Company to £17,500. Then we ask you to sanction the addition of £7,000 to the reserve fund, making it £27,000. We lay great stress on the importance of increasing this fund as much as possible, because in case of accidents it would enable us to make large repairs without being put to great financial inconvenience thereby. We are firmly convinced, too, that if we are able to show a larger reserve fund than we can at present the value of the Company's shares will proportionately rise in value. Our auditor, you will see by his certificate approving of the accounts, refers to the investment of £10,905. 12s. 6d. as having been realised. I quite agree with him that the investing of our reserve fund in debentures of our own Company is not quite desirable, however good a return it might yield, for in times of emergency the sum would hardly be available at a minute's notice, and we might not find people willing to take them at our price. Since the close of 1887 we have sold debentures at a profit, and invested them in securities which at any moment are convertible into cash, and which at the same time give us a fair remuneration. The remark of the auditor regarding our not making an allowance to the steamer for depreciation is answered by the amount that we propose to write off on this occasion. He concluded by formally moving the adoption of the report and accounts.

Mr. THOS. FIELDEN CAMPBELL seconded the resolution.

Mr. WELLS wished to know if there was any particular reason why the Company's accounts should be kept differently from those of any other company. By the way they were at present kept, and owing to the way the dividends were paid, the public were not able to fully appreciate the position of the Company. He thought it would be very desirable, too, if the auditors adopted the principle of other telegraph companies, and showed of what the investment account was composed. He thought it would be an advantage to have a detailed statement of it.

Mr. MASON could not agree with the last speaker as to the investment account. If their auditor was satisfied that the money was invested in a proper manner, and in accordance with the Articles of Association, he thought it would be more to the advantage of the Company that they should not know the particulars of the investments.

The CHAIRMAN: I can assure you that our auditor fully approves of the investments which we have made. As regards the payment of the dividends, we are only just now beginning, so to say, to get a firm hold of dividends. The previous year we were only able to divide 3 per cent, and I think we are approximating the policy of other companies by giving a portion of it in the middle of the year and a further distribution at the end of the year. Of course it lay in our power when we divided 3 per cent. at the beginning of the year, to give only 2 per cent. to our shareholders; but we thought it would please them better to receive the full amount that we thought we were justified in giving.

A SHAREHOLDER: Are the debentures terminable?

The CHAIRMAN: In 1902, when I hope we shall make an exchange at a lower interest.

The resolution was then put to the meeting, and carried unanimously.

On the motion of Mr. MASON, seconded by Mr. THORNTON, the retiring Directors, Mr. Alfred Marshall and Mr. Henry Roberts, were unanimously re-elected, as was also the auditor, Mr. J. Weise, on the motion of Mr. THORNTON, seconded by Mr. MASON.

The CHAIRMAN having briefly acknowledged this renewed mark of confidence, the proceedings terminated.

Submarine Cables Trust.

The seventeenth ordinary annual meeting of the certificate holders in this Trust was held on Tuesday, at Winchester House, Old Broad-street, under the presidency of Sir James Anderson.

The SECRETARY (Mr. Lewis Wells) read the notice convening the meeting and the minutes of the sixteenth annual meeting, which were confirmed by the present meeting, and signed by the Chairman as correct. The report of the Directors was taken as read.

The CHAIRMAN: I have very few remarks to make, but some of them will give a clearer exposition of the report. Our revenue for the financial year which has just terminated was £17,948, as against £14 528, but in 1887 we brought into the accounts the large balance of £2,140, whereas we began this year with a balance in hand of only £95. In both years we have paid our coupons at the rate of 4½ per cent, but we carry forward to the current year a balance of £1,448, which, as stated in the report, is equal to an additional 8s. 6d. per cent. The interest payable on our certificates is cumulative, but our revenue has not enabled us to pay the coupons beyond those due on October 15, 1887, leaving the last coupon in arrear. The trust deed under which we work provides that interest shall be payable half yearly, viz., on 15th October and on 15th April. If we distributed the balance of 8s. 6d., which we have in hand, at once, the April coupon would have to be paid in three instalments, because in October next we shall not have sufficient funds to pay the whole outstanding £2. 11s. 6d. To avoid the inconvenience of paying one coupon by three instalments, your Trustees propose, with your approval, to hold the money in hand until October 15th, when they will pay £2 10s., and the balance of 10s. will be met on January 15th, 1889. On April 15th next year, we shall pay as much as possible on the October coupon. Due notice of the dates of payment will be sent to all the certificate holders who furnish the secretary with their names and addresses. In paragraph 3 of our report we refer to the falling off in our receipts. That is mainly owing to our investment in Anglo-American Company's stock, and I am sorry to say I do not know anything that I can at present add as to the prospect of that improving. The Eastern and Eastern Extension Companies—in which we hold a large amount of stock—are, however, paying very fair dividends—a fact which keeps up our revenue. By and bye, if the American "pool" companies can come to some agreement with their competitor, we hope to be in an improved position. For the present we are powerless in regard to that matter. With these few remarks I now propose

"That the report and accounts of the Trustees, now submitted to the meeting, be approved and adopted."

The Right Hon. VISCOUNT MONCK seconded the motion.

Mr. WEATHERBY made an inquiry as to the balance in hand on April 15, and was answered by the SECRETARY.

The CHAIRMAN put the motion, and it was carried unanimously.

The auditors, Mr. John G. Griffiths and Mr. John Gane, were afterwards re-elected.

Mr. WEATHERBY, in proposing a vote of thanks to the Directors, expressed a hope that they would do all they could to keep down the expenses as much as possible.

Mr. GRAY seconded the motion, and it was carried unanimously.

The CHAIRMAN: I am much obliged to you for the confidence you express in us. With reference to the expenses, we are always watching them in order to keep down the amount as far as possible.

The meeting then separated.

The Great Northern Telegraph Company.

This Company held its annual meeting at Copenhagen on Saturday evening, April 28th, when the Chairman, Mr. Tietgen, after reading the report, said that the state of the cables had been very satisfactory during the past year. In Europe there had been only four interruptions, which was an unusually small number, and in Eastern Asia there had been seven, which was also below the average. The repairs had been effected by the aid of the Company's cable steamers and engineers, with their usual skill and promptness. A question which has at all times been a most important one to telegraph companies, and one which always attracted general attention, was the life of a cable. Ignorant pessimists had put the limit at ten years because they had known instances of cables which had lasted no longer, but they had forgotten to mention the special causes for this short duration. These causes were, as a rule, external, such as an unfavourable condition of the bottom, &c., and less frequently owing to faulty manufacture of the cables. Others, including the Directors of the present Company, had taken a more hopeful view, although they expressed their opinions with the greatest caution, in the absence of reliable experience. Such experience had since been gained. Their oldest cable was the Danish-Norwegian, which had served close upon 22 years, but which in reality was older, as the Company's predecessors had bought it "second hand." It was of a somewhat primitive construction, and there was at the present time only about one-fourth of the original cable in use. The Anglo-Danish cable was put down in 1868, and had thus entered upon its twenty-first year. The state of this cable was altogether satisfactory, although it had been necessary to strengthen it at certain places, especially in the proximity of the English coast, where it was exposed to a considerable amount of trawling. Equally satisfactory is the state of the Scotch-Norwegian, the oldest Swedish-Russian, and the Danish cable, which are all 20 years old. Next in age came the Company's East Asian cables, which were now in fairly good condition. The principal mistake had been that their sheathing had been too weak to resist the dangers to which they were exposed. As a further illustration of this, he might mention that in the year 1870 a reserve portion of the same cable had been used in Europe—between Finland and Aaland—where the conditions of the bottom were very difficult, and of this cable, which was originally 57 miles long, there are only seven miles left of the original type—the rest had been renewed. All the Company's cables of a more recent date, both in Europe and Eastern Asia, are in an excellent state, including the French-Danish (dating from 1873), which for several years was the cause of considerable anxiety, until it had been strengthened in the right manner and in the right places. Their experience tended altogether to prove that the core of a cable resting perfectly undisturbed on the bottom of the sea is almost imperishable. This applies especially to gutta-percha cores, which the Company was adopting more and more. As to the sheathing, this could scarcely, even under the most favourable conditions, be said to be imperishable, though if proper materials were used a long life was possible. The shareholders had, he submitted, every reason to be satisfied with the state of the Company's cables. The principal events of the past year were the negotiations with the Chinese Government, which, the Chairman regretted to say, had not yet been brought to a satisfactory termination. About a year ago the Company, in union with its present ally in China, the Eastern Extension Company, commenced the negotiations with the Chinese Government. The representatives of the two companies, Mr. Henningsen and Mr. Judd, went up to Tientsin last April to lay their complaints and the proposals for a future arrangement before the Vice-King; the Managing Director of the Company at the same time visited St. Petersburg, where the Government desired minute information as to the Company's plans and intentions. The result was that the Russian Legation at Pekin was instructed to render the Company what assistance they could. The Vice-King referred the matter to the Chinese Director of Telegraphs, who resides at Chesoo, and the negotiations dragged on for the greater part of the summer. As was expected, the Chinese Government wanted to evade the concession of 1881, which was contended to be an illegal document, not having been sanctioned by the Tsung-li-Yamen, or what may be termed the Chinese Foreign Office. The Great Northern Telegraph Company had therefore framed an agreement between the two companies and China, which could take the place of the concession; but this draft did not, to begin with, meet with the approval of the Director for the Chinese Telegraphs. This official wanted a different base for the negotiations, and this had also been agreed to, although it would make the agreement more complicated. No sooner

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had a fresh draft, however, been framed before the Chinese Government entirely abandoned their original views, and demanded fresh negotiations on the base of the Company's own proposal. Coupled with this were, however, several new demands, to which the Company objected and to which they only acquiesced after a considerable amount of pressure both from the Chinese Government and the Russian Legation at Pekin. The result was the Chesoo agreement of August 10th, 1887, signed by the representatives of the two companies and by the Chinese Director of Telegraphs on behalf of the Chinese Government. The Company had looked upon this agreement as a definite result, although not so favourable and satisfactory as wished for; but it had now rested with the Tsung-li-Yamen for seven or eight months for ratification without anything having transpired as to the fate of the agreement. Although the Chairman considered further discussion on the subject of this agreement, which might yet turn out to be stillborn, idle, he thought it expedient to correct some gross misrepresentations which had appeared in the Chinese press, and he also wanted to draw attention to the somewhat extraordinary proceedings of the Shanghai and Hong Kong Chambers of Commerce, inasmuch as these bodies had made objections against the agreement at head-quarters without knowing its contents. It had thus been circulated that the Company had paid China 100,000 taels for the agreement, and it had even been insinuated that this or other sums of money had found their way into the pockets of private Chinese individuals. No such thing had, of course, taken place; and, as a matter of fact, there would have been more occasion for the Chinese Government to try the power of gold with the Company than *vice versâ*, as the latter had only reluctantly accepted the agreement. The present state of affairs was this: that while the cables hitherto had transmitted the whole of China's telegrams to and from abroad, the time was now at hand when the Chinese land lines would obtain connection with the neighbouring countries' lines across the inland borders, and thus open new outlets for the traffic, against which the concession of 1881 would have protected the Company if it had been respected. What the Chinese telegraph authorities and the Great Northern Telegraph Company have now agreed upon is simply working hand-in-hand instead of against each other, by mutually influencing each other's rates and at the same time dividing the profits of the traffic, so that the profits for telegrams from and to those towns in China where the cables are landed mostly go to the cable companies, while the money for telegrams from and to other towns goes to the Chinese Administration. The public can of course choose what route they like. It had required a fair amount of resignation on the part of the Directors to accept this new order of things, as it will at once deprive the Company of a not unimportant profit derived from the traffic between Chinese towns, that are not "cable towns" and abroad, even if the public, which is probable for many years yet, will prefer the cables to the overland lines. And the agreement will further debar the Company from sharing in that increase of traffic which undoubtedly will take place to and from the interior of China when that country is opened for European progress. In lieu of all these sacrifices, the Company obtains the certainty of a *perhaps* less remunerative, but, on the other hand, more staple future in China. The Chinese telegraphs obtain, for their part, a considerable larger profit than they for some years could expect to earn if acting independently; but, on the other side, they give up an essential share in the profits on telegrams to and from the cable towns. That this agreement was a fair and just one, viewed from an impartial standpoint, would appear from the fact that both the English and the Russian Legations at Pekin had given the negotiations their support, as well as the whole of the Corps Diplomatique at Pekin. The *doyen* of the Corps Diplomatique, the German Ambassador, had announced the steps taken by the Hong Kong and Shanghai Chambers of Commerce as entirely unjustified and unfounded. Under the present circumstances it was impossible to predict what would be the final result of these long-pending negotiations, nor would the Chairman venture any prophecy as to what would happen. In order to be prepared for all eventualities the Directors proposed to put something substantial by for a rainy day. The Chinese Government had in the past year pushed their telegraph works with less energy than during the preceding years. The northern line he mentioned last year had been prolonged to the Russian frontier by two side lines, and the Yunnan line, *vid* Hankoo towards the south, had advanced to the border of Tonkin. These are the lines which have mostly brought about the negotiations referred to. China has further laid her first submarine cable in connecting the island of Formosa with the continent in the proximity of Foochoo. The Pescadores islands were at about the same time connected with Formosa. The Corean line has not yet been completed, a steamer, with cable on board, having been lost in the Red Sea. The Chairman had already last year stated that the Russian Government had introduced the Wheatstone system, by the aid of Danish telegraph clerks, between St. Petersburg and Irkutsk. A further step had now been taken in this direction by the engagement of a similar number of Danish gentlemen for the lines to the east of Irkutsk. The gross profits during the year 1887 amounted to 5,594,442kr. (including surplus from 1886), of which, fees for telegrams accounted for 4,806,717kr. The total expenses were 1,166,361kr.; of this amount 686,367kr. went to salaries, 164,682kr. to expenses connected with stations, agencies, &c., and 164,682kr. to the ordinary inspection of lines and cable steamers. The net profits were 4,428,080kr. of which 571,500kr. had been paid for interest and reduction of debentures. The shareholders had already obtained 5 per cent., or 1,350,000kr., and it was now proposed to give them an additional dividend of 4½kr. per share—equal to 675,000kr. To the reserve and renewal fund were added 1,000,000kr.; to the pension fund, 50,000kr.; to the Directors, 27,000kr.; and 754,580kr. were proposed being carried forward to this year's account.

The Directors' proposal was unanimously passed.

The CHAIRMAN also mentioned that it was the intention of the Company to make a good show at the forthcoming Copenhagen Exhibition.

West India and Panama Telegraph Company.

Report of the Directors for the half-year ended 31st December, 1887, to be submitted to the twenty-second ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, London, E.C., on Wednesday, the 16th inst, at twelve o'clock:—

1. The amount to credit of revenue is £44,945. 14s. 11d., and the expenses have been £24,884. 13s. 8d., leaving a balance of £20,061. 1s. 3d., which, with the balance of £1,826. 11s. 6d. brought from last account, makes a total of £21,887. 12s. 9d. Of this sum the Directors have placed £3,000 to reserve, leaving an available balance of £18,887. 12s. 9d., with which it is proposed to deal as follows:—

Payment of 10s. per share on account of arrears of dividend on the First Preference Shares	£17,281	10	0
Balance to current half-year's account.....	1,606	2	9
	£18,887	12	9

2. The traffic receipts for the six months show an increase of £3,623. 12s. 3d., as compared with the corresponding period. The gross revenue is also augmented by the profit on the charter of one of the repairing ships to a connecting Company, an improvement in exchange, and other exceptional causes.

3. The value of the cable used in the further repair of the original Jamaica-Porto Rico section, reported last November, amounts to £7,063, and has been, as on former operations on this section, charged to the reserve fund. The total expenditure for cable only, in restoring this important duplicate line is £31,331.

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SILICIUM BRONZE AND SILICIUM COPPER WIRE.

The best for overhead Telephone and Telegraph Lines,

AND ALL ELECTRICAL PURPOSES.

Hard Drawn High Conductivity Copper Wire.

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BEARINGS, BUSHES,

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THE PHOSPHOR BRONZE COMPANY (Limited),

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4. As must always be expected from the exceptionally unfavourable nature of the West Indian seas, numerous interruptions of cables have occurred during the half year, and the Company's two ships have been frequently engaged. Owing to the duplication of the greater part of the system the communications with the Colonies, except in one instance, have not been materially affected. All the cables are now in working order.

5. The Company's ss. "Grappler" is now on her way to London to take out 258 knots of new cable which is being manufactured under contract.

6. Should the International Conference on the question of the bounties granted by Continental States to their sugar industries arrive at a satisfactory conclusion, it is hoped that the result will be beneficial to West Indian interests.

7. In accordance with the Articles of Association, Charles William Earle, Esq., and William Ford, Esq., retire at this meeting, and offer themselves for re-election.

8. John George Griffiths, Esq., the auditor, also retires, and offers himself for re-election.

NEW COMPANIES REGISTERED.

UNITED KINGDOM TELEPHONE UNION (LIMITED).—This Company was registered on the 28th ult., with a capital of £10,000,000, in £5 shares, to carry on telephonic operations, with power to take over any existing business of a similar nature. The subscribers are :—

	Shares.
James Brand, 65, New Broad-street, chairman United Telephone Company	1
J. S. Forbes, Chelsea Embankment, deputy-chairman United Telephone Company	1
J. B. Morgan, Oxford-court, Cannon-street, managing director United Telephone Company	1
J. Thompson, Wilmslow, chairman Lancashire and Cheshire Telephone Exchange Company	1
R. Raynsford Jackson, West-hill, Sydenham, chairman National Telephone Company	1
J. Winstanley, Dublin, chairman Telephone Company of Ireland	1
D. O. Bateson, 77, West Cromwell-road, chairman South of England Telephone Company	1
C. Nash, Bath, chairman Western Counties and South Wales Telephone Company	1
R. T. Wilkinson, Sunderland, chairman Northern District Telephone Company	1
J. Batten, 15, Airlie-gardens, Campden-hill, director United Telephone Company	1
Dillwyn Parrish, 2, Copthall-buildings, director United Telephone Company	1
W. C. Quilter, M.P., 74, South Audley-street, director United Telephone Company	1
F. R. Leyland, 49, Princes'-gate, director United Telephone Company	1

Registered without special articles.

PROTEAN BATTERY SYNDICATE (LIMITED).—This syndicate was registered on the 28th ult., with a capital of £5,000, in £10 shares, to carry on business as electricians, and for such purposes to adopt an agreement of the 2nd of February, between William Kingsland and Milford Norsworthy. The subscribers are :—

	Shares.
William Kingsland, 49, Cambridge-road, Gunnersbury, electrician	1
M. Norsworthy, 34, Old Broad-street, chartered accountant	1
A. W. Webb, 57, Perham-road, S.W.	1
E. R. Gibson, Lloyd's, underwriter	1
P. Lloyd, 34, Old Broad-street, insurance broker	1
J. Davies, 5, Finsbury-square, auctioneer	1
J. Bidden, 68, Wood-street, Woolwich	1

Registered without special articles.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended May 4th, 1888, amounted to £4,387.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this company for the month of April, 1888, amounted to £1,800.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of April, 1888, amounted to £51,582, and to £43,136 in the corresponding period of 1887.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of April, 1888, amounted to £37,331, and to £35,965 in the corresponding period of 1887.

GREAT NORTHERN TELEGRAPH COMPANY.—The latest traffic returns of this company are as follows :—Receipts in April, 1888, £21,400 ; from January 1st to April 30th, 1888, £85,200 ; corresponding months, 1887 and 1886, £81,520 and £78,480 respectively.

ORIENTAL TELEPHONE COMPANY.—At the adjourned meeting of the shareholders of this company, to be held on Friday, the 25th inst., the proposed dividend of 2½ per cent., free of income-tax, for the past year, on the paid up capital of the company other than the vendors' shares, will be again recommended by the directors. The transfer books of the company will be closed from the 22nd to the 26th May, both days inclusive.

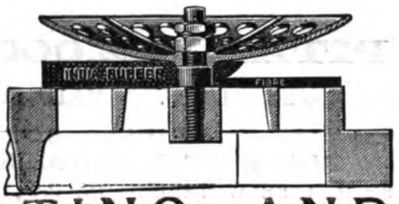
WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended May 4th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,649.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended April 30th, 1888, are £3,268, as compared with £3,027 in the corresponding period of 1887. The January receipts, estimated at £5,718, realised £5,965.

PERSONAL.—Mr. Basil Gee has taken charge of the London sales department for cable and wire of Walter T. Glover and Co., 10, Hatton-garden, E.C., and Salford.

NEW VALVE

No Rubber, Percha, or Leather.



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Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, May 9, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending May 9, 1888.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American	38 39	3 10 5	Jan., Apr., July, Oct.	38	...
2,614,820	Stock	20/0	Do. Preferred	64 65	4 4 7	,, ,,	64½	64
2,614,820	Stock	nil.	Do. Deferred	12½ 13½	...	February	12⅝	...
130,000	£10	3/0	Brazilian Submarine	12½ 12⅝	5 12 0	Mar., June, Oct., Dec.	12⅝	12½
16,000	10	3/0	Cuba Submarine	12⅜ 13½	6 1 0	February and August	13½	...
6 000	10	10/0	Do. Preference	18½ 19½	4 2 1	,, ,,	19⅜	19½
12,931	5	2½%	Direct Spanish (£4 paid)	3⅜ 4½	3 10 0	March & September	4	...
6,000	5	5/0	Do. Preference	8½ 9½	4 4 3	April and October	9½	...
60,710	20	2/0	Direct United States	8⅜ 8⅝	4 10 0	Jan., Apr., July, Oct.	8⅝	8½
380.000	10	2/6	Eastern	11⅜ 12	4 12 9	,, ,,	11 11/16	11⅜
70,000	10	3/0	Do. 6 per Cent. Preference	14½ 15½	3 19 0	,, ,,	15 7/16	14½
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 8	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅜ 13	5 0 0	Jan., Apr., July, Oct	13	12 11/16
22,050	10	5/9	German Union Telegraph and Trust	9 9½	7 7 4	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅞ 6⅛	5 1 0	Jan., Apr., July, Oct.	6 1/16	5 15/16
178,992	10	3/0	Do. 6 per Cent Preference	13½ 14½	4 5 0	,, ,,	14⅜	13½
150,000	10	5%	Great Northern	14½ 14⅝	5 0 0	Jan., July, and April	14⅝	14½
17,000	25	5/0	Indo-European	38 40	6 5 0	April and October	38½	...
38,348	10	3%	London Platino Brasilian	5½ 6	5 0 0	May and November	5 7/16	...
9,000	8	4/0	Reuter's	7⅞ 8	5 0 0	April and October	7 15/16	7½
388,225	Stock	12%	Submarine	140 150	9 3 4	February & August	...	...
80,000	10	6/0	West Coast of America	5⅞ 6½	8 0 0	January and July	5⅞	5 11/16
150,000	100	8%	Do. Debentures	112 117	6 16 2	June and December	...	...
88.321	10	nil.	West India and Panama	⅞ 1⅛	...	...	1 1/16	1
34,563	10	9/0	Do. 1st Preference	10⅞ 11½	8 8 9	April and October	11⅛	11
45,181	15	3/9	Western Brazilian	9⅞ 10⅛	6 5 11	March & September	10⅛	9⅞
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 10	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	⅞ 1	5 0 0	Yearly	1	...
220,000	£1	...	Oriental (11s. paid)	⅛ ¼	...	...	...	...
80,000	5	5/0	United	14⅞ 15½	4 5 3	June and December	15½	14⅞
50,000	5	2/6	United River Plate	4⅞ 5⅛	...	April and October	...	...
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb. '86	Anglo-American Brush (£4 paid)	2⅜ 3½	...	...	2 15/16	...
23,692	5	nil.	Do. (fully paid)	3⅜ 4	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅛ 2½	...	...	2 1/16	2⅜
312,000	½	0/1½ '86	Maxim-Weston	1/16 1/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	39½ 40½	6 1 0	March and July	40½	39⅝
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16⅝ 17⅛	5 14 3	February & August	17⅛	17⅛

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

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The principal objects of the Corporation are :—

1. Performing the duties of Trustee, Executor and Administrator.
2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the duties of the family solicitor.

The Corporation acts as Trustees for the Debenture Holders in Public Companies.

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GEORGE PEARSON, *General Manager and Secretary.*

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NOTES.

The Continuous *versus* Alternating Current discussion gives promise of perennial vitality. On Wednesday, at the Society of Arts, the redoubtable Mr. Crompton once more set forth the views with which our readers are now, perhaps, sufficiently familiar—this in addition to his reply last night at the Society of Telegraph-Engineers, which we shall report in due course in our next issue. A Paper on the same subject, which comes to us from Chicago (where it was recently read by Prof. F. B. Badt, before the electric club of that city), contains at least one point which we believe to be novel. Prof. Badt, like most electricians who are not partisans of a "system," believes that each method is good in itself, and has its own special field of usefulness. At the same time he is strongly impressed with the special economical advantages of transformer working, and his Paper is chiefly devoted to a consideration of the merits of that system for central station lighting. The point which we have referred to as novel is this, that in a high-tension alternating-current circuit, where the machine is separately excited, there is less danger to human life arising from an accidental break in the circuit than is the case with a continuous-current machine, where the field-magnets are in the same circuit. In the discussion which followed, Mr. Cutter, of the Thomson-Houston Company, stated that in their experience linesmen and others who had been accustomed to continuous currents, after working for a while with alternating currents, objected to go back to the former.

The beauty and ingenuity of the Van Rysselberghe system of simultaneous telegraphy and telephony has always been beyond dispute, but as a practical and efficient system we have from the first held that its application must be limited to circuits on which the telegraph service is not (as a rule) of a pressing character. It is largely for this reason that no use has been found for the system in this country, and the very considerable success which it has attained abroad is simply a proof of the comparatively low telegraphic development of the countries where it is found useful. This remark does not, of course, detract either from the merits of the invention or from its actual utility, nor should we deem it necessary to say this but for the extravagant claims which are continually being made by its supporters. In Switzerland, however, the weak points of the system are beginning to be admitted. It has recently been given up on the line from Geneva to Lausanne, and is now to be abandoned between Basle and Zurich. As estimates of the cost of the system are not easily attainable, we may mention that the equipments at these stations cost about £300 a piece. Dr. Rothen (Director of the Swiss Telegraphs), who has had considerable experience with the system, says that "although the ordinary Morse signals do not suffer, the Hughes printing apparatus is often deranged, and the employment of high-speed instruments, such as the Wheatstone, would probably be impossible." On this last point there can be little room for doubt. In addition to this, much larger batteries are required, and it has also been found extremely difficult to preserve the condensers from destruction by discharges of atmospheric electricity. From the telephonic point of view, Dr. Rothen says that the transmission is feeble, "and the extinction of the telegraphic signals is obtained only in theory." For all this the system has done, and will doubtless continue to do, good service where circumstances happen to lend themselves to its employment, and especially where the telegraph is second in importance to the telephone, and where the circuit is of copper wire.

The audience who assembled at Kensington on Friday evening last to hear Mr. de Tunzelmann's lecture upon the Telephone were privileged to witness some highly interesting experiments with Mr. C. A. Bell's "water-jet transmitter." Since it was shown last year to the Royal Society we believe that this is the first occasion of a public exhibition of this remarkable instrument. As a long-distance transmitter there is no doubt whatever that it is capable of yielding results of a far superior character to those obtainable from any carbon transmitter, simply because there is no limit to the amount of battery power which may be employed.

In the now classical Paper "On the Predetermination of Dynamo Characteristics" by Mr. Gisbert Kapp, every one will remember the striking and beautiful analogy pointed out by the author between an electro-magnet and a voltaic battery immersed in a conducting fluid. It was probably owing to the introduction of this concrete and readily understood illustration that the Paper owed much of its subsequent success in modifying and enlarging the views of dynamo builders; and the *kudos* due to Mr. Kapp for its discovery is in no way lessened by the circumstance which we are about to mention, namely, that it affords one more proof that there is nothing new under the sun. In the *Phil. Mag.* for June, 1852, there is a Paper by Faraday, in which occurs the following passage:—"The magnet . . . may be considered as analogous

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in its condition to a voltaic battery immersed in water or any other electrolyte. . . . . I think the analogy with the voltaic battery so placed is closer than with any other case of *static* electric induction, because in the former instance the physical lines of electric force may be traced, both through the battery and its surrounding medium, for they form continuous curves, like those I have imagined within and without the magnet. . . . . No one, I think, will doubt that as long as the battery is in the fluid, and has its extremities in communication by the fluid, lines of electric force having a physical existence occur in every part of it, and in the fluid surrounding it. I conceive that when a magnet is in free space there is such a medium (magnetically speaking) around it. . . . . What that surrounding medium, deprived of of all material substance, may be, I cannot tell, perhaps the æther. I incline to consider this outer medium as *essential* to the magnet; that it is that which relates the external polarities to each other by carried lines of power; and that these must be so related as a matter of necessity." FARADAY proceeds to explain in what sense he uses the term *magnetic conduction*, which is of such frequent occurrence in the "Experimental Researches." In light of the last mentioned fact it seems hardly worth while to discuss the question to whom belongs the honour of inventing the term *magnetic resistance*. We understand, however, that a claim is put forward in this respect on behalf of EDISON.

AT the Physical Society on Saturday last some conversation took place with regard to Mr. OLIVER HEAVISIDE'S proposal (in the last number of *The Electrician*) to introduce the term "magnetic reluctance." A general disposition was shown to accept the proposal, both Lord RAYLEIGH and Prof. SILVANUS THOMPSON speaking in favour of its adoption.

MR. PREECE, on Thursday evening, remarked with great propriety that he wanted facts, and cared nothing for opinions. But when he went on to add "not even for the opinion of the editor of a technical journal," every right minded person will at once admit that for the moment Mr. PREECE went too far. But we are not at all angry—as the *Mikado* used to say; we know he did not really mean this, else why did he take so much pains to meet the criticism for which the technical journals were alone responsible? We shall, therefore, venture with confidence to ask Mr. PREECE'S careful perusal of our leader this week, wherein we have set forth at length our editorial views upon the subject under consideration.

UPON another point connected with technical journalism Mr. PREECE was good enough to offer *his* opinion, and we shall not be so rude as to say that we care nothing for it, because it happens to some extent to coincide with our own, and we are rather glad of an opportunity to say a few words on the subject. Mr. PREECE has the most decided objection to anonymous correspondence in the technical press. We may say at once that we believe our own record in this matter to be exceptionally good. A reference to the index which we published last week will show that out of 161 letters in our last volume only nineteen were signed with a *nom de plume*, and more than one-half of these were letters of inquiry from students and others. We have therefore no defence to make; nor, indeed, do we entirely agree with Mr. PREECE in this matter. While deprecating an unnecessary resort to anonymity, yet there are not a few cases in which the practice is perfectly justifiable. Such, for instance, as the case above mentioned of letters of inquiry. If a man wants to know the meaning of Ohm's law, and the editor cannot tell him, or for some reason does not wish to take the responsibility of doing so, does Mr. PREECE see any valid objection to his signing himself "An Ignoramus," or even for writing himself down as Dogberry desired? In other cases a signed letter might partake of the nature of an advertisement, for which due provision is made outside our correspondence columns. Or, to come to the point, in such a case as that under discussion, why should not the doings of a corporate body like the SOCIETY OF TELEGRAPH-ENGINEERS be subject to the unsigned criticism of those whose commercial interests are directly affected, if the writers find it desirable not to take sides too openly, and if the editor chooses to accept the responsibility of their insertion? On the other hand, we fully recognise and, as some of our correspondents have occasion to know, we act upon, the principle that anonymous letter-writing is an undesirable thing in itself, and not to be resorted to without good and sufficient reason.

UNLESS our esteemed contemporary the *Electrical Review* of New York has been made the victim of a very silly joke, the Mather Electric Company of Hartford, Connecticut, are responsible for the introduction of a startling innovation in dynamo-electric machinery. This is nothing less than placing the driving engine inside the armature! From the drawing accompanying the description, the engine appears to be of the Rigg type; it "is contained within a steam-tight metal casing, upon the outside of which the armature is mounted." The idea appears to us to be capable of still further development, for why should not the boilers be put inside the field magnets?

THE declaration of an interim dividend at the rate of 12½ per cent. per annum must be a very welcome announcement to the shareholders of "WOODHOUSE AND RAWSON (LIMITED)," especially as the sum carried forward is sufficient to have raised that dividend to no less than 40 per cent. But while heartily congratulating both the directors and the shareholders on the results attained, still, in view of the fact that further capital is to be called up and that the issue of 6 per cent. debentures to the extent of £30,000 is contemplated, it is desirable not to overlook the fact that the funds which have enabled the directors to produce these encouraging results have not been wholly derived from trading and manufacturing operations. A part of the profits—what part the Chairman did not disclose—is derived from financial transactions in connection with the UNIVERSAL AUTOMATIC MACHINE COMPANY. The directors are to be congratulated on the prudence and foresight which they have displayed in the matter—but, on the other hand, it is very evident that this is an entirely different thing from the

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development of a permanent business capable of yielding such results as the above.

WE regret to notice the demise of our worthy little contemporary *The Telegraphist*, which, after a courageous struggle of about four years' duration, has had to bid farewell to the telegraphists. We are almost as sorry for them as we are for Mr. LYND, who vainly imagined that by supplying what would be useful to them in their profession he would earn their support. It would seem that they are a good deal more bent on getting their reward than on deserving it. Only the paper that will air all grievances, and invent them when none exist, finds favour with the spirits which at present rule the destinies of the British and Irish—especially Irish—operators. The singularly selfish views of their leaders have been lately revealed by the inspired questions with which the POSTMASTER-GENERAL is being continually pestered in Parliament—such, for example as how it comes to be that a clerk brought from the country is paid as much as one appointed in the capital?

Rome.—The General Post Office and the Central Telegraph Office in this city are now lit by electricity.

Interruption of the Barbadoes Cable.—We are informed that the cable between St. Vincent and Barbadoes is interrupted.

Theatre Lighting.—The Town Council of Olmütz has decided that the town theatre shall next season be lighted by electricity.

Buda-Pesth.—The business of Messrs. Bruckner, Ross and Co. (which was the oldest electrical firm in Austria) has been taken over by Messrs. Ganz and Co.

Southampton.—The Southampton Town Council has decided to seek the necessary powers to borrow £1,440 for the purposes of an experimental electric light installation.

Kojeteim.—The sugar factory of H. Redlich, in this town, is being fitted up with an extensive Edison installation, by H. R. Bartelmus. M. F. Jehl is the consulting engineer.

St. Etienne.—We learn with regret that the Edison underground main system has not proved satisfactory at St. Etienne. In many cases the subscribers are going back to the use of gas.

Kiel.—Bremen and Co., of Kiel, are employed at the present moment upon a central station for arc and incandescent lamps in the Imperial Torpedo Works at Friedrichsort, near Kiel.

Barcelona Exhibition.—The pavilion set apart for the Queen of Spain at the Barcelona Exhibition is being fitted with telegraphic and telephone apparatus for the exclusive use of Her Majesty.

Cable to the Azores.—Portuguese advices state that a contract was signed in London on April 26th between the concessionnaires of the submarine cable to the Azores and a leading English construction company.

Verona.—The local company which was recently formed here for the purpose of establishing a central station has been obliged to abandon the scheme. The gas company, however, is about to undertake the necessary works.

Buenos Ayres.—A correspondent writes to say that during a very heavy storm in Buenos Ayres, on the 2nd inst., a house was struck by lightning, causing the death of two young men, brothers, who were inmates at the time.

Electric Light Breakdown.—The Vienna correspondent of *The Times* states that on Wednesday evening, 16th May, the Austrian Jubilee Industrial Exhibition had to be closed "because the electric lighting went wrong."

The Edison Company in Egypt.—It is announced that the representative of the Edison Company has entered into negotiations with the Egyptian Government to light the principal towns, commencing with Cairo and Alexandria.

Vienna.—We understand that an extensive addition will shortly be made to the electric lighting plant in the new Town Hall in Vienna. At the present moment there are over 650 lamps installed, and this number it is proposed to raise to over 2,000.

Mr. Crompton on Electric Lighting from Central Stations.—At a meeting of the Society of Arts, which was held on Wednesday evening last, at which Colonel Hamilton presided, Mr. R. E. B. Crompton read a Paper on "Electric Lighting for Central Stations." The Paper was almost entirely of a non-technical character.

Variability of Magnets.—The *Centralblatt für Elektrotechnik* mentions a Deprez ammeter (Breguet pattern) which they recently had reason to re-calibrate. When new 26 amperes gave a deflection of 44 degrees; but on re-calibrating the same deflection was obtained with a current of 17·3 amperes.

Baudot's Printing Telegraph.—The Italian Telegraph Department have recently acquired the rights of Baudot's quadruple printing telegraph. The apparatus in question is already working satisfactorily between Rome and Paris, and in all probability it will very shortly be adopted on other important lines in Italy.

Thetford.—Electric lighting has recently been adopted at the St. Nicholas Iron Works, Thetford. The residence of Mr. C. Burrell, the owner of the works, is also lit by the current. Gas costs 5s. per 1,000ft. at Thetford, and our informant states that many tradesmen and others in this district are anxious to have a central electric lighting station.

Brussels Exhibition.—The Anglo-American Brush Electric Light Corporation (Limited) have entered into an important contract with the Executive Committee of the Brussels Exhibition for the lighting of part of the buildings and gardens by means of arc lamps, and will have the sole right to supply the light to stall exhibitors and others within the area covered by their contract.

Breslau.—The committee nominated by the Town Council of Breslau to report upon the best way of lighting the town by electricity, recommend the construction of a large central station to supply 5,000 lights, within a radius of 1,200 metres from the station. The committee propose that Messrs. Siemens and Halske, of Berlin, should erect the necessary works, and that the town should run the installation. No definite decision has yet been arrived at.

Toulouse.—The central station at Toulouse, which has been already at work for several months, will shortly receive a very considerable extension. The proprietor, M. de Chanteau, has obtained permission to make use of a fall of water at Bazacle, which it is anticipated will provide a force of 1,200 horse-power. The gas company at Toulouse has just completed the electric lighting of the theatre, a job which they have had twelve months in hand.

The Lighting of the Tunnels on the Kieff-Odessa Line.—This is a chapter of the Snakes in Iceland type. We stated some few months ago—on the authority of a Continental journal—that the tunnels on the railway line between Kieff and Odessa had been lit by electricity. We now learn from a source at

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least equally authentic that there are no tunnels on the line between Kieff and Odessa. It therefore seems probable that they are *not* lit by electricity.

The International Society of Electricians.—The annual general meeting of this Society has just been held in Paris, when the following appointments were agreed to :—President : M. P. Lemonnier. Vice-Presidents : MM. Becquerel, Bergon, Carpentier, Gariel, Marié-Davy, and Lebert. Secretary : M. Seligmann-Lui. Secretaries of Sections : MM. D'Arsonval, Hospitalier, De Vasonty, Napoli, Sartiaux, and Vivarez. Treasurer : M. Dumoulin-Froment.

Students' Conversazione at the Technical College, Finsbury.—The annual students' *conversazione* of the Finsbury Technical College will be held on Friday, May 25th, commencing at 7 p.m., when a lecture will be delivered by Prof. S. P. Thompson on "Polarisation of Light," and a lecture will also be delivered by Prof. J. Perry on "Magnifying Springs." A concert will be given during the evening. Tickets may be obtained from the office of the college.

Mexico.—Advices from the city of Mexico report that new poles for the electric light are being daily erected in different parts of the city. The extension of the electric light appears, however, to have had a curious effect in producing an abundance of sand-flies and cockroaches in the city. According to a local scientist they both hail from Lake Texcoco, attracted at night by the electric light. Many varieties of insects, even if not nocturnal in their habits, are said to be thus attracted.

Middlesborough.—An entertainment was given a few days since at Borough-road, Middlesborough, by the district manager of the Northern District Telephone Company. The company had two transmitters at the Tyne Theatre, Newcastle, where the Carl Rosa Opera Company were performing, connected to a direct line running to the Middlesborough Telephone Exchange, thence to Borough-road, where nine receivers were placed round a table and connected. The company assembled heard the opera from beginning to end; not only were the words clearly rendered, but the least variation in expression was distinctly audible.

The Paris Exhibition of 1889.—All our readers, and particularly those who remember the valuable services rendered by Mr. John Aylmer, of Paris, as Secretary to the English Commission of the Paris Electrical Exhibition of 1881, will be glad to learn that the committee presided over by the Lord Mayor for carrying out the British Section of the Paris Universal Exhibition of 1889 have appointed him their hon. secretary in Paris. We are sure that a better selection could hardly have been made, and that Mr. Aylmer's management will render the larger Exhibition next year, as far as the English section goes, as great a success as that of 1881.

Telephones in France.—Inter-urban telephonic communication in France is now in many cases no longer limited to the offices at either end. At Paris, Havre, Lille, and Brussels, the subscribers can henceforth talk to one another from their own homes. The subscribers wishing for this additional privilege pay an extra sum of 50fr. per annum. This does not dispense with the charge for each five minutes' conversation, which is 1fr. between Paris, Lille, Rouen, Havre, and Rheims, and 3fr. between Paris and Brussels. The number of subscribers is as follows :—Between Paris and Havre, 85; between Paris and Lille, 145 ; between Paris and Brussels, 12.

The Late Sir Charles Tilston Bright. — At the weekly meeting of the Balloon Society, held at St. James's Hall, on Friday evening, May 11th, Mr. W. White, F.S.A. (late President of the Architectural Association), in the chair, the following resolution was adopted, moved by Mr. W. H. Lefevre, C.E., seconded by General Brine, R.E., "That this meeting of the members of the Balloon Society deeply deplores the removal by death of Sir Charles Bright, M.I.C.E., the pioneer of transatlantic telegraphy, and desires to record its deep sense of his eminent services rendered to engineering, science and literature, and that this resolution be sent to Lady Bright and relatives."

Chatham. —A local journal says that the local Electric Lighting Company is making good progress, and the engineer hopes to have everything in working order by the end of June. All the shares are taken up, and orders have been received which will absorb the whole power of the plant now being laid down—which is estimated to produce 4,000 incandescent lights of 10 candle-power each. Great difficulty has been experienced in obtaining a foundation for the heavy engine and dynamo on Messrs. Woodhams and Levy's wharf, as beneath the upper layer of made ground a thick deposit of blue clay was met with; this involved a heavy expenditure for piles in order to get a good foundation.

City and Guilds of London Institute.—Old Students' Association.—The next meeting of the Old Students' Association will be held at the Finsbury Technical College, Leonard-street, E.C., on Tuesday, May 29th (instead of on Wednesday, May 23rd, as previously announced), at 7:30 p.m. The following Paper will be read :—"Some Installation Breakdowns," by Reginald J. Jones, A.S.T.E. and E. The author will deal with accounts of breakdowns of plant, faults, &c., in actual practice in connection with—(*a*) "arc" dynamos and driving gear, (*b*) "incandescent" dynamos and driving gear, (*c*) motors, (*d*) arc light circuits, (*e*) incandescent light circuits, (*f*) arc lights, (*g*) incandescent lamps, fuses, &c. A smoking concert will be held early in June, further notice of which will be given.

The Electric Light at Railway Stations.—The question of the electric lighting of railway stations was discussed at the recent meeting of the International Railway Congress held at Milan, and it was stated that installations of this description have much increased of late years. In France, the goods station at La Villette and the St. Lazare terminus are lighted by electricity, while there are partial installations at Paris, Marseilles, Bellegarde, and Lyons. In Germany, forty-six stations are so lighted, Strasburg, with its 70 arcs and 100 incandescents, coming first. In Austria, only four stations possess complete installations. In Belgium there are seventeen stations so lit, and in Italy six. Arc lamps are generally preferred to gas; but in many cases the Lucigen light is employed on account of its cheapness.

The Metropolitan Theatres Bill.—At a meeting of the Balloon Society, held at St. James's Hall, Piccadilly, last week, Mr. William White, F.S.A. (late President of the Architectural Association), in the chair, an address was delivered by Mr. E. E. Marriott (of the Cyanite Fire Prevention Corporation, Chelsea) on "Fire Prevention," at the close of which the following resolution was adopted :—"This meeting is of opinion that the Metropolis Theatres Bill, introduced into Parliament by Mr. Dixon-Hartland, M.P., for the better regulation of theatres and music halls in the metropolis, deserves support, believing that it will secure, under the control of Her Majesty's Secretary of State for the Home Department, greater safety and security for theatres and music halls and all places of amusement and entertainment; and that a copy of this resolution be sent to Mr. Dixon-Hartland, M.P., and a petition, signed by the chairman on behalf of the meeting, be presented to Parliament."

Exeter.—At a meeting of the Exeter Town Council last week, the Exeter Electric Light Company petitioned to be

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allowed to erect overhead wires.—Alderman Daw asked if the company were properly registered, whereupon Alderman Ellis queried whether Alderman Daw had asked his question as solicitor to the Gas Company, or by virtue of his position as an alderman.—Alderman Daw expressed surprise at such a remark falling from the chairman of the Electric Light Company. He was not there in the interest of the Gas Company, and he thought the imputation should be withdrawn.—The Mayor said the articles of registration were lying at his (the Mayor's) office.—Alderman Ellis said he was under the impression that Alderman Daw was aware that the company was a substantial one, that shares were being readily taken up, and capital subscribed.—Mr. Blackburn pointed out that there could be no question as to the substantiality of the company, seeing that the original projectors spent £1,000 in lighting the streets of Exeter as an experiment.—Ultimately the application of the company was referred to the Streets Committee.

Messrs. Mather and Platt's Dynamo Catalogues.—This well-known firm has issued a new edition of their dynamo catalogue, Part I. referring to the Edison-Hopkinson type, and Part II. to the "Manchester" type. Each of these machines is too well known to require any detailed notice on our part. The machines are well adapted for use as motors, especially where weight is a secondary consideration, and visitors to the Manchester Exhibition last year will well remember the small "Manchester" motor driving a large wall-paper printing machine. The firm also give special attention to slow-speed dynamos for ship lighting, and plant of this type is now in use by the Admiralty. Where space is limited and high-speed engines are not desirable, the Mather and Platt grip pulley and belt-tightening gear is very effective. We also note that the firm are paying attention to the construction of dynamos designed especially for testing and teaching purposes. The "Manchester" machine at the City and Guilds Central Institution will be familiar to many of our readers. The catalogues are prefaced by some interesting and important details of tests carried out upon these machines (chiefly by Dr. Edward Hopkinson), which have already been fully reported in the technical press.

Electric Lighting at the Italian Exhibition.—The Italian Exhibition is lighted by three hundred arcs of 2,000 c.p. nominal, distributed throughout the buildings and grounds, and one hundred glow lamps, fixed in the Welcome Club. The installation is on the Thomson-Houston system, and has been laid down by Messrs. Laing, Wharton, and Down, of 82, New Bond-street, London. There are ten arc dynamos, each of thirty-five lamps capacity, and one glow lamp dynamo, of one hundred lamps capacity. All the dynamos are driven from one counter shaft, running at 250 revolutions per minute, and provided with 4ft. 6in. pulleys, the pulleys on the dynamos being 16in., and the speed 820 revolutions. Motive power is supplied by Davey-Paxman boilers and engines, there being three locomotive boilers, each of 100 actual horse-power, and one compound undertype combined engine and boiler of 40 nominal horse-power. In addition, there is fixed a compound engine of the girder type, of 40 nominal horse-power, running at one hundred revolutions per minute, and driving from an 8ft. 6in. fly-wheel on to a 3ft. 6in. pulley on the counter shaft. There are also two Windsor engines of the inverted compound type, each of 30 nominal horse-power, running at 180 revolutions, and driving from a 5ft. 6in. fly-wheel on to a 4ft. pulley on the counter shaft.

Fatal Thunderstorms in Germany.—Last week several severe thunderstorms occurred in Germany. The papers state that several people have been struck by lightning in villages lying in the Puttbus district. At Guhrow a young man and woman, on their way home from working in the fields, were overtaken by the storm, and both were struck dead by the lightning. The oxen which were following them at a distance of some twenty yards, drawing a cart, were stunned, and lay for some time unconscious. The young woman's skull was split, while only two small blue spots, one behind the ear and one on the breast, indicated how the man had met with his death. In the village of Ruben a woman who was at work in a field took shelter from the storm in a neighbouring wood, and unfortunately met with the same fate. At Alt-Dobeln a tavern was struck by the lightning. The wife of the owner, who was sitting sewing at a closed window at the time, states that the lightning came through the roof, flashed across the room over her head, and dashed against the window at which she was sitting, smashing several panes of glass. It then bounded back into the room, passing between her two children, girls of nine and ten, who were sitting together on a bench, and ultimately left the house through the wall of another room. The children were unconscious for some minutes, probably from fright, as they do not appear to have sustained any injuries from the lightning.

Proposed Central Station at Birmingham.—"We understand," says the *Birmingham Daily Post*, "that there is now on foot a project for applying electric lighting to a limited but important area in Birmingham. Some time ago the Committee of the Old Library, in Union-street, came to the conclusion that, for the comfort of the readers and the preservation of the books, it would be desirable to substitute electric lighting for gas-lighting, provided that favourable conditions could be arranged. They consulted Messrs. Chamberlain and Hookham on the subject—the electric lighting established by that firm in part of the Art Gallery being very satisfactory—and it was found to be perfectly easy to light the library, as desired; but a difficulty occurred as to the provision of the motive power for the production of the light, the committee regarding it as impossible to make room for an engine in any part of the library premises. This difficulty, however, can be overcome by making such provision elsewhere; but in order to justify that expenditure it is necessary that a considerable area should be lighted, on conditions which would ensure to the promoters of the enterprise a sufficient number of lights, and an undertaking for permanent use of them. Having had inquiries from other persons in the neighbourhood of the library, Messrs. Chamberlain and Hookham have marked out a district bounded by High-street, New-street, and Corporation-street, up to Union-street; and have ascertained that from a common centre any building in this area can be conveniently lighted by electricity, provided, of course, that persons using the light are willing to give permission for the necessary connection from house to house. They are now, we understand, taking means to learn how far the tenants of buildings within this area, which includes the library, are disposed to avail themselves of the advantages of such a scheme. Their proposal is to supply the electric light by meter, on conditions similar to those in operation in Liverpool, where a scheme of private lighting, approved by the Town Council and the Board of Trade, is now successfully working, on terms which allow the light to be supplied at from three farthings to one farthing per lamp per hour, according to the number of hours of consumption."

Electric Lighting in the Sandwich Islands.—A transatlantic contemporary, *Modern Light and Heat*, says that "the Thomson-Houston Electric Company has received a very interesting letter from Mr. W. A. Faulkner, Superintendent

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Government Electric Light Honolulu, regarding the Thomson-Houston plant which has been installed there. No time was lost in setting up the engines and dynamos after their arrival, and on March 23rd the city was illuminated for the first time by the electric light. Honolulu, the principal city of Hawaii, is peculiarly well situated for electric lighting on account of the water supply, which can be easily utilised for generating the necessary power. The station is situated about 2½ miles from the centre of the city, and is about 400 feet above the level of the sea. Water power at the station is derived from 300 foot head, carried through 5,296 feet of pipe 15 inches in diameter, and there is a pressure of 130 pounds to the square inch. This is a part of the city water supply doing work at the station on its way to the reservoir. The power is supplied by a double discharge mining wheel, 20 inches in diameter, making 1,250 revolutions per minute at the pressure above mentioned. This wheel drives two dynamos, both manufactured by the Thomson-Houston Electric Company, one of twelve, and the other of 50-light capacity; the smaller machine carrying its lights on six miles of wire, and the larger one on fifteen. Both machines have worked admirably, and have given from the start every satisfaction. On the 23rd ult., the day of starting, a distinguished company assembled at the station, among whom were her Royal Highness Princess Kialani, heiress presumptive to the throne, and his Excellency L. A. Thurston, Minister of the Interior. The Princess, under the direction of Mr. Faulkner, completed the circuit, and had the honour of lighting the city for the first time with the new lights. The start was most successful, every lamp burning. The scene in the city was very exciting, the streets being thronged with people, many of whom had been waiting some time to see the lights turned on, and all appeared very much pleased at the result. The lights have been lighted every night since, and the installation has been a most successful one in every way. The members of the Government were so much pleased with the operation of the plant that it is more than probable that the present system will ere long be extended."

Report upon Jarman's Electric Tramcar.—We have received a copy of a report upon the Jarman Electric Tramcar from Messrs. Walker and Hyde, consulting engineers and patent agents. No figures are given save some of a very incomplete character relating to the power expended on a single journey. The following are the most important paragraphs:—"The whole of the locomotive machinery is arranged beneath the floor of the car, and comprises two series electric motors, both armatures of which are mounted upon one spindle, a wrought-iron pinion of 12 teeth being keyed centrally upon said spindle, the motion being thus transmitted to intermediate shaft. The motor pinion gears with a mortise wheel of 48 teeth, and a second pinion of 24 teeth, also keyed upon the intermediate shaft, gears with a similar mortise wheel of 48 teeth keyed upon the driving axle of the tramcar. The peculiarity of the gearing lies in the fact that the mortise wheels above referred to are geared with cogs formed of vulcanite fibre, and flanges are extended up to the top of the tooth, the whole being secured by pins passing through the width of each cog at the pitch line, and which are riveted over through the flanges. The motors are arranged so that while one is propelling the car in one direction the armature of the other is rotating freely within the corresponding field, thereby allowing of the free circulation of air for cooling. In this way one motor may be used for the outward journey, and its armature may be cooled while the other motor is performing the return journey. If additional power be required both motors may be used at once. The accumulators being arranged in trays mounted upon wheels and placed under the seats, may be run out through doors at each end upon a suitable truck or platform upon the arrival of the car at the charging depot, and in our opinion the operation of taking out the discharged cells and replacing them by others newly charged could be performed by two men in five minutes. There were 23 persons upon the car, the general structure of which is much heavier than the modern cars of the same rating now being used upon the metropolitan lines, and we consider that the whole system has been well designed and carried out in a practical and efficient manner, and if a charging installation for even two or more cars was laid down, there would be a distinct saving per car mile over the present cost of maintaining a number of horses to perform the same work, and that the system could be worked, even on a small scale, efficiently and profitably."

Professor Blyth on Wind Power for Electric Lighting.—An interesting paper dealing with the production of electricity by wind power was read by Professor Blyth before the Glasgow Philosophical Society the other night. The professor said that as far as he knew the first suggested application of wind power to the production of electricity was by Sir William Thomson, at the York meeting of the British Association, although no doubt the idea was in the minds of many people before then. During last summer Professor Blyth had an opportunity of making a practical experiment. He erected a small windmill for supplying electric light by means of storage cells to a small cottage in the village of Marykirk, where he spent his summer holiday. The windmill was of the old English type, and was erected in the garden. The tower consisted of a wooden tripod firmly fixed in the ground, and strongly braced together by bars of wood. The windshaft stood about 33 feet above the ground, and carried four sail arms at right angles to each other, each being about 13 feet long. The dynamo, an old form of Bürgin, was driven directly from the fly-wheel by means of a rope, and a workable speed was attained even when the windmill moved at a comparatively slow speed. The current from the dynamo was employed to charge twelve electric power storage cells, which supplied the incandescent lamps in the cottage. As yet he had only used at one time 10 eight candle-power 25-volt lamps, but he found that storage for more could be quite easily obtained. One day when a good breeze was blowing he stored as much in half a day as gave light for four evenings of about three or four hours each. As yet, however, he had not had time or opportunity to test fully the capabilities of his arrangement. For one thing, he required a more suitable dynamo and a much greater storage capacity, so as to take advantage of all the wind blowing, and when this was done he had no doubt whatever regarding the complete success of his experiment. While charging, the current passed through a cut-out arrangement, which immediately disconnected the cell from the charging circuit when the dynamo ran below a certain speed. In this way the windmill could be allowed to run day and night, as it would only store when a certain speed was attained, and the cells were effectually prevented from discharging themselves through the dynamo even should it stop. On several occasions he had used the stored electricity to drive a small turning lathe, and he had begun to make a light form of crriage to be driven by the same. In conclusion, the professor jocularly remarked that he preferred wind power to water, because the latter was usually tied up. The landlords, however, had not yet claimed a right over the wind, although a place that had a good draught might come to have a money value. In the course of a discussion which followed, the hope was expressed that Prof. Blyth would continue his interesting experiments.

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ON THE INFLUENCE OF SELF-INDUCTION ON THE RATE OF DISCHARGE OF A CONDENSER.

BY DR. OLIVER LODGE.

Mr. Sumpner's letter on page 761 of *The Electrician* for 4th May, 1888, very clearly establishes his statement that the time required for practically complete discharge of a condenser can be diminished in certain cases by inserting in its circuit a moderate amount of self-induction, leaving everything else the same. The point is a curious one, and I congratulate Mr. Sumpner on having noticed it. Anyone would have thought that since the time-constant of a condenser circuit is $\frac{2L}{R}$ an increase in self-induction would have retarded its discharge, and a decrease would have accelerated it. And this is what does happen so long as there is sufficient self-induction to make the discharge oscillatory. Nevertheless, if one proceeds to diminish self-induction still further, the time of discharge begins to lengthen in an unexpected manner, until it is ultimately possible exactly to double the time of a discharge by removing all trace of self-induction from the discharging circuit, supposing this to be experimentally feasible.

One finds that with $L = \frac{1}{2} SR^2$ the time taken over a complete discharge is just the same as when $L = 0$; also that when $L = \frac{1}{4} S R^2$ the time of discharge is just half the preceding, and is then a minimum. This happens to be just the condition when the character of the discharge changes from oscillatory to continuous. The minimum value of the time constant is $\frac{1}{2} S R$, which it has when $L = \frac{1}{4} S R^2$. Altering the self-induction either above or below this value lengthens the time of the discharge, though not in a symmetrical manner; increasing the self-induction above $\frac{1}{4} S R^2$ lengthens the time constant in a simply proportional manner without limit, but decreasing it below $\frac{1}{4} S R^2$ lengthens the time-constant in a parabolic manner towards an upper limit S R, which it attains when $L = 0$.

The following curve shows the whole thing.

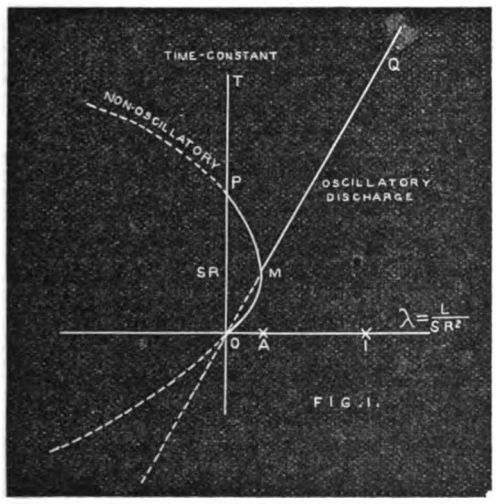

FIG. 1.

Plotted horizontally are successive values of the ratio L to $S R^2$, a ratio which I call λ, and which may be altered by varying the discharging circuit. Unit length is shown by 0 1. Plotted vertically are corresponding values of the time-constant T; viz., the time required for the charge of the condenser to sink from any value to $\frac{1}{e}$th of that value. In a time 2 T the charge is reduced to $\frac{1}{e^2}$, in 3 T to $\frac{1}{e^3}$, and so on.

Now, as e^3 is $(2{\cdot}71828)^3$, or about 20, and e^4 is about 54, it follows that in a time equal to five or six times T the condenser is, for all practical purposes, completely discharged. In a time 7 T only one-thousandth of its original charge remains in the condenser; and in 21 T it is reduced to less than a thousand-millionth.

Hence, if we plot the value of T we represent all we need know as regards the total time of discharge of a condenser or Leyden jar.

The curve consists of two distinct portions. One portion is a straight line, M Q, sloping upwards at the gradient 2 S R vertical to 1 horizontal, and indicating the time-constant of the oscillatory discharge for different values of λ. The dotted part of this line below M has no particular meaning.

The other portion of the curve is a parabola, with axis horizontal and vertex at M, a point characterised by the co-ordinates $\lambda = A O = \frac{1}{4}$, and $T = A M = \frac{1}{2} S R$. This portion of the curve corresponds to the continuous form of discharge.

The height A M represents the minimum time-constant spoken of above, viz., its value when $L = \frac{1}{4} S R^2$. The height O P represents the value of the time-constant (S R) when L is nothing. The most important part of this parabolic curve is P M; the dotted part does not concern us at all, and the bit M O is of small importance, for there are two time-constants to the non-oscillatory discharge; points on M P indicate values of one of them, and points on M O indicate values of the other. The bigger of the two is not only intrinsically more decisive of the time of the discharge, but its term is multiplied by a larger coefficient than the other enjoys. One coefficient always exceeds the other by the amount S R. The smaller one vanishes for $\lambda = 0$. Both become infinite for $\lambda = \frac{1}{4}$.

Theory of the Discharge.

But it now remains to consider what effect the size of these coefficients exerts upon the *rate of discharge*. Plotting the time-constant does not tell us everything, for though it is the value of the time-constant that decides the *ultimate time of complete discharge*, yet upon its earlier stages the coefficients can exert a very appreciable effect, and accordingly conditions which cause the rate of discharge to be at first comparatively slow may ultimately make it overtake its competitor.

One can hardly make this fully clear without writing down the equations.

The equation to the current at any instant during the discharge of a condenser of capacity S is of course

$$L\frac{dC}{dt} - RC = V - V' = \frac{Q}{S} \quad . \quad . \quad . \quad . \quad (1)$$

where Q is the charge remaining in condenser at any time, and $C = -\frac{dQ}{dt}$. This equation contains the whole theory of a discharging condenser, neglecting the static capacity of the discharging conductors, and ignoring the series of facts experimentally observed with certain dielectrics as "residual charge."

It should be well known (perhaps it is)* that Sir Wm. Thomson originally established this equation and worked out its prime consequences in 1855.

Integrating the equation, it becomes

$$Q = Q_0 e^{-mt}\left(\cos n\ t + \frac{m}{n}\sin n\ t\right) \quad . \quad . \quad (2)$$

which in case n is imaginary may be more conveniently written with $n\sqrt{-1}$ for n,

$$Q = Q_0 e^{-mt}\left(\cosh n\ t + \frac{m}{n}\sinh n\ t\right). \quad . \quad (3)$$

where, in either case,

$$m = \frac{R}{2L}; \text{ and } m^2 - n^2 = \frac{1}{LS}.$$

Sometimes it is more convenient to write the equation in the form

$$\frac{Q}{Q_0} = \frac{m+n}{2n} e^{-(m-n)t} - \frac{m-n}{2n} e^{-(m+n)t}. \quad . \quad . \quad (4)$$

It is to be understood that all these four equations are mathematically identical, and express the same series of facts in other words. Sometimes one form is convenient, sometimes another. One can always write the ratio of actual to original

* Since this was written Dr. Fleming's capital expository article on all this appeared in last week's *Electrician*. There is no excuse for not knowing it now.

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potentials, V/V_0, instead of the ratio of the charges, Q/Q_0, if one so prefers.

Now what we are at present interested in is to see how different values of L affect the rate of decay of Q; especially do we want to compare the rate of discharge with any specified small value of L with the corresponding rate when L is completely abolished—supposing this to be experimentally possible. It is not practically possible to dispense with self-induction altogether, but for the case when a jar overflows its edge, sparking direct from one coating to the other, it is as small as practicable. Perhaps, however, in this case R^2 is smaller still, and so this overflow discharge may be very oscillatory. The easiest way to make L negligibly small is to make R big; it is the ratio $L/_{SR^2}$ which is the vital quantity, the ratio I have called λ above.

Let us for purposes of comparison write down the form of the discharge equation when L is zero. It is very simple, representing a simple logarithmic curve,

$$Q = Q_0 e^{-\frac{t}{RS}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

$\frac{1}{RS}$ may be called the logarithmic decrement; or $\frac{1}{e^{RS}}$ may be called the common ratio of the decreasing geometrical progression formed by the charge remaining in the jar at equal short intervals of time after the discharge has begun; or RS may be called the "time-constant" of the discharge (the meaning of this term being popularly explained above); and this last plan is commonly the handiest. This time-constant for $L = 0$ we may hereafter quote as T_0. $T_0 = RS$.

The time-constant of the oscillatory discharge represented by equation (2) is $\frac{2L}{R}$; while for the continuous discharge represented by equation (3) or (4) there are two time-constants of unequal importance, viz. :—

$$\frac{1}{m-n} \text{ and } \frac{1}{m+n}$$

But in considering the circumstances of the discharge for different values of m and n it is manifest that everything depends on the relation which exists between L and SR^2; hence it will be convenient to write out the equation in terms of this ratio λ.

So written it becomes

$$\frac{Q}{Q_0} = \frac{1+\sqrt{(1-4\lambda)}}{2\sqrt{(1-4\lambda)}} e^{-\frac{1-\sqrt{(1-4\lambda)}}{2\lambda SR}t} - \frac{1-\sqrt{(1-4\lambda)}}{2\sqrt{(1-4\lambda)}} e^{-\frac{1+\sqrt{(1-4\lambda)}}{2\lambda SR}t} \quad . \quad . \quad (6)$$

and it is the time-constants here indicated which are plotted as the parabola in the above figure.

The expression (6) may be made to look a little neater by writing a single symbol, say μ, for the repeatedly occurring quantity $\sqrt{(1-4\lambda)}$; it then becomes

$$\frac{Q}{Q_0} = \frac{1+\mu}{2\mu} e^{-\frac{2}{1+\mu}\cdot\frac{t}{T_0}} - \frac{1-\mu}{2\mu} e^{-\frac{2}{1-\mu}\cdot\frac{t}{T_0}} \quad . \quad . \quad (7)$$

Rate of Discharge from Instant to Instant.

At this point it may be as well to differentiate our equation with regard to t, because it is the rate of decay of Q with which we are specially concerned. We want to see how different values of λ—that is, of L—affect it.

Now, differentiating any of the above equations, except (5), we get

$$C = -\frac{dQ}{dt} = \frac{V_0}{nL} e^{-mt} \text{shin } nt \quad . \quad . \quad . \quad (9)$$

or else the same thing with sin instead of shin; which gives the discharge current at every instant when self-induction is present.

This we have to compare with

$$C' = \frac{V_0}{R} e^{-\frac{t}{SR}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

the value of the discharge current with no self-induction.

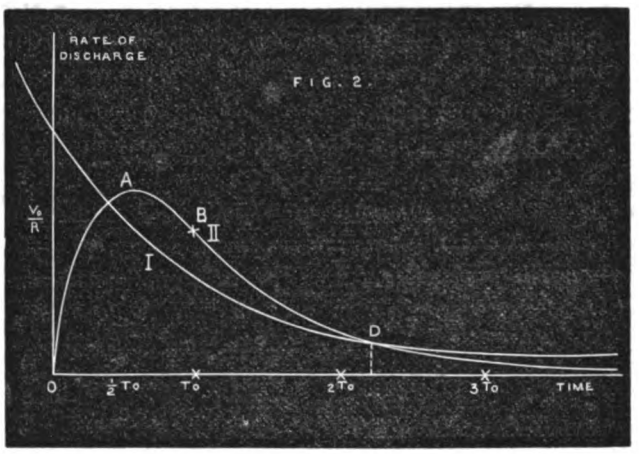
Now the first thing we notice is, that whereas the current without self-induction begins with a maximum value $\frac{V_0}{R}$ and gradually tails off logarithmically, the current with self-induction begins with the value zero and then rapidly increases till it may overtake the other.

The most interesting simple case of (9) is obtained when L is close upon $\frac{1}{4} SR^2$—that is, when $\lambda = \frac{1}{4}$ about; it may be a little bigger or a little less. In either of these cases equation (9) simplifies to

$$C = \frac{V_0 t}{L} e^{-\frac{t}{2\lambda SR}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

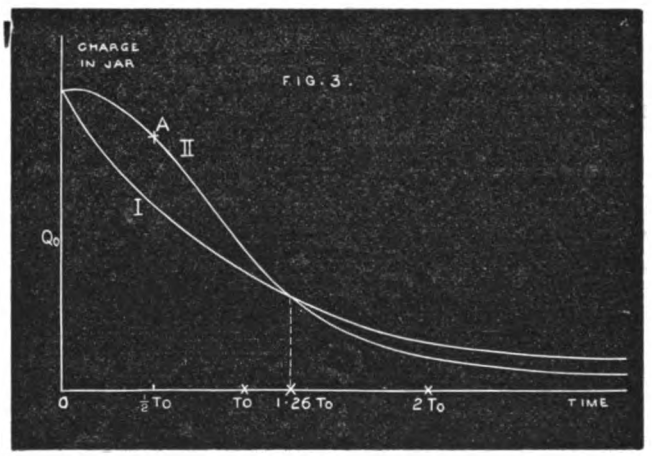
where the thing to notice is the occurrence of t in the coefficient; a coefficient which increases simply with the time. The time-constant is $2\lambda SR$; so if λ were exactly $\frac{1}{4}$ the time-constant in this case would be just half that for no self-induction.

The current at different times for these two cases $\lambda = 0$ and $\lambda = \frac{1}{4}$ are plotted in Fig. 2.



Curve I. represents the strength of the discharge current of a condenser in a circuit of no self-induction. $T_0 = SR$. This curve corresponds to the point P in Fig. 1.

Curve II. represents the strength of the discharge current of the same condenser in a circuit of the same resistance, but with self-induction enough just to bring the discharge to the verge of oscillation, this being the condition which effects complete discharge in the shortest time possible. This curve corresponds to the point M in Fig. 1.



Curve I. shows the charge remaining in the jar at any time, the circuit being practically devoid of self-induction.

Curve II. shows the same thing for $L = \frac{1}{4} SR^2$—that is, for the quickest discharge possible. At first Curve I. has the advantage, but at a time 1·26 RS the second curve overtakes it and discharges the jar more rapidly.

At a time $\frac{1}{2} SR$ from commencement of discharge this current reaches its maximum value; it is then $\frac{2}{\sqrt{e}}$ times the corresponding current for $L = 0$.

At a time SR it is $\frac{4}{e}$ times this corresponding current; and the ratio between them is never bigger than this.

At a time 2·16 SR the two currents are just equal; and after

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that the inductionless current exceeds the other: ultimately without limit.

These curves show the changes of relative value which the rates of discharge pass through according to the value of the ratio λ; but they do not inform us directly as to which empties the jar first. Let us, therefore, to be quite explicit, plot Q also for the two most interesting cases.

The $\lambda = 0$ case gives a mere logarithmic curve; but the $\lambda = \frac{1}{4}$ case gives an initially horizontal curve rapidly sloping down till it overtakes the other at a point $1{\cdot}26\ T_0$ and then passes below it. At a time $\frac{1}{2}\ T_0$ the charge remaining in jar is $\frac{2}{\sqrt{e}}$ times as great in this case of shortest time of discharge as it is when $\lambda = 0$, but the hurry of the later stages of the discharge more than makes up for the delay of the earlier ones.

Mechanical Analogue.

A pendulum in treacle was long ago suggested by Lord Rayleigh as an analogue to the Leyden jar discharge. The analogy may easily be made exact by considering a loaded spring bent aside or compressed in a resisting medium in such a way that gravity is not concerned with the motion, and then let go.

The pliability of the spring corresponds to the capacity of a condenser, its displacement to the electric charge. The load or inertia corresponds to the self-induction of the circuit; the viscosity of the fluid to its resistance. If the viscosity friction be supposed to vary accurately as the speed, then the equation to the motion is

$$m \frac{dv}{dt} - \mathrm{R}\, v = k\, x$$

where x is the displacement and v is the velocity $\left(-\frac{dx}{dt}\right)$.

Writing m for L, $\frac{1}{k}$ for S, and x for Q, in the electrical equation (1), the two are seen to be the same, and everything we have said applies to the mechanical analogue as well as to the electrical phenomenon.

It is obvious mechanically that if the resistance is moderate and the mass considerable the recoil of the spring will be accompanied by oscillations; also, that with high resistance and small inertia the motion will be a mere slow sliding or leaking back. The resistance may be so great as to amount to actual insulation. Again, it is plain that there must exist between the strength of the spring, the mass of its load, and the viscosity-coefficient R of the substance, some definite relation which shall constrain the recoil to be a simple dead-beat return to the position of equilibrium, without delay and without overshooting the mark. This relation we now see to be

$$\mathrm{R}^2 = 4\, km,$$

and under these circumstances the recovery of the spring is the quickest possible.

THE RISE AND PROGRESS OF TELEPHONY IN THE UNITED KINGDOM.

(Continued from page 689, Vol. XX.)

The work of the metropolitan exchanges is chiefly carried on by girls, except at some of the City exchanges which are situated in positions rendering the employment of girls undesirable. The work at these is done by boys, who for the most part continue in the service of the company in some of its various departments. The switch-boards are of various constructions, as is inevitable, owing to the rapid progress which is being made in the technological development of telephony. Improved switch-boards are adopted as they come out in the new exchanges, and are gradually introduced into the older ones. The older forms necessitated the operators calling to each other across the room to make the required connections, leading to a continual noise in the switch room, which was by no means favourable to the rapid and accurate despatch of business.

The multiple switch-board, which is coming into general use in the principal telephonic exchanges throughout the world, obviates all this. Each board is connected with all the subscribers to the exchange, who are thus within reach of the operator sitting at each board, while only a certain number of these can call the operator at any one board. Corresponding to each of the latter is a small shutter, which falls when the subscriber rings his bell and exposes his number. The operator then inquires the number of the subscriber with whom he wishes to be put in connection, and if the latter's wire is not engaged—this being ascertained by a tapping arrangement, which, if the wire is in use, produces a noise in the operator's telephone on touching the terminal—the operator calls the other subscriber, takes up the pair of terminals attached to one of a series of flexible wires placed in front of the board, and by placing one terminal plug in the brass hole in connection with one subscriber's wire and the other in the one connected with the other subscriber's wire, places the two subscribers in communication. We need not say that the whole operation is carried out in very much less time than it takes to describe it.

At each of the trunk exchanges one operator devotes his or her whole time to listening at a telephone in connection with the central exchange, and at the central exchange all the operators listen at their telephones, as no call bells of any kind are used to and from the central exchange. Each operator at the central exchange is furnished with a flexible wire and terminal plug, in connection with a separate telephone fixed in front of his board. When asked for any exchange he ascertains which, if any, of the trunk wires are free by touching their terminals with his plug, which he is supposed to keep strapped to his finger. If any trunk wire is in use a noise is produced in the before-mentioned telephone on touching the trunk terminal with the tapping terminal. The operators at the central trunk exchange are all boys.

For speaking purposes Leclanché cells are used. For calling purposes magneto-generators are now generally used. They are, however, decidedly objectionable when used as vigorously as they often are by impatient subscribers, owing to the large amount of noise which they produce by induction in the neighbouring lines.

The over-house poles and standards are all made of iron, and the networks of wires proceeding from the exchanges are supported on massive constructions built up of iron girders with cross struts and ties, firmly attached to the roof of the building containing the switch room. These constructions are known as "derricks." The wires are of iron, hard copper, phosphor-bronze, and silicious bronze. Where a number of wires are running in the same direction they are made up into cables, and these cables are supported on iron rings passing over iron supporting wires stretched between the standards.

The map which is given this week will show the actual positions of the trunk exchanges whose connections were exhibited in the diagram accompanying our last chapter, and also those of the smaller exchanges actually constructed and in process of construction.

(To be continued.)

JUVENILE LECTURES.

THE APPLICATION OF ELECTRICITY TO LIGHTING AND WORKING.*

BY W. H. PREECE, F.R.S.

Lecture II.

(Continued from page 10.)

I will now show you how electric currents can be used to produce rotation or to produce motion. The history of motors is extremely interesting; it commences in the year 1823, when Mr. Barlow, the father of the present well known engineer, the engineer of the Tay Bridge, and past president

* A course of two Lectures delivered before the Society of Arts on January 4th and 11th.

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of the Institution of Civil Engineers, showed how it was possible to produce rotation by means of currents of electricity. The great apostle of electricity, Faraday, in 1831, did the same thing; and in 1833, Ritchie produced that very instrument that I showed you; but as far back as 1839 there was a Scotch gentleman, of the name of Davidson, who thought that this principle was applicable to the drawing of trains on railways, and I have a slide, which Mr. Carpenter will now throw upon the screen, showing his locomotive.

You now see a picture of that machine (Fig. 8), as used on the Edinburgh and Glasgow Railway, or rather, I will not say it was used, because I do not think it could have been used, but it was tried on that railway as far back as 1842. You see there were eight electro-magnets, through which currents were

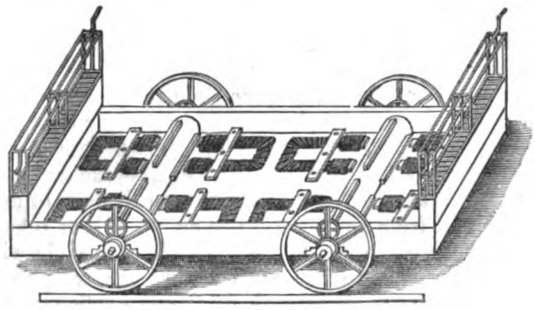

Fig. 8.

passed, and these rotated the wheels. The machine worked at the rate of nine miles an hour. Other distinguished scientists have worked in this direction. Jacobi, of St. Petersburg, about the same time, drove a boat on the River Neva by means of an apparatus very similar to Davidson's. Froment, whose apparatus I showed you, applied this principle to his workshops in Paris; the tools in his shop were worked by an exactly similar motor to that which I showed you just now. Motors are innumerable. I have on the table here models of all the various patterns. Here is a very well-known motor, the invention of an American named Griscom; here is a motor, and I have no doubt if I pass a current of electricity through the electro-magnet of which it is formed you will see that it rotates rapidly and works a fan. I will not dwell much on the various kinds of motors that are used. Mr. Immisch has distinguished himself very much in this direction, and I shall show you several of his motors at work. Mr. Parker, of Wolverhampton, has made one of the prettiest motors (Fig. 9), and

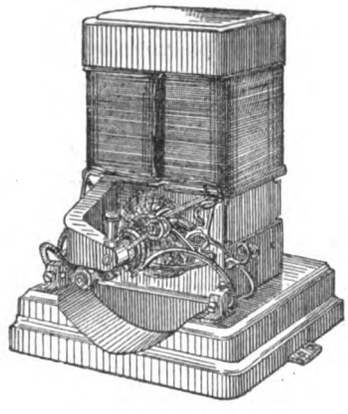

Fig. 9.

I shall show you it also at work. There is nobody who has done more for the practical application of this principle than Mr. Reckenzaun, and I shall show you his motor; and again, Dr. Hopkinson, as well as the house of Messrs. Siemens, have done an immensity to assist this application of electricity.

But I want to illustrate to you the property that the electric current has of transferring power from one place to another. We can produce power in this room, and we could, without difficulty, transfer the power produced here to Liverpool, to Edinburgh, or even to New York. There is absolutely no difficulty whatever in transferring from this very room energy produced by means of the dynamo machine, and sending it if you like to Kamschatka. Of course the amount of energy you are able to transmit is quite another question; the amount varies very much with distance. Telegraphy is entirely dependent on the power which electricity gives us to reproduce mechanical effects at a distance. It would have taken a good deal too much time to have brought before you to-night the various systems of telegraphy. I will show you one, and that one of the earliest and simplest, the old A B C telegraph of Wheatstone. Here is one: it contains a little dynamo machine; when I turn the handle round I am converting the energy of my body into currents of electricity. Currents of electricity are produced by turning the handle, and I am able, by means of little finger keys (similar to the keys of an accordian) placed around the machine, to adjust or arrange the number of currents of electricity that go to the end of the table where the receiving instrument is fixed. As far as the apparatus itself is concerned, it does not matter whether the motor and receiver are separated by eight or ten feet or by eight or ten miles. You can see by this power we are able, in telegraphy, to transmit signals to any distance we like, and at any speed we like. I have mentioned that this power is used for winding clocks, and I will not refer to that again; but this power of transmitting energy to distances is used for a great many practical purposes. For instance, all of you who travel by railway, and I doubt whether anybody here does not travel by railway, are dependent upon this power of electricity to secure safety and to give knowledge of the approach and departure of trains. Sounds can be produced by striking blows, blows being the expenditure of energy, and here I have a bell which is struck by its hammer whenever I send a current through its magnet, and so I reproduce by the current an action similar to that of the elbow. But this same power that electricity gives us to reproduce energy at a distance can be used for purposes which some would be inclined to say are more useful than telegraphy. There may be some people who still look upon a telegram with an amount of horror, and when an envelope containing a message is handed to them immediately turn pale and feel themselves rather affected; but, while many do not care about telegrams, everybody likes water. It does not matter to what class a person belongs he indulges some time or other in water, and any apparatus that will facilitate the production of water will attract our attention. I have here the little Parker motor I mentioned, and a pump. When I send a current of electricity the motor works, and in its turn, by a pulley, works the pump. Mark you, the pump and motor are only a few feet from me, but it would be just the same if they were ten miles away. This simple system of pumping water by electricity is used to a very large extent. There are a great many people who employ electricity now, as I told you at our last lecture, to light their houses, and those who employ electricity to light their houses can employ the same currents and the same power exactly to raise water.

There is a friend of mine near East Grinstead, Sir Francis Truscott, who has his house fitted with electricity. He used to employ two men every day in raising water from a depth of 150ft. to fill his tanks, but when he had secured the use of electricity for lighting his house, I suggested to him that he might just as well use it for raising his water. It was no sooner suggested than acted upon. A little motor, not much larger than that you just saw, works for two hours a day, and supplies a full quantity of water for the house, and the services of the two men were dispensed with in that respect. There is no reason on earth why those people in the country who depend upon manual labour for the raising of water cannot raise their water with greater speed and more efficiency by means of an electro-motor; in fact, this is carried out to a very large extent in South Wales by Mr. Brain. In the collieries in the Forest of Dean electro-motors are used to a very large extent to raise water from depths of hundreds of yards, and through distances that

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approach from a mile to two miles. Well, the same power exactly that can be used to raise water can be used for many other purposes.

The present Prime Minister of England is a very advanced electrician. There is no man in England who has applied electricity so much for domestic and useful purposes as Lord Salisbury has at Hatfield. He was one of the earliest in the field; he has at Hatfield currents of electricity which are not only used for pumping but also for chaff cutting, turnip cutting, for sawing timber, and for many other farming and domestic purposes.

To-night I am also able to show you this operation of sawing by electricity. The same motion that you saw in raising water we will apply here. Through the kindness of our chairman, Mr. Anderson, we are able to show the arrangement we have here. At one end of the table we have an Immisch motor; it is so small that you can scarcely see it at a distance; it would go in a moderately sized hat, but it will, on a current of electricity going through it, develop three horse-power. It will set a pulley in rotation, that pulley has a strap on it which works the counter-shafting behind me, and from this counter-shafting there are bands that work two or three machines that I shall refer to directly. I now want to call your attention to the circular saw which has been lent us by Messrs. Churchill. Sawing in country houses like Lord Salisbury's is required for cutting up the timber required for fires and for many other purposes, and here we have, by means of this motor, the countershaft and the circular saw at work. Here also is a Singer sewing machine driven in the same way.

(To be continued.)

TELEPHONES IN THE RIVER PLATE.

The last mail from Buenos Ayres brings news of what looks very much like a threatened opposition to the existing companies having exchanges in the Argentine and Uruguayan Republics. Subscriptions were being invited in Buenos Ayres for capital by a new telegraphic-telephonic company of the River Plate (*Compania Telegrafico-Telefonica de la Plata*), the total capital of which was $500,000, in 5,000 shares of $100 each. The Buenos Ayres *Standard*, alluding to the venture, has the following:—

"The promoters of the new company have secured the well-known Van Rysselberghe patent. The importance of this patent cannot be exaggerated, since simultaneous communication can be held on one wire by telegraph and by telephone—a most ingenious contrivance of the Belgian *savant*. The company intend applying this patent to a cable between this city and Monte Video, and it is probable that two cables will be laid down for the purpose under the superintendence of the inventor of the patent."

The Argentines are conspicuous for their use of the telephone. According to official information issued by M. Agustin Gonzalez, the Director of the Argentine Information Office in this country, Buenos Ayres last year possessed one subscriber for every 173 inhabitants, as compared with one for every 865 in Paris, one for every 1,179 in Vienna, and one for every 1,930 in Berlin. From the few details to hand the proposed object and scope of the new company are not clear, except as regards the laying of cables between Monte Video and Buenos Ayres. It is to be hoped that the undertaking does not contemplate competing in the same districts as the existing companies, at any rate for the present. In Buenos Ayres, and in Monte Video more especially, telephone competition has in the past been disastrous. A year last December only, it will be remembered, the prospectus was issued in this market of the United River Plate Telephone Company (Limited), with a capital of £500,000, the object being to amalgamate two companies, namely, that of the United Telephone Company of the River Plate in the Argentine Republic, Uruguay and Paraguay, and that of the River Plate Telephone and Electric Light Company in the Argentine Republic and Paraguay, but not in Uruguay. The aim of this amalgamation was to put a stop to the then existing competition. Further, one of the amalgamating companies—that of the United Telephone Company—was itself the result of an amalgamation of two former companies combined together to fight the River Plate Company. Notwithstanding the popularity of the telephone in the River Plate, it is scarcely likely that the position can have become so changed as to warrant a new competitor when but 18 months ago there were already too many. If, as is possible, the new local company referred to is projected with a view to facilitate intercommunication between the exchanges of Monte Video and the River Plate, shareholders in the existing companies will probably have no reason to complain, and the true interests of telephone enterprise in the Argentine Republic and in Uruguay will not suffer. Nothing is said as to the construction and laying of the cables across the river.

PHYSICAL SOCIETY.

At the meeting of this Society held on the 12th inst. Prof. S. P. THOMPSON read a Paper on

"The Condition of Self-Excitation in a Dynamo Machine."

The author pointed out that as early as 1867 it was known that dynamos possessed the power of self-excitation, and the explanation usually given was that a small amount of residual magnetism remained in the field-magnets, so that when the machine was set in motion a feeble induced current was sent round the magnets. This increased the magnetism of the field-magnets, which in turn produced a stronger induced current. This explanation was even then recognised as faulty, as the limit to which self-excitation went on depended on the resistance in circuit as well as on the speed, and self-excitation did not take place at all for a given speed unless the resistance were below a certain value (for series-wound machines), and for a given resistance it only took place when the speed exceeded a definite minimum value.

In the present Paper the author gives an explanation of the observed facts, that the extent of self-excitation, and also the possibility of self-excitation at all, depend on the speed and on the resistance in the circuit. In a former Paper, in which the author considered the "dead turns" or the conditions necessary for self-excitation to take place at all, the investigation was based on the Lamont-Frölich formula, which is only an approximate representation of the relation between magnetising force and induced magnetism. In the present paper the author makes no assumption with regard to this relation, but merely bases his investigation on the ordinary laws of magnetic induction, with the assumption, however, that the secondary magnetism due to cross-magnetisation may be neglected.

Let N be the number of lines of magnetic force passing through the armature, n the number of revolutions per second, C the number of wires on outside of armature, E the E.M.F. between the terminals, i the induced current, S the number of turns on the field coils, ρ the magnetic resistance, and R the electrical resistance.

Then we have $$E = n C N;$$

and therefore $$i = \frac{E}{\Sigma R} = \frac{n C N}{\Sigma R},$$

where ΣR is the sum of the resistances in the circuit.

Now $$N = \frac{4 \pi S i}{\Sigma \rho},$$

where $\Sigma \rho$ is the sum of the magnetic resistances. Therefore we have the two equations

$$\frac{i}{N} = \frac{n C}{\Sigma R}$$

and $$\frac{i}{N} = \frac{\Sigma \rho}{4 \pi S}.$$

Equating these two values of i/N we obtain

$$4 \pi n C S = \Sigma \rho \, . \, \Sigma R.$$

The product of the magnetic resistance with the electrical resistance will therefore remain constant, provided the quantities on the left-hand side of this equation are unchanged, so that if R be diminished while the speed remains constant self-excitation will go on until, by further magnetisation of the iron, the product is raised to its original value. The dynamo will not excite itself if ΣR is greater than $4 \pi n C S / \Sigma \rho$. Similarly, for a given value of ΣR, excitation is impossible if $\Sigma \rho$ is more than $4 \pi C S / \Sigma R$.

Now, the magnetic resistance is made up of the sum of two quantities, the resistance of the air gap (α), and that of the iron (β), so that $$\rho = \alpha + \beta.$$

Similarly, $$R = a + x,$$

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where a is the internal resistance, which is a fixed quantity, and x is the external resistance, which is capable of variation.

We have therefore

$$4\pi n \mathrm{C}\,\mathrm{S} = (a+\beta)(a+x).$$

When self-excitation begins β is practically zero, but a has a fixed value, so that when R is very great, self-excitation cannot begin unless the speed is correspondingly high. It is to be noted that the amount of magnetic leakage is neglected, the amount of this depending on the construction of the machine.

Now, suppose the speed to be given, and suppose $\beta = 0$, then, if x_1 be the greatest value of x for which self-excitation can take place, we have

$$x_1 = \frac{4\pi n \mathrm{C}\,\mathrm{S}}{a} - a.$$

Similarly, the greatest value of β when $x = 0$ is given by the equation

$$\beta_1 = \frac{4\pi n \mathrm{C}\,\mathrm{S}}{a} - a,$$

The author pointed out that the constancy of the products $\Sigma\rho\,\Sigma\,\mathrm{R}$ was evident geometrically, for if the curve of magnetisation be drawn by taking the values of the current (i) as abscissæ, and those by the E.M.F. (E) as ordinates, the electrical resistance is represented by the tangent of the angle of slope of this curve, and E is proportional to N and i to S i; so that the magnetic resistance, which is proportional to $\frac{\mathrm{S}\,i}{\mathrm{N}}$, is proportional also to the cotangent of the same angle, and the product of the tangent of an angle into the cotangent of the same angle is necessarily a constant quantity.

For shunt-wound machines, if Z is the number of turns, r_a the resistance of the armature, and r_s that of the shunt coils, the formula obtained is

$$4\pi n \mathrm{C}\,\mathrm{Z} = \Sigma\rho\left(r_a + r_s + \frac{r_a r_s}{\mathrm{R}}\right).$$

If R is increased the quantity in brackets is diminished, so that $\Sigma\rho$ increases, and self-excitation will only take place for a certain minimum value of R depending on the value of the magnetic resistance.

The author mentioned that Mr. Kapp had pointed out the great difficulty in getting small machines to excite themselves. If a model of a given machine could be made with every part reduced in the same proportion it would not excite itself on the same resistance because the magnetic resistance would be greater in the smaller machine, since the reduction in the area of the magnetic circuit would be proportional to the square of the reduction in its length. But everything cannot be reduced in the same proportion, as the air-gap must have a certain value, and the air-gap increases the difficulty of self-excitation.

The author pointed out that according to the results given in the present Paper a dynamo with only a small clearance should have a smaller number of dead turns than one with a larger clearance; but he was not aware that this had ever been noticed.

In the course of his exposition, Prof. Thompson drew the attention of the Society to Mr. Oliver Heaviside's suggestion in the last issue of *The Electrician* of using the term "magnetic reluctance" in place of magnetic resistance, and observed that for his own part he was disposed to adopt it.

Mr. Kapp stated that the subject dealt with in the Paper was well known to the makers of dynamo machines. His own plan was, after using the machine, to get rid of the original condition of the iron, to run the machine at the least speed for self-excitation, and then form the relation

$$\frac{\text{minimum speed}}{\text{minimum voltage}} = \text{constant};$$

and from this and the constructive data of the machine he calculated the minimum value of $\Sigma\rho$, which is nearly equal to a, and he had called this minimum value the critical value of the magnetic resistance. He had always found this critical magnetic resistance smaller than that of the air-gap alone. Prof. Ewing had suggested that this might be due to the copper on the armature, as the copper is counted as forming part of the air-gap, and the magnetic resistance of copper is not the same as that of air. As an example of this, he stated that in the case of a certain machine he had found the critical value of the magnetic resistance between the pole-pieces to be proportional to 1,450 times the double air gap, instead of 1,860 times the double air gap. He had found this difference greater in low-tension dynamos, and this tended to confirm Prof. Ewing's suggestion, as in these machines there was more copper in proportion to the air clearance. A modification was also introduced by the fact that dynamos have a tendency to continue as they are, not to excite or not to fall off when once excited. For example, if a machine were started on a low resistance, say 5 ohms, and would work up to 12 ohms before ceasing to give a current, then the machine would not start on 12 ohms, but the resistance would have to be lowered to 8 or 9 ohms. With a shunt-wound dynamo the opposite effect was observed.

Prof. Perry suggested that this might possibly explain why the air resistance, instead of being represented, as done in Dr. Hopkinson's curves, by a straight line through the origin tangential to the characteristic curve, is really represented by a straight line through the origin intersecting the characteristic.

Mr. Kapp observed that the difficulty of obtaining self-regulation for constant current for an E.M.F. below a certain value was due to this intersection of the magnetic resistance with the characteristic, as the region between the origin and point of intersection was unstable.

Prof. Ayrton said that Prof. Thompson's results could not be directly applied to determine the critical speed and resistance, firstly, because no account was taken of permanent magnetism, which produces an E.M.F. of 3 or 4 volts at ordinary speeds, and, secondly, because a is not a constant, as was assumed. a is not of the nature of a Wheatstone bridge resistance, for two reasons—in the first place, owing to the resistance due to the self-induction of the armature, which is considerable for small currents, and, in the second place, because there appears to be a sort of resistance between the brushes and the commutator, which may possibly be due to jumping. With a large external resistance and small currents he had found this as high as 1,000 ohms.

Lord Rayleigh pointed out that the fact that no current was produced below a certain speed had been very simply explained by Sir William Thomson many years ago. His reasoning was based on Faraday's dynamo, a revolving copper disc touched by conducting wires at its centre and circumference, and he also showed that above a certain speed a state of instability ensues, and ultimately the current decreases without limit. The reason that no definite speed is determined is that the work done against E.M.F. is proportional to the square of the current, and so is the work spent in the circuit, so that the two balance each other. He did not like the term magnetic resistance, as the term resistance was of great use in many parts of physics in cases where there was work to be overcome. In the case of magnetic resistance, on the other hand, there was no work to be overcome. He would be quite ready to adopt the term "magnetic reluctance" if it were generally approved.

Prof. Ayrton stated that he had often found that a dynamo could be made to excite itself at a lower speed than it otherwise would by pressing the brushes against the commutator, showing the existence of the resistance to which he had referred before.

Prof. Perry pointed out, as a mechanical analogy, that centrifugal pumps have to be started at a higher speed than the minimum speed at which they will run when once started.

Prof. Thompson, in reply, stated that he was not oblivious of Sir William Thomson's Paper, which formed the foundation for the study of critical velocity. He had noticed that a machine could often be started by putting on or taking off the brushes, but he was not sure which operation produced the effect. He agreed with Prof. Ayrton that a was not a constant, and had only treated it as such more or less approximately. He thought that the reason that a was not constant was due to the great variation in the magnetic resistance of iron in its lower stages of magnetisation. He thought that the difference observed by Mr. Kapp was due to the fringing of the magnetic field.

Mr. Kapp stated that he had added an amount equal to half the air-space to allow for the fringing of the field.

Prof. Thompson thought he had probably made too small an allowance. In reply to Prof. Ayrton, he stated that the slight residual magnetism would make no practical difference. When the speed was small and the resistance great the dynamo would behave, in fact, like a magneto machine, and the current would only increase very slowly with the speed. The amount of this slow increase would depend on the amount of the residual magnetism, but its effect would be inappreciable after the critical point was passed.

Prof. S. P. Thompson then read a Note on

"The Conditions of Self-Regulation in a Constant Potential Dynamo Machine."

In "Dynamo Electric Machinery" a formula

$$\frac{\mathrm{Z}}{\mathrm{S}} = \frac{r_s}{r_a + r_m}$$

is given as expressing the ratio of the numbers of turns in the shunt and series windings of a compound dynamo. This is on the assumption that there is no saturation within the working limits. As this assumption is not legitimate a correcting factor is necessary. The factor is shown to be the ratio of the average permeability over the whole working range to the permeability corresponding with no external current. The formula is transformed so as to be expressed in terms of the "natural" data of the machine, which, as shown in a previous Paper, can be calculated from its details.

Mr. Blakesley read a Paper, "On Magnetic Lag," which we shall report next week.

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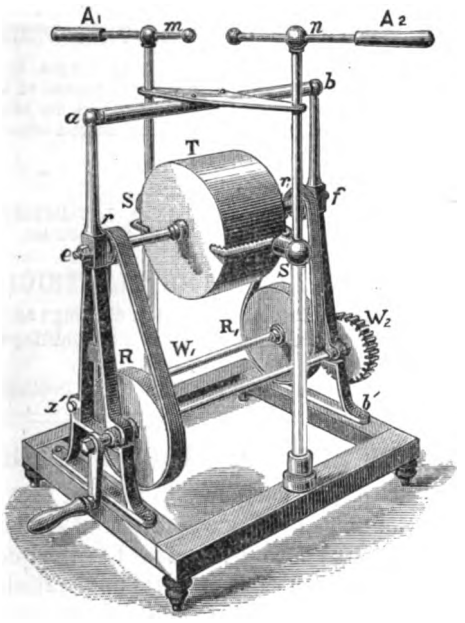
THE GRASER INFLUENCE MACHINE.

A Vienna instrument maker of the name of Graser has recently brought out a new influence machine of somewhat novel construction. This machine, which is chiefly intended to be used to free air from dust and other impurities, is shown in the accompanying figure. The iron supports $a\,a'$ and $b\,b'$ are screwed to a four-legged wooden frame, their tops being joined together by the vulcanite rod $a\,b$. These two uprights support the axles $e\,f$, W_1 and W_2; $e\,f$ is fixed, and is made of steel. Upon $e\,f$ are two vulcanite collars, one of which is joined to the pulley r, and the other to the pulley r_1; at the middle of these two collars are the two ebonite cylinders T, one within the other. In the figure the external cylinder T, communicating with the pulley r, alone is visible. The internal cylinder, which is 8 mm. smaller than the first, is connected to the pulley r_1. The two lower axles, W_1 W_2, each carry a large pulley, R and R_1, and a toothed wheel. The axle W_2 carries in addition the handle M. The pullies r R and r_1 R_1 are united respectively by straps, allowing us to turn r R_1, W_2 and T in the same direction as M, and r R, W_2 and the internal cylinder in the reverse direction. The wooden frame also carries two uprights, which are partly of glass and partly of metal, terminating in the metallic knobs m n. In the middle of these supports are two metallic knobs, S S, each carrying a collecting comb in close proximity to the external cylinder. The fixed steel axle $e\,f$ carries a vertical metal rod inside the cylinder.



The Graser Influence Machine.

At each end of this rod there is a comb, which is at right angles to the corresponding external one. The two exciters A_1 A_2 are movable inside m and n.

The machine requires to be excited by external means.

THE WATER-JET TELEPHONE TRANSMITTER.

At the lecture on the telephone at the Warwick-road schools, Earl's Court, by Mr. G. W. de Tunzelmann, B.Sc., announced in our columns last week, some highly interesting experiments were exhibited.

The United Telephone Company had connected the schools by a special wire to the Gloucester-road Exchange, and from there a connection was established with the Brighton Exchange, where a cornet player had been provided. The audience showed great interest in the transmission of the sounds of the cornet, and of conversation from Brighton, both by means of Edison's loud-speaking telephone, and also by means of a large number of ordinary Bell receivers, which had been provided by the Company, and which were connected in a series of groups with the Brighton line. A number of the early forms of telephones were also exhibited.

Some members of the choir of St. Matthias' Church, to which the schools are attached, sang in the vestry, and the sounds were transmitted to the lecture room by two Blake transmitters, and by Mr. C. A. Bell's water-jet transmitter respectively. This was the first occasion on which the jet transmitter had been tried with Edison's loud-speaking telephone, and the sounds were transmitted with great clearness.

The lecturer illustrated the action of the jet by allowing a simple jet of water from a small orifice to fall upon an india-rubber diaphragm stretched upon the upper end of a vertical brass tube, adjusted at a certain distance from the orifice, this distance being less than that at which the jet became discontinuous. A trumpet-shaped tube was fitted to an aperture in the side of the brass tube close to the diaphragm. When a watch was tightly pressed against the glass tube from which the jet proceeded the jet was thrown into vibration, and the ticking of the watch was reproduced with sufficient loudness to be heard throughout the room.

The jet transmitter, which excited great interest at the *conversazione* of the Royal Society last year, consists of a small jet of water, acidulated to render it a conductor, falling upon two electrodes, consisting respectively of a platinum wire and a platinum ring concentric with the wire, and separated from it by a ring of glass or ebonite. The connection between the electrodes is formed by the nappe of the jet; and when the jet is thrown into vibration by the sound of the voice the variation of the resistance between the electrodes causes it to act as a transmitter of great delicacy. This delicacy is so great that the voice of a person speaking in his ordinary tone at a distance of fifteen or twenty feet from the instrument is reproduced in a distant telephone with the most perfect distinctness. One of the experiments shown by the lecturer was to hold a watch against the sounding-board, to which the jet tube was attached, when the ticking was reproduced in a telephone in connection with the transmitter with sufficient loudness to be heard throughout the lecture room.

The lecture was of a most interesting character, and was listened to throughout with the greatest attention by a large and appreciative audience.

MEETINGS OF SCIENTIFIC SOCIETIES.

(TO-NIGHT) FRIDAY, May 18th.

ROYAL INSTITUTION.

9 p.m. Lecture, "La Reproduction Artificielle des Roches Volcaniques." By M. ALPHONSE RENARD.

SATURDAY, May 19th.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Later Works of Richard Wagner" (6). By Mr. CARL ARMBRUSTER.

TUESDAY, May 22nd.

ROYAL INSTITUTION.

3 p.m. Lecture on "Conventions and Conventionality in Art." By Mr. SIDNEY COLVIN, M.A.

ENGINEERING SOCIETY (King's College).

4:15 p.m. Paper on "Harbours." By Mr. COCHRANE.

WEDNESDAY, May 23rd.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

Annual Dinner at the Holborn Restaurant.

THURSDAY, May 24th.

SOCIETY OF TELEGRAPH-ENGINEERS.

8 p.m. Extraordinary General Meeting at the Institution of Civil Engineers. On "His New Standard and Inspectional Electric Measuring Instruments." By SIR WILLIAM THOMSON, LL.D., F.R.S.

ROYAL INSTITUTION.

3 p.m. Lecture on "The Growth and Sculpture of the Alps." By Prof. T. G. BONNEY, D.Sc., LL.D., F.R.S.

FRIDAY, May 25th.

CITY AND GUILDS OF LONDON INSTITUTE (Technical College, Finsbury).

7 p.m. Students' Annual *Conversazione*. Lecture on "Polarisation of Light." By Prof. S. P. THOMPSON. And on "Magnifying Springs." By Prof. J. PERRY. Concert and Exhibition of Drawings, Apparatus, &c.

ROYAL INSTITUTION.

9 p.m. On "Personal Identification and Description." By Mr. FRANCIS GALTON, M.A., F.R.S.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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The Electrician.

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THE DIRECTORY FOR 1888 IS NOW READY.

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THE PORTRAIT OF SIR JOHN PENDER.

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THE FIRE RISKS OF ELECTRIC LIGHTING.

It is difficult to shut one's eyes to the fact that the position which the SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS has drifted into with regard to the question of fire risks and installation rules is a little undignified, not to say ridiculous. To pose as "guide, philosopher, and friend" is excellent when one's counsel is accepted with gratitude and our philosophy is believed in by the admiring crowd; otherwise, as we have said, the attitude leans towards the ludicrous. In the face of so serious a danger no man is better qualified to make the best of things all round than is Mr. PREECE, and everyone will recognise the admirable way in which he has acquitted himself of the task. As regards the rules agreed to by the Committee we are not aware that a word of adverse criticism has yet been uttered, save, perhaps, in respect of the contingent or conditional clauses to which we referred in some detail in our issue of the 13th April. We still think that cases in which it is found necessary to refer to "some suitable material," to "special precautions" (of a wholly undefined character), to certain things which are to be done "if possible," and so on, would be better provided for by an explicit reference to the dispensory power of the Inspector. Mr. ALEXANDER SIEMENS thinks that the rules should be so framed as to draw a perfectly hard and fast line from which the Inspector should have no power to allow any deviation whatever. If this is really in any sense of the word a practicable thing, by all means let it be done. But we think that most practical men will share our scepticism as to its possibility, and in

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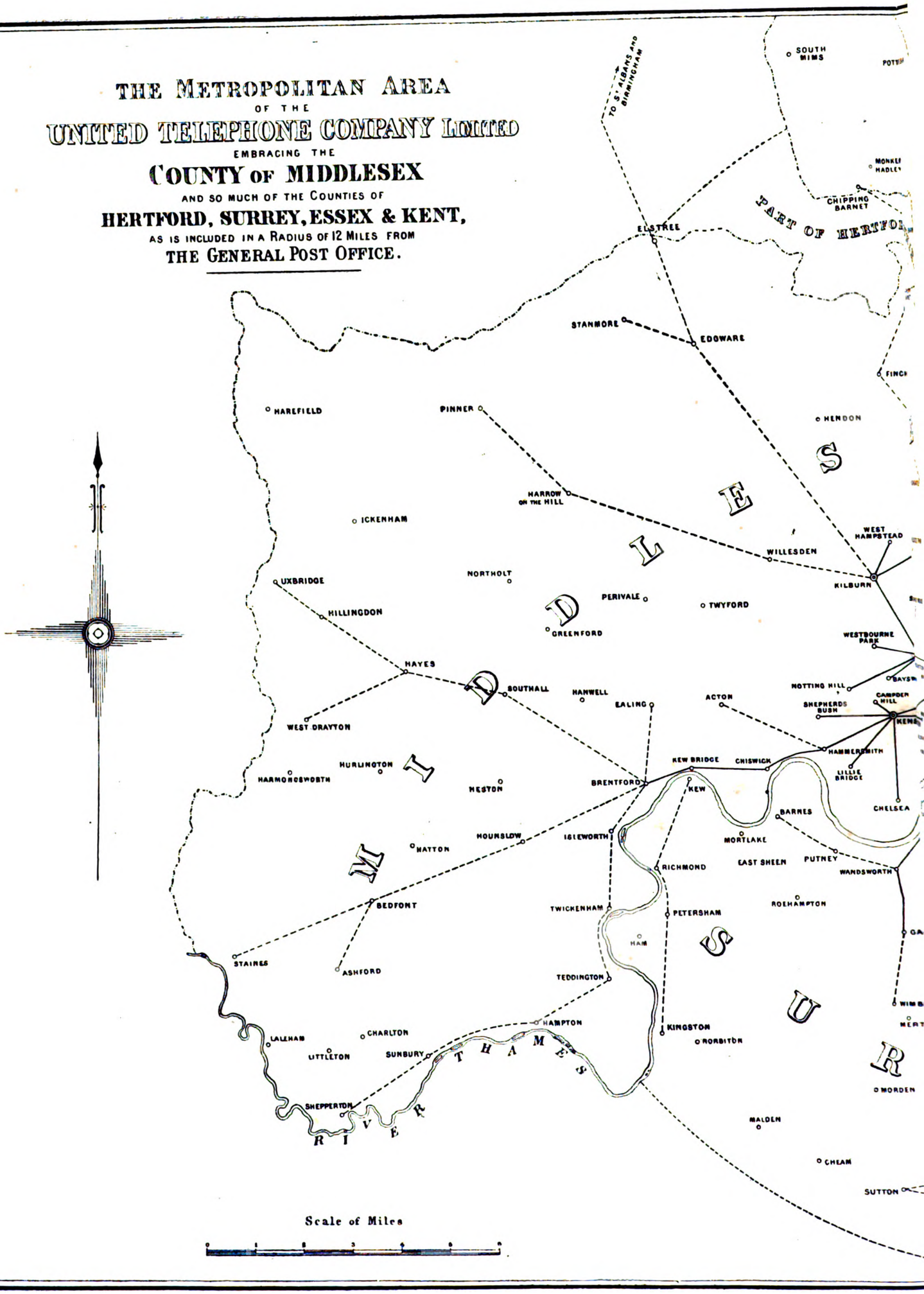

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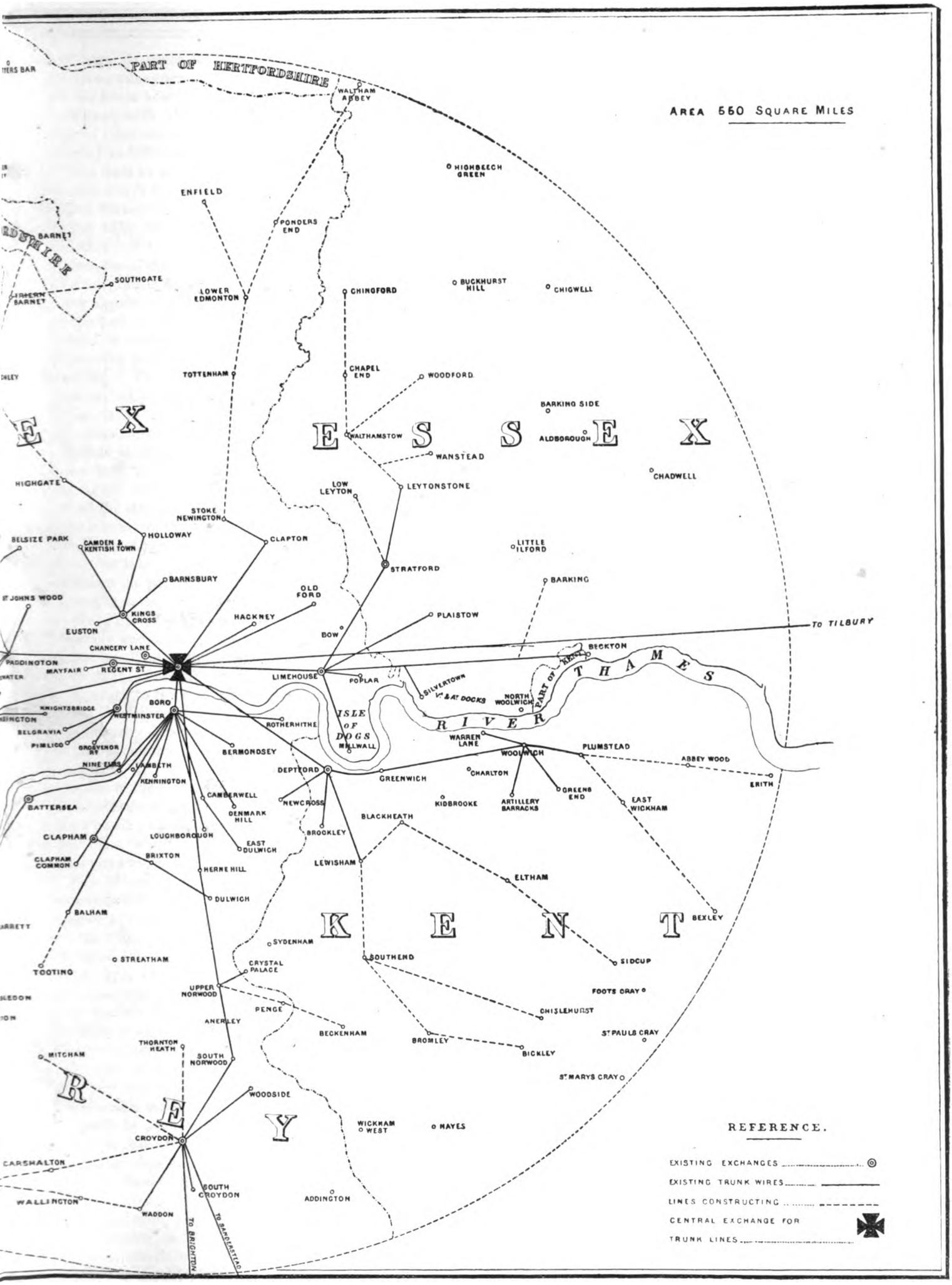

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any case it would involve the redraughting of every rule which contains such phrases as those above quoted. Moreover, we fail to see how the course which Mr. SIEMENS advocates is consistent with the preamble which declares that "these general rules are not intended to supersede any detailed rules which Fire Offices may issue for their own protection."

This leads us at once to the consideration of what is, after all, the *crux* of the position, namely, the attitude of the Fire Offices towards the Society and towards the general question of fire risks from electric lighting. The difficulties of the situation would be greatly simplified if the Fire Offices were themselves unanimous in the matter. Unfortunately, as we all know, this is not the case. We may, however, accept with some degree of satisfaction the assurance of Mr. NEWMAN on the part of the Guardian Office, that one of their chief objects in issuing a set of rules of their own has been to hasten the period when a single code shall be universally accepted. The method adopted is certainly a little ambiguous, but possibly it will, after all, have the desired effect. What it is really important to know is how many of the more influential Fire Offices are really acting with or are prepared to be guided by the Phœnix Office. On this point some very conflicting statements have been made. Mr. CROMPTON stated, and we ourselves have several times received the same assurance, that a very large percentage of the total interest of the Fire Offices recognises the leadership of Mr. HEAPHY; but, however this may be, we suppose it may safely be taken for granted that no absolutely unanimous action on the part of the Fire Offices is to be looked for at the present moment. It is true that there exists a body known as the Fire Offices' Committee, but it is a fact not perhaps generally known that the authority and prestige of this Committee is only of a very limited character. Still, there is no doubt that it forms the best, if not the only, available avenue of approach to the Fire Offices in general, and the Committee of the Council no doubt did wisely in opening negotiations in this quarter. The fact that the preliminary negotiations led to the appointment of a Sub-Committee, who subsequently dealt with Mr. HEAPHY alone, as the representative of the interests of the Fire Offices, may be presumed to imply that the other offices were content to leave the matter in the hands of the Phœnix; unless, indeed, it means that the Phœnix is the only office which takes any sufficient interest in the whole affair; and we should be sorry to think that that is the case.

This brings us to the "personal equation" for which no rational solution has yet been found. It is, nevertheless, impossible to believe after all that has happened that the whole scheme is to be wrecked upon a sentimental point of this character. It is well, however, that the difficulties should be fully and fairly faced, and it is therefore necessary to remark that the question does not entirely lie between the Society on the one hand, and Mr. HEAPHY on the other. It involves also the susceptibilities of those offices who are not willing to recognise any exceptional position on the part of the Phœnix Fire Office. It is impossible to deny that the objection of these dissentients to take any share in advertising a rival is not wholly of an unreasonable character; at any rate, it is rather unlikely that they will be open to argument on this ground. All that can be said is that if these offices are, as we believe them to be, in a minority, then it will be well for the Society to direct its efforts to the establishment of a *modus vivendi* with the Phœnix Office.

In conclusion, writing as we do before the resumption of the discussion on Thursday evening, we have only to add a strong expression of opinion that, if the Committee be reconstituted, it should contain the contracting element in very much larger proportion than it does at present. Three representatives of the contracting interest—of whom perhaps only one is thoroughly conversant with the minute details of installation work—out of a Committee of twenty-three members, even though it included some of the highest professional talent which the Society can boast of, may surely without unfairness be described as a very poor pennyworth of bread to an intolerable deal of sack.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER IX.—*Magnetic Fields.*

(Continued from Vol. XX., page 754.)

106. *The Earth's Magnetic Field.*—If a light rod or strip of steel be mounted at its centre on a horizontal axis so that it is perfectly balanced and free to move in a vertical plane, and it is then taken off the pivot and subjected to the process of magnetisation, it will be found on replacing it in its bearings that it will appear to have one end heavier than the other; that is, the rod will take up a definite inclined position, and will not remain in any other position but this. This effect is due to the magnetic field of the earth, and in our latitude it is the north pole of the pivoted magnet which is so "inclined" or "dipped" downwards. By the exploration of the magnetic field of an ordinary bar magnet (as shown in Fig. 60) it may be noticed that the suspended needle "dips" when near either pole; but when over the centre or equator of the magnet it remains horizontal, and we account for the effects observed on the surface of our globe by imagining its axis to be a huge magnet, whose north pole lies towards the geographical south, and whose south pole lies towards the north. If we shift the position of the magnetised steel rod until it is free to move in a vertical plane *coinciding* with the direction of the magnetic meridian, we have the greatest angle of dip, and the magnetised rod is lying in the direction in which the "intensity" of the earth's field is greatest.

The angle which the rod or needle so inclined makes with the horizontal is termed the angle of "*Dip*" or "*Inclination.*" As we go further north the "angle of dip" increases, and we should expect to find the needle nearly vertical in regions near the geographical north pole. Similarly, on going south the "dip" decreases until there is no dip at all. We are then on the "magnetic equator" of our globe, and this equator, in which there is no angle of dip, runs very nearly through Aden, Madras, Penang, and Borneo, being several degrees north of the geographical equator. Going further south still the needle "dips" the other way—that is, with its south pole downwards, the angle of dip at the City of Melbourne being about the same as in London now—viz., about 67 degrees. At the time it was first observed in the year 1576, it was 71° 50′ in London, and it steadily increased, until in 147 years after that time it had reached 74° 42′, since which it has been slowly decreasing down to our present time.

It is not within the scope of these Papers to describe the methods of taking measurements of terrestrial magnetism; these are continually carried out at the different Observatories, with instruments of great precision, as for example at Kew and Greenwich, and continuous records kept.

The "*Total Intensity*" of the earth's field is the intensity measured in a direction inclined to the horizontal by the angle of dip or inclination, and in the vertical plane of the magnetic meridian. In order to express this total intensity in units of magnetic measurement, or indeed to express the strength of any magnetic field in units, we must first define the unit magnetic pole and the unit of force.

107. *The Unit of Force* on the centimetre gramme-second system is that force which acting on a mass of one gramme, free to move, imparts to it every second an acceleration or increase of velocity of one centimetre per second, or, in other

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words, that force which acting for one second on a gramme gives it a velocity of one centimetre per second. This unit of force is termed the "*Dyne*," and is equal to about the weight of 1·02 milligramme. If a mass of one gramme were allowed to fall by the action of gravity, the force exerted on it would be 981 dynes, because its acceleration would be 981 centimetres per second every second. Now, all bodies fall at the same rate, from the same height, in vacuo, whatever their mass, since one gramme experiences a force of 981 dynes, two grammes double that force, and so on, the ratio between force and mass being constant; and this ratio is the acceleration due to gravity. Hence the acceleration due to gravity is constant and equal to 981 centimetres per second per second, and the force in dynes exerted on any body in the earth's gravitation field of force is found by multiplying this acceleration by the mass of the body in grammes. As an example of this, take one kilogramme (1,000 grammes): the force of gravitation on each gramme is 981 dynes, and, therefore, on one kilogramme is 981,000 dynes, and it is precisely this force acting on the mass which gives it what we call weight. Again, one English pound is equal to 453·6 grammes, and therefore its weight is equivalent to $453{\cdot}6 \times 981 = 44{,}500$ dynes nearly.

108. *The Unit Magnetic Pole.*—We can now define the unit magnetic pole, which on the C.-G.-S. system is that pole which, placed at one centimetre distance from an exactly similar pole, exerts a force upon it of one dyne. Here we have a measurable quantity, and having established the unit pole, we can measure the strength of any pole in C.-G.-S. units by the force it exerts on a unit pole placed at one centimetre distance from it. Coulomb established by means of his torsion balance, described in most text-books, the law of inverse squares with reference to magnets—that is, that the force exerted between two magnetic poles varied directly as the product of their individual strengths, and inversely as the square of the distance between them. If two magnetic poles, when placed five centimetres apart, experienced a force of four dynes between them, we should know that the product of the strengths of the two poles was equal to $(5)^2 \times 4 = 100$, and if the strength of one of the poles was equal to unity, the other pole would be 100 units in C.-G.-S. measure. In that case the unit pole would be acted upon by a force of four dynes, due to a magnetic pole of strength of 100 units placed five centimetres away. In other words, the unit pole would be in a magnetic field equal to four C.-G.-S. units; this brings us to unit magnetic field.

109. *Magnetic Field of Unit Intensity.*—In the C.-G.-S. system the unit magnetic field is that field which will exert a force of one dyne on a unit magnetic pole placed in it, so that when we speak of a magnetic field of so many C.-G.-S. units it means that a unit magnetic pole placed in it would experience a force equal to that number of dynes. Sometimes a field is expressed as equal to so many dynes; this is a careless and incorrect way of expressing it, what is meant being that the field would exert that number of dynes force on a unit pole. There is no name given to the unit magnetic field, so that the strength of a magnetic field is simply expressed as so many C.-G.-S. units. It is also assumed that the number of lines of force per unit area (the area being at right angles to the direction of the lines) is a measure of the intensity of a magnetic field, and the unit intensity of field is taken as one line of force per square centimetre area. This assumption is a very convenient one for working out problems in magnetic fields. Suppose we mark a line due east and west on a table, and mark a certain point on the line. Now let a long bar magnet be laid on the line, one pole being at four centimetres distance from the fixed point. Consider the intensity of magnetic field at the point, due to the nearer pole of the magnet. Taking the strength of the magnet pole to be 80 C.-G.-S. units, the intensity of field at the fixed point would be $\frac{80}{4^2} = 5$ C.-G.-S. units, because if we could place a free pole of unit strength at the fixed point it would be acted upon by a force equal to five dynes. The intensity of field at this point could also be expressed by the density of lines of force, viz, five lines per square centimetre. We are here supposing the magnet to be so long that we may neglect the action of the other pole. If, now, a short magnetic needle, such as a small compass needle, was placed so that its centre exactly covered the fixed point, and in a line at right angles to the bar magnet, there would be a force acting on each pole tending to turn it about its centre. If the strength of each pole were 10 C.-G.-S. units, there would be a force of $5 \times 10 = 50$ dynes at each end of the needle acting in opposite directions, and therefore tending to move the needle about its centre. Now the needle has been placed in the magnetic meridian, and therefore is parallel to the horizontal component of the earth's field, which would be ·18 C.-G.-S. units. This field would therefore act on each pole of the needle with a force equal to $\cdot 18 \times 10 = 1{\cdot}8$ dyne. Now, if we freely suspend the needle horizontally about its centre it will move through a certain angle, depending on the resultant of these two forces.

We need only consider one end of the needle to find the angle through which it will be deflected from the meridian and the two forces acting at one end are at right angles to each other. Therefore, by the parallelogram of forces, it is evident that

$$\frac{\text{force due to bar magnet}}{\text{force due to earth}} = \text{tangent of angle of deflection;}$$

that is, $\frac{50}{1{\cdot}8} = 27{\cdot}7 = \tan \text{ of } 87°56'$.

The needle would therefore be deflected nearly 88 degrees from the north and south line, and would lie in the *direction* of the resultant force.

Similarly, by the parallelogram of forces, we may find the *amount* of the resultant force, the ratio being

$$\frac{\text{force due to bar magnet}}{\text{resultant of both forces}} = \text{sine of angle of deflection;}$$

whence

$$\text{resultant force} = \frac{50}{\sin 87°56'} = \frac{50}{\cdot 99934} = 50{\cdot}034 \text{ dynes.}$$

The intensity of field, or number of lines of force per square centimetre in the direction of the resultant force, will therefore be

$$\frac{\text{resultant force}}{\text{strength of needle pole}} = \frac{50{\cdot}034}{10} = 5{\cdot}0034 \text{ C.-G.-S. units.}$$

The field, in this case due to the magnet, is so much more powerful than that of the earth that it is practically equal to the resultant.

It will now be understood what is meant by saying that the total intensity of the earth's magnetic field is equal to ·47 C.-G.-S. units. The total intensity of the earth's field does not come into the calculations with galvanometers, since the needles are not used pivoted in the angle of dip; but the needles of galvanometers being horizontal, they are acted upon by the horizontal component of the earth's total magnetic force, usually denoted by the letter H. It is evident that, knowing the value of the total force of the earth in the direction of the dipping needle, and the angle of inclination which this force makes with the horizontal, we can resolve it into two component forces, one acting horizontally, the other vertically.

Resolving it, we have the

horizontal component = total intensity × cosine of angle of dip.

Thus in the year 1879 the total intensity in London was ·4736 C.-G.-S. units, and the angle of dip was 67° 42′. From this we get the horizontal component

$$= \cdot 4736 \times \text{cosine } 67° \ 42'$$
$$= \cdot 4736 \times \cdot 37945 = \cdot 1797 \text{ C.-G.-S. units.}$$

Similarly resolving for the vertical component we have the

vertical component = total intensity × sine of angle of dip.

Therefore for the same year the vertical component was

$$= \cdot 4736 \times \sin 67° \ 42'$$
$$= \cdot 4736 \times \cdot 9252 = \cdot 4381 \text{ C.-G.-S. units.}$$

The value of the horizontal magnetic field of the earth is on the increase, and is now equal to ·18 unit in London, while the total intensity is decreasing gradually in value.

(*To be continued.*)

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EDISON AND SWAN ELECTRIC LIGHT COMPANY v. HOLLAND AND OTHERS.

WEDNESDAY, MAY 9TH *(continued)*.

Examination of Mr. BERNARD PROCTOR resumed by Sir HORACE DAVEY: I saw numerous lamps during the period referred to. Those lamps were made partly by Mr. Swan and partly by Mr. Stearn, Swan supplying carbon and Stearn exhausting and mounting. I saw them at Bell's-court and Moseley-street, in Newcastle. All those were vacuum lamps. They were all incandescent lamps, with platinum wires sealed into a glass bulb exhausted of air, and carbon conductors. As far as I remember those lamps contained carbon, some made from paper and some from thread. Some would have thicker ends at the union with the platinum than others. The carbons varied in thickness, but thinness was aimed at. They were all much thinner than the pencil carbon used in the original lamp F I B 1. The shape of the carbon conductor was arched or horse-shoe, not looped. Most of them were simple horseshoe. I saw some of these carbon conductors before they were put into the lamp, and had them in my hands. I do not think any of them were shown by Mr. Swan at his lectures prior to 1879. I am an experienced chemist. I know from Mr. Swan how some of these carbons were made; from my own knowledge I do not know, as I never prepared them, and have no personal experience. I should think as a scientific man it is perfectly impossible these carbons could have been cut by a saw and file out of a gas retort. I saw these lamps running frequently during the period mentioned, sometimes singly, sometimes as many as twenty at a time. When two or three were burning together they did not all burn with the same luminosity. I always supposed that arose from the difference of thickness in the carbons and varying resistance. As individual lamps, many of them would be about 10 to 12 or 14 candle-power. I remember Mr. Swan having a gas engine erected at Moseley-street. That was in the spring of 1879. It was for working his dynamo. I remember an alteration being made in the fly-wheel of the engine, but cannot fix the date. The lamps burned a little unsteadily, and the alteration was made in the hope of securing greater steadiness of light. My impression is that that took place in 1879. The carbons I saw in the lamp at Mr. Swan's establishment would in all probability represent the carbons I saw prepared to be put in the lamps. I also saw at the Post Office, Newcastle, lamps made by Swan burning. That was in Mr. Heaviside's room. The lamps at Moseley-street had thin strips of carbon from a material cut before being carbonised. Some would be one-tenth to one twentieth of an inch wide, and about one fiftieth of an inch thick, in the form of a strip; others much smaller, not so wide, none thread-like. In point of size, they were very similar to, but rather smaller than, the carbon in J I 3, one of the lamps made by Mr. Gimingham when, as he said, following Edison's specification. I believe the lamps were all exhausted by a mercury pump known as the Stearn pump. I never witnessed the exhaustion of any of them, but I have seen the pump. At Moseley-street I, of course, saw the staff of Swan's assistants and workmen, altogether about 20 men. I also met several of Mr. Swan's relatives at Moseley-street, and occasionally strangers. I remember seeing Mr. Swan's sister, his brother-in-law, Prof. Herschell, and many others it is difficult to name. From time to time I have seen a great many friends of Mr. Swan at the establishment, but I cannot mention them individually. Certain points I saw at the works I understood were secret and in confidence, others I knew were public matters. As to the lamps I saw, Mr. Swan said nothing to me about them being secret or shown in confidence. So far as I know, and from my personal observation, so far as seeing and examining the lamps were concerned, no mystery was made of them by Mr. Swan.

Cross-examined by the ATTORNEY-GENERAL: I was Mr. Swan's partner as Swan and Proctor, chemists, about 1879. I have known Mr. Swan about forty years. I was in 1879 one of Mr. Swan's most intimate friends. I have no recorded memorandum of the dates on the lamps of which I have spoken. I trust to memory as my guide. I was examined at the last trial. I met Mr. Stearn, I think, in 1879, but I am not certain. I knew Mr. Stearn after he came to Newcastle. I probably saw him at Mr. Swan's house at that date. He resided at Rock Ferry, near Birkenhead.

When were you first asked about those dates and the lamps you saw by anybody on behalf of the Brush Company?—At Christmas, about five months ago.

Did you not know perfectly well through the whole of the year 1879 that Mr. Swan was experimenting with reference to incandescent electric lamps, and intending to patent his dicovery if possible?—I believe Mr. Swan intended to do so, but that is not positive knowledge on my part.

Had Mr. Swan any Sprengel pump at all at that time?—I think he had.

Will you undertake to say that prior to the beginning of 1880 Mr. Swan had any Sprengel pump at all?—I could not say positively.

Had he any glass-blowing apparatus which would blow these bulbs, or is it not a fact that during 1879 he had no glass-blowing machinery fit to blow the bulbs of incandescent lamps?—I think that is so.

Is it not a fact that all through 1879 Mr. Swan was sending carbons to Mr. Stearn to be put into lamps, to have the glass for them, and to be exhausted?—I have already stated that so far as I understand that is what took place.

Did not Mr. Swan tell you in October, 1879, or thereabouts, that he was afraid Edison would anticipate him?—I do not remember. I will not say he either did or did not.

Do you remember being shown a letter in which Mr. Stearn referred to Edison's experiments as reported in *Nature* and the *Mechanic* in October, 1879?—I do not remember.

Did it not come to your knowledge before the end of 1879, about November or October, that Edison was supposed to be working on the same lines as Swan?—Yes; it came to my knowledge that he was working on similar lines.

Do you not remember this passage being either read or shown to you in a letter of 3rd October, 1879, from Mr. Stearn to Mr. Swan:—"Have you seen the account of Edison's experiments in vacuo in this week's *Nature* and the *Mechanic*? He has trodden so closely on our ground that if he has patented his process I am afraid he has anticipated you entirely." Does not that bring back to your mind that you were told by Mr. Swan in October, 1879, that Edison might have anticipated him?—I cannot say I remember that.

Did not Mr. Swan tell you that as far as Edison's experiments or trials were concerned he did not mention carbon?—I do not remember that.

Did you ever see a lamp exhausted or glass blown in Swan's premises until the Christmas of 1879?—I cannot undertake to say so. My impression was that they were all blown at Birkenhead at that date.

Did you see several lamps that came back from Mr. Stearn in the year 1879?—Yes.

With a very few exceptions had not every lamp sent up by Mr. Stearn got the carbon conductor broken?—I know a great many carbon conductors were broken; I cannot say what proportion. I had no record at that time.

Had some of the lamps which came back from Mr. Stearn copper coils inside the bulbs between the glass and the carbon?—I do not remember copper coils.

Had they platinum caps?—I do not know that any of them had platinum caps. I remember the caps being made, but cannot give the date.

Shown lamp and asked—Did you see one or more lamps similar to that in the year 1879, after it came back from Mr. Stearn?—I do not remember having seen such.

Did you learn from Mr. Swan in December, 1879, that he thought Edison had been working on carbon?—That would be the date at which he learned Edison had been working on carbon, through a letter in the *Daily News* copied into the *Pharmaceutical Journal*.

Do you remember Mr. Swan, at or about Christmas, asking you if you had seen the letter in the *Daily News*?—I know we talked about it.

Did Mr. Swan tell you, about Christmas, 1879, that he was afraid Edison had been working carbon?—I have no doubt that something of that kind occurred.

Were not some of those lamps which Mr. Swan showed you lamps in which there was carbonised paper?—I believe some of those lamps which Mr. Swan showed me were of carbonised paper.

Mr. JUSTICE KAY: Tell me what you knew?—That Mr. Swan was hoping to obtain an electric light on the incandescent principle in which he proposed to use carbons made from vegetable parchment.

Do you know where the carbons came from that were sent to Mr. Stearn?—I believe Mr. Stearn prepared them himself.

Did you not know that Mr. Swan was getting his carbons which went to Stearn from Carré?—I think he told me that he got his carbons for the pencil lamp from Carré.

Was not the great difficulty experienced by Mr. Swan experienced in getting the platinum attached to the carbon?—I knew there was great difficulty.

Mr. A. W. HEAVISIDE, examined by Sir HORACE DAVEY, said:—I am superintending engineer of the Postal Telegraphs at Newcastle, and have held that place for 18 years. I knew Mr. Joseph Wilson Swan in the years 1878-9, and had conversations with him on the subject of incandescence and electric lighting frequently. I was in the habit of meeting him now and then. He was interested to talk to me about telegraphs, and I was interested to talk to him about the Swan lighting. I was two or three times at his establishment in Moseley-street in 1879. Mr. Swan asked me to do some work for him. On a few occasions he came to my battery room in the second half of 1879. He appeared to be in a difficulty as to what power he was using in lighting his lamps by means of whatever apparatus he might have at hand, and I was able to tell him approximately by certain tests the amount of current he was using, and also the resistance of the lamps when cold. I think it was matter of conversation that in order to make his lamps successful it was necessary to make his filaments as thin as possible, and of as high resistance as possible. Occasionally Mr. Swan would come to my battery room with a lamp, and I would join up certain bichromate batteries with these lamps for the purpose of running, and we would observe the effect with a given power. That was to find out what current was necessary to illuminate those lamps in a satisfactory manner. Those lamps were bulbs of glass fitted with horseshoe filaments. The conductors were then alike.

The Court adjourned at four o'clock.

THURSDAY, MAY 10TH.

The examination of Mr. A. W. HEAVISIDE was resumed by Sir HORACE DAVEY.

Witness said: Of the carbons I saw there were two classes. In one kind the line of light was even, while in the other kind, if you looked at them from one angle the line of light was finer than if you looked from the right angle. I tested Mr. Swan's lamp on several occasions prior to November, 1879, frequently in presence of friends of Mr. Swan and my own friends. Other persons were present whose names I cannot recall, and in addition to that there was at least one of my staff always present. When I commenced these tests I had loose wires run from the various batteries to the point where we placed the lamp. These loose wires were very inconvenient for making changes in the arrangements of the batteries, therefore I had a test-box put up of a simple character

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to enable these tests to be made more conveniently. This test-box was put up prior to November 15th, 1879. I remember that, because on November 15th, 1879, I opened a class, and gave my first lecture. That enables me to fix the date. Mr. Swan did not say anything about treating these communications as confidential, neither did that seem to be necessary, because there was general conversation in the Chemical Society as to the proceedings of Mr. Swan. In the latter half of 1879 I had no request for secrecy.

Cross-examined by the ATTORNEY-GENERAL: At the time I speak of I was in the employment of the Post Office, with a staff of from 40 to 200 under me. I was not paid by Mr. Swan at all; everything I did was done as a friend. Witness was here asked to draw on a piece of paper a horseshoe and the lamp round it as he remembered them at the beginning of 1880. On being asked to draw others, such as he saw in 1879, he said he could not do so, as the one he had drawn was simply a type.

Cross-examination continued: I continued to work for Mr. Swan during the greater part of 1880. In the year 1880, I saw at Mr. Swan's establishment at Moseley-street a very large number of lamps of that kind. They were being worked by his dynamos and gas-engine. Some of them had a second coil in the horseshoe. I am not sure whether I ever saw a coil in the horseshoe before December, 1879. In 1879 I knew nothing whatever about the manufacture of the lamps. I did not know if Mr. Swan had any glass-blowing apparatus in 1879. I had heard the name of Mr. Stearn. I did not know he was asking for Mr. Swan. I can only tell you from Mr. Swan's information what the carbons were made of in 1879; I understood from him it was parchmentised paper in some form or other. All my experiments were made with bichromate batteries, chosen because they were the most suitable I had. The maximum pressure put on in 1879 was about 120 volts. I did not know in the end of 1879 that Mr. Swan was hoping to patent an improved incandescent lamp. That was never referred to by him directly or indirectly. I do not remember the date of Mr. Swan discovering or inventing the thread lamp. I believe it was brought to me in the beginning of 1880. I tried the resistance of the thread lamp in the same way as the others. There was higher resistance. Of the twelve lamps I tested, the highest resistance would be not more than 24 ohms. The minimum resistance would be very difficult to remember. Of those twelve none of them had copper coils inside the glass bulbs. I did not see lamps with platinum caps in 1879. [Shown B S P 3.] I never saw such a lamp as that in my life. I discussed with Mr. Swan why the lamps I examined broke down. One specific case occurred in 1879. The specific point was the difficulty of connecting the carbon with the platinum. I cannot fix the dates on which I saw the lamps at Moseley-street before November, 1879. I knew the lamps brought to me were vacuum lamps. I always thought Mr. Swan was earlier than Mr. Edison in the use of threads for his carbons or filaments. In the end of 1879 the name of Edison cropped up frequently, as he inundated the country with communications as to what he was doing.

Mr. GEORGE HOWARD PATTESON, examined by Mr. GRAHAM, said: I am an earthenware manufacturer at Gateshead. I originally served my apprenticeship with Mr. Swan as a chemical and scientific apparatus dealer. I was with Mr. Swan from January 7, 1876, to January 16, 1880, and after that as an assistant till June, 1880. My father at that time was a manufacturer of pottery, and had ovens for baking the pots. Mr. Swan gave me small crucibles, requesting me to get them put through my father's furnaces, and bring them back to him, which I did. They were put through the furnaces with the earthenware in the ordinary process of manufacture. After they had been through the furnaces they were brought to my father's house, and I took them to Moseley-street, and gave them either to Mr. Swan or Mr. Mayfield, the manager. I am not perfectly clear whether I saw Mr. Swan pack a crucible, but I am perfectly certain I saw him unpack at least one after it had been baked. I saw Mr. Swan take from that crucible small strips of what had apparently been, and what I was given to understand had been, small strips of paper, which strips were wrapped in paper, and packed in powdered charcoal. I took at least half-a-dozen crucibles to my father's works. The pieces were of varying widths, from $\frac{1}{8}$th of an inch to $\frac{1}{16}$ths or $\frac{1}{4}$ of an inch, and in length about $1\frac{1}{2}$ or 2 inches. I took some of these crucibles to be fired prior to October or November of 1877. The heat in the particular furnaces in which the crucibles were fired was raised very slowly, taking 24 hours to reach a dull red heat, after which it was carried to its highest degree. I remember Mr. Swan trying some experiments with electric lamps in a room in which I worked—testing the light and exhibiting it to others. I can only fix the date by reference to Mr. Swan's public lecture. The lamps which I refer to as being exhibited in the chemical room were exhibited prior to Mr. Swan's first lecture in January, 1879. The shape of the conductor in the lamp I refer to was straight. It was from 1in. to $1\frac{1}{2}$in. in length. The conductor was flat in one case, in another the conductor was also straight, but the section was circular. The lamps were incandescent for varying lengths of time up to several minutes' duration. The platinum wires were fused into the glass. [Shown F I B 1.] One of the lamps I saw resembled this, and the other had the flat burner I referred to but otherwise resembled this. During the time the lamps were being tried in Mr. Swan's works several persons were present, amongst others Mr. Proctor, Sir William Armstrong, Prof. Herschell, Mr. John Patteson, and others. Besides those gentlemen the staff were present. I heard no instructions as to secrecy. I was present at the lecture on the 3rd of February, 1879, and remember Mr. Swan exhibiting a lamp on that occasion. The lamp at the lecture burned thus—the burner became heated to red heat, giving nothing like the light that incandescent lamps do now. I remember a gas engine being put up at Mr. Swan's works. It came to Moseley-street on 3rd or 4th March, 1879. Between that date and the date of Edison's patent, November, 1879, I saw Mr. Swan experimenting with some other lamps in the late summer of 1879. The bulbs of these lamps were a good deal more rounded than the earlier ones, and somewhat resembled a radiometer in shape. [Witness here, at the request of counsel, made a sketch of the lamp.] He then continued: I saw more than one lamp of this sort during the interval we are speaking of. They burned fairly satisfactorily, and I do not remember any as having broken down.

Cross-examined by Mr. ASTON, Q.C.: I was with Mr. Swan during a portion of the year 1880. During that year I did not know that Mr. Swan took out two patents at that time. I will pledge my memory that there were no lamps tried in my presence after January, 1880. In 1880 I had control of the chemical room and most of the apparatus stock. I saw the lamps of which I have made a sketch tried in the engine room.

Mr. JOHN THOMAS MAYFIELD, examined by Mr. GRAHAM, deposed: I am an electrician, carrying on business in Queen Victoria-street, London, and was formerly manager at Mr. Swan's works in Newcastle. I was with Mr. Swan from April, 1874, till October, 1879. I was manager of the scientific apparatus department. I remember Mr. Swan carrying out experiments with electric lamps. That lamp was in use in the months of October and November, 1870. The conductor had been made from carbonised paper. Other lamps were being made by Mr. Swan at that time with various conductors. Mr. Swan experimented in every direction, so that anything that could be carbonised would naturally be there. I remember Prof. Herschell, Sir William Armstrong, Mr. Barker, Mr. Proctor, and Mr. Patteson seeing the experiments. I remember Mr. Swan delivering lectures at Gateshead and Sunderland. I believe he there exhibited the same lamp as at the Literary and Philosophical Institute. My impression is that as soon as Mr. Swan had described the incandescent lamp and turned on the current it was allowed to remain on during the rest of the lecture at Sunderland. That would be from a half to three-quarters of an hour.

Mr. JOHN RIDLEY, examined by Sir H. DAVEY: I am a mechanical and electrical engineer at 25, Newgate-street, Newcastle-on-Tyne. I am acquainted with Mr. Joseph Wilson Swan, and have done work for him, first on the 5th March, 1879, in Moseley-street, Newcastle. The work was erecting an Otto gas engine and various other work, such as fixing dynamos, wires and other things not connected with electric work. The wires were fixed for running lamps. I fix this date, 5th March, by my day book, into which entries were made by me at the time. On the 5th March, I received the engine from the North Eastern Railway Company. The dynamo machine was at work on April 5th, 1879, or thereabouts. I cannot tell when it was first at work. The dynamo was then driving lamps. I was frequently, during the year 1879, at Mr. Swan's place at Moseley-street. I saw the dynamo at work many times. It was driving lamps. I saw the lamps burning. Other persons were present at the time, such as Mr. John Cameron Swan, Mr. Proctor, and Prof. Herschell.

Cross-examined by the ATTORNEY-GENERAL: Will you pledge your oath that you ever saw a horseshoe lamp with a loop before the year 1880?—I never saw a lamp without a loop until I came to the Electric Exhibition in the Crystal Palace.

Will you pledge your word that you ever saw a lamp with a loop at Mr. Swan's until the beginning of 1880?—I did.

Cross-examination continued: I do not know the material that the first loop lamp Mr. Swan made was composed of. In the latter end of 1880 I heard that the carbon for Mr. Swan's lamp was made of thread. I have nothing beyond the book produced to enable me to state the number of days I went to Swan's. I was not there at all between 24th May and 23rd October, 1879. From the book I can swear that I was at Mr. Swan's on April 5th and May 3rd. I have seen the dynamo run for transformer or induction experiments many times. I did not know where Mr. Swan was getting his lamps from in the year 1879.

Mr. WM. MENZIES, Mr. CHAS. BLACKBURN, and Mr. JOHN LANG gave evidence of a similar character to that of the last witness.

The Court adjourned at 4 o'clock to meet again on Monday at 10:30.

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MONDAY, MAY 14TH.

Mr. EDWARD WILLIAM TURNER, examined by Mr. FINLAY, said: I am second-class superintendent of the Liverpool Telegraph office, and reside at Rock Ferry. I resided there in the year 1878-9. At that time Mr. Charles Henry Stearn was a neighbour of mine. I had communication with him on the subject of electric lamps and electricity. He had a work room in his house. I have been present in that room and have seen him running lamps. The first one I saw was in the summer of 1879. I saw two or three lamps being run during that year at Mr. Stearn's house. These were shown to me about the months of July or August. The first lamp I cannot describe, as it was in a dark room. The second I remember Mr. Stearn holding up to the light for me to see. It was a simple loop of thread formed like a bow. It was enclosed in a globe-shaped glass with a stem and a kind of a point on the top, the connections of the burners being down the stem. I have seen people at Mr. Stearn's house looking at the lamps. I was never told to keep secret what I had seen.

Cross-examined by Mr. ASTON: The first lamp I saw at Mr. Stearn's was in the summer of 1879. I saw other lamps at subsequent periods extending to November, 1880. From time to time during that period Mr. Stearn showed me the lamps upon which he was experimenting. I can only describe the thread of the lamp I saw as like shoemakers' wax.

Mr. JOHN ALLAN, examined by Mr. FINLAY, said: I am battery man in the Liverpool Postal Office. I remember being introduced to Mr. Stearn by Mr. Turner in 1879. I fitted up batteries at Mr. Stearn's house. I remember seeing electric lamps there. The lamp was pear-shaped, with a carbon burner having a thread-like appearance. The burner was the shape of a horseshoe, and appeared to be as thick as a sewing thread. I could not say how many of the lamps I have seen, as they were packed away in a box as soon as tested. I daresay I have seen half a dozen of them. I have seen them burning when being tested. Many people besides myself saw those lamps at Mr. Stearn's. Nothing was ever said

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about keeping secret what I had seen. It would be in August, 1879, that I saw those lamps.

Cross-examined by Mr. ASTON: I went to assist Mr. Stearn in the summer of 1879, and was with him till the spring of 1880. All the lamps I saw at that time had horseshoe-shaped burners. I never saw any with straight burners. I have seen a good many lamps packed and sent off from Mr. Stearn's. I saw at least six packed in cotton wool about the month of August. The packing was going on all the time I was with Mr. Stearn, after testing. I had charge of the batteries which were in the cellar. There were about 30 cells. They were of the Bunsen type. The cells were afterwards increased to 60, and gave a better result. I could not fix the time or date of increase.

Mr. ROBERT ROBERTS, examined by Mr. FINLAY, said: I am a builder and joiner, and reside at Rock Ferry. In 1879 I was engaged on work for Mr. Stearn, at his house. That was during the months of July and August, 1879. While there I saw electric lamps. I have seen sometimes one, two, or three, or as many as half a dozen at a time. The burner was the shape of a long horseshoe, and appeared like a black thread.

Cross-examined by Mr. ASTON: I was frequently at Mr. Stearn's in the year 1880, and have often seen electric lamps tried by him. I never saw a burner that was a straight rod. All the burners I saw were of the loop shape. The lamps were lighted when I saw them.

Mr. PERCY SELLON re-called was examined by Mr. GRAHAM as follows: In the end of November last I went to the manufactory of Messrs. Carré, at 19, Rue de la Ville Estrapade, Paris, and I purchased similar carbons to those in the case now produced, which were about one foot long, and some of which were one millimetre diameter and others half a millimetre in diameter. These are some of the colours.

Mr. FINLAY: I want to exhibit F I B 2 to be identified by General Webber, one of the directors of the Anglo-American Company, who is not here at the moment; but, subject to your lordship allowing him to identify exhibit, we have completed the Defendants' case.

Mr. ASTON said his side desired to call evidence to rebut the evidence for the Defendants.

Mr. JUSTICE KAY: That you have a right to do. You have not called Edison.

Mr. ASTON: No, my lord.

Mr. JUSTICE KAY: Nor Cheesborough.

Mr. ASTON: No, my lord.

Mr. JUSTICE KAY: Then, do you object to the passage in Edison's subsequent specification beginning, "I have discovered," &c.?

Mr. ASTON: We leave that in your lordship's hands.

Mr. JUSTICE KAY: No, no, you cannot do that. It is for you to say whether you object or not.

Mr. ASTON: We cannot call Edison, my lord.

Mr. JUSTICE KAY: I do not wish to dictate to you for one minute. You do not call Edison, and you made an objection. All I want to know is whether you now object to this being received as evidence or not.

Mr. ASTON: Not as evidence, my lord.

Mr. JUSTICE KAY: Then you do not object. I cannot help using that against you for what it is worth if you do not object.

Mr. ASTON: Well, there it is, my lord, for what it is worth. We could call Cheesborough, but he is only a patent agent.

Mr. JUSTICE KAY: I do not wish to dictate to you as to how you are to conduct your case. Conduct it as you like; but I wish to know whether you object to this subsequent statement or not. I understand that you leave it for what it is worth.

Mr. ASTON: Yes, my lord.

Prof. JAMES DEWAR was then called on behalf of the plaintiffs, and examined by Mr. MOULTON: I am Professor of Chemistry in the University of Cambridge, and for many years have devoted my attention to chemistry and electricity. Since the year 1872 I have more or less continued my investigations on the behaviour of carbons both in the arc and by incandescent heating.

I take you to the specification of Edison's patent 4,576. You have been in court most of the time hearing the evidence of the witnesses for the defendants. I call your attention first to the evidence with regard to the process of carbonisation. In November, 1879, was the process of carbonisation a known process?—Yes, perfectly well known.

Had it been known for a long time?—Since the beginning of last century—1760 at any rate, and probably thousands of years ago.

Would you take this as a definition of carbonisation which has been given by Mr. Swinburne—"Carbonising is simply raising the proper material to a high temperature out of contact with air"?—Undoubtedly that is a very simple and fair definition.

It is almost identical with the definition of Prof. Thomson, taken from "Brand and Taylor's Chemistry." Is that a well-known book?—Certainly.

Were the steps necessary to be taken to perform this process of carbonisation well known in November, 1879?—Of course they were well known. Absolutely nothing has been added to the stock of public knowledge as to carbonisation, as regards carbonising filaments, as required for the objects of this specification, since November, 1879.

What were the precautions necessary to be taken as known in 1879?—Merely the exclusion of atmospheric air.

How was that effected?—That was effected by either heating in a close vessel, the volume of which was not very large in comparison to the size or body to be carbonised, or the substance was placed in a larger vessel, and packed in powdered charcoal or other inert substances.

Are these precautions sufficient to enable anybody to carbonise?—Perfectly sufficient; I have tried it hundreds of times.

Was the term carbonisation a chemical term?—Yes, it was a term perfectly recognised in technical science.

Mr. JUSTICE KAY: It was recognised when I was a boy.

Examination continued by Mr. MOULTON: Taking Cheesborough in 1871 I put to Prof. Silvanus Thompson his description of carbonisation. Was that common knowledge at the date of the specification?—It was.

In your opinion are the references to carbonisation in Mr. Edison's specification sufficient to direct a person wishing to perform the process there described, and to find out the precautions?—I think so.

It has been suggested that things so slight as filaments cannot be carbonised with sand. Have you tried the experiment yourself?—I have.

How did you try it?—I tried it with a crucible of about four cubic inches, the same size as that mentioned by Mr. Crookes. I then put in it sand, and about 100 pieces of vegetable fibre. Each length would be about four or five inches long, and the thickness before carbonisation would be about a fifth of an inch. Before carbonisation I put them close together in the crucible, then I filled it up with sand. The sand was coarse. I then luted on the cover in the ordinary way, and placed it in a crucible of larger size, knowing the material was very porous. The cover was placed upon the crucible and luted, and then I put the whole into a furnace. The furnace was at a full red heat at the time. I allowed it to remain there about two hours, keeping up the heat, and the result was as shown in the specimens I now hold in my hand (specimens produced).

Mr. JUSTICE KAY: Were any of those in the crucible destroyed?—I do not think so, but so far as I estimate, in the removal I lost about 3 or 4 per cent.

Am I to take it none were attacked by the oxygen in this process of carbonisation?—No.

Witness here produced three exhibits which were marked respectively I D 1, I D 2, and I D 3.

Mr. MOULTON: What kind of sand did you use?—It was common sea sand.

Will you explain the operations which in your opinion resulted in the process of carbonisation?—The sand physically displaced about two-thirds of the air. When carbonisation begins, wood or vegetable fibre gives off 250 times its volume of hydro-carbon and other vapours. At that temperature it would be 500 times its volume. This enormous quantity of gas of course displaces the whole of the air in the interstices of the sand.

After displacing the oxygen by the gases going off, would that have another effect in protecting the carbonising?—They would protect it because they are reducing the gases.

Was all this known in 1879?—Yes, perfectly well known.

Mr. JUSTICE KAY: As this has already been made entirely clear by witnesses on the other side, we need not go over it again.

Examination resumed: Any person in 1879 wishing to carbonise a small body like a filament, do you think he would have any difficulty in doing so?—No difficulty in the world.

In the instance given you put the crucible into a larger crucible. Have you also performed the operation without the larger crucible?—I have performed the same operation by using a plumbago crucible.

They are thicker in the walls?—Yes.

Mr. JUSTICE KAY: Would that have some effect on the carbon?—It may; but it is chiefly want of porosity and thickness of the walls that prevail. It was packed in the same way, and the experiment was perfectly successful; just as much so as the other.

Have you mounted any filaments carbonised by yourself?—Yes, I have mounted one of these filaments in Edison's way, and exhausted it. The lamp is not very elegant, but it is perfectly practicable. [Lamp produced, marked I D 5.]

What do you mean by Edison's way?—By fixing the filament on to the platinum by carbonisation with the lampblack wires and then carbonising it.

In the carbonising of that lamp did you use anything that was not common knowledge in 1879?—I did not.

Mr. JUSTICE KAY: How long did you run it?—I ran it for several hours.

In your opinion does that lamp show any signs at all as yet of breaking down?—I do not think so. The darkness of it is partly due to the manipulation of the glass being bad.

Examination continued by Mr. MOULTON: For the purpose of a useful filament being made, in your opinion is it necessary to take any precautions against distortion?—None other than the packing which I have described, either in fine sand or in fine charcoal.

Have you tried to make a lamp in any of the ways mentioned in Edison's specification?—I have tried making an experimental lamp with a tar putty filament.

First, with regard to rolling it out, what is your opinion on the point?—It is merely a question of manipulative skill.

How do you roll yours out?—I simply roll it out on two flat surfaces.

What were your surfaces?—I took two surfaces of brass, but it does the same on a flat surface of paper or wood so long as it is flat.

Do you think it was necessary, in order to enable a person to roll this out, that any special directions should be given?—I do not think any directions would enable one to roll them out if they had not manual dexterity.

With regard to operations in which tar and lampblack are to be combined, what do you say?—I say Edison's description of the consistency of the material to be employed is the only mode in which you could convey a physical state to this body which will work.

Do you think any person trying to perform the process described in the specification would have any difficulty with carbon filaments?—I do not think so.

With regard to the length of the filaments, what do you say?—I say there is no difficulty in rolling the filaments to different lengths.

And, do you think it was necessary or requisite to mention any special length?—I do not.

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Witness here produced an experimental lamp which he had made from lampblack. The exhibit was marked I D 5.

Will you tell his lordship how you made that lamp?—This is simply a lampblack tar putty filament which I rolled when carbonised, and attached it with the lampblack to the wire. I carbonised the putty and tar putty at the same time with the two platinum wires inserted.

Mr. JUSTICE KAY: Was this done in sand?—No, it was done in carbon.

By Mr. MOULTON: With the platinum wires attached?—Yes. Afterwards the two platinum wires were slipped into the other two, heated through the glass without clips.

Have you run that lamp?—I have.

With what result?—I think it is a very good experimental lamp indeed.

Supposing that mode of constructing a lamp were reduced to practice and used on a large scale, in your opinion would it turn out a practical and useful lamp?—I see no reason whatever why it should not.

Can you tell how long it would last?—I cannot, but I have run it for about two hours.

This lamp was neither run on the pump nor subjected to Cheesborough's process?—No.

Would these processes have improved it if they had been used?—Yes, immensely.

I would next ask you as to your other experiments?—I cut from a length of platinum wire two equal pieces. I placed one of the pieces in fine lampblack and heated it to a white heat in a furnace for about two hours. I then took the resulting platinum. It has the appearance of being slightly attacked on the surface. In order to test its porosity I sealed it into a vacuum tube. Then I had a similar tube, into which I sealed the platinum wires which had not been carbonised. I exhausted the two tubes simultaneously, so that they had each the same vacuum. They were connected. They were then of identical appearance when the electric discharge passed. I sealed the connecting tube so as to secure the connection. I then passed the electric discharge. The appearance was exactly the same. I measured the appearance by the striation. If there was the slightest leak into one of these tubes, the alteration in the appearance is the most delicate test we have of an impaired vacuum. I repeated that operation after standing twenty-four hours, and the tubes remained of identically the same appearance.

Take now W C 22.—There are two separate pieces of platinum wire, which were placed in the same crucible, the only difference being that the spiral P 2 had lampblack containing a little sand mixed with it. The crucible was subjected to a white heat for more than in hour. The result shows the deleterious effect of silicious compounds in presence of carbon and platinum.

Did you examine scientific periodicals on the point to see if this phenomenon had been observed by other people?—It is quite well known.

I do not know whether you yourself have tried the method of making a lamp by rubbing tar putty on thread?—Merely experimentally; I never mounted any such.

Did you find any difficulty in carbonising?—None whatever.

Examination continued: I have myself rolled filaments of lampblack and tar. If rolled fine the filaments can be made into the form of a spiral. I have a specimen of a filament so coiled. Supposing the winding of the spiral was made so close as in that specimen, it would have the effect with regard to radiation which Edison mentions. Judging from my experiments, all the methods of making filaments mentioned by Edison can be carried out. I have tried the coiling round a helix of copper wire and succeeded in carbonising. I heated it with diluted nitric acid to dissolve away the copper. I did not mount that filament, but was satisfied it was a practicable thing. Nitric acid has no action on carbon.

The Court then adjourned for luncheon.

After luncheon the examination of Prof. DEWAR was resumed by Mr. MOULTON, as follows: I ran one of the lamps which have been put in for about 20 hours. It was at white heat. It gave a good light. Beyond the fact that the glass was not so clear I have not the slightest doubt that it would work well if properly exhausted. With regard to the non-conducting non-carbonisable substance mentioned in Edison, I gather that its intended use is to isolate one coil of this close spiral from touching the other during carbonisation. I have tried experiments with the coating upon a filament to see if the lamp would be a workable one. The specimen I produce now is an ordinary Edison lamp, the filament of which is made, I believe, of bamboo fibre, which I opened, and coated the filament with lime. I thereafter exhausted the bulb, and ran the lamp for about three hours. A great portion of the lime has been knocked off by the action of the current. I think it is due to the high velocity of the residual particles of air always left in the bulb. I say that used in Edison's way—an exceedingly thin coating on the outer surface—does no damage to the working of the lamp.

It has been said that filaments must be freed from impurities in order to give them proper life. Is that necessary?—I say it is not.

Examination continued: Parchmentising to a certain extent takes out the impurities. The parchmentising process is not intended to deal with impurities, but with the character and structure of the resulting carbon. With that exception it does not alter the construction, but it makes the carbon more homogeneous. It is a matter of practice to get lamps that offer the same resistance and run together. With the exception of Cheesborough's process, I do not know of any way that would make the lamps uniform. Before the date of Cheesborough's specification I made a great many experiments with carbon, especially in connection with the electric arc. I have known Deprez's Paper since the year 1872, and before that; I know the kind of carbon deposited by that process. In 1879 I was engaged in a research which made me very anxious to get carbon tubes which were not porous. I tried to improve all the carbons I could find in the market by subjecting them to Sidot's process. I did not, however, succeed. It never struck me for one moment to employ Deprez's process to improve carbon and make it non-porous. The effect of Cheesborough's process is exactly what he has described; it produces a carbon which is much more homogeneous than can be produced by furnace deposition. The hydro-carbon forms a deposit which lodges in the carbon. Flashing renders the filament much more stable, more elastic, less liable to disintegration of the lamp, and of course thereby increases the light of the lamp, enabling it to be run at a higher temperature and for a longer time. It has been proved that this deposit of carbon gives a greater proportion of light say for the same expenditure of energy. With regard to the process as described by Cheesborough, it is an admirable description. Supposing the second process there described be used, the carbon pencils would be suitable to light incandescent lamps. I say there is also a fair description of the substances, all of which work satisfactorily in the way. Referring to Deprez's Paper, there is nothing in it that led me to use the Cheesborough process. I do not think Deprez's was well known, unless to specialists working in carbons at high temperatures. I cannot say from reading Deprez's Paper whether the experiment with the carburetted hydrogen was incandescent or arc. I made a lot of experiments in 1866, before the last action. I have some of the specimens of Sidot's process which I made for the last trial. I have repeated the experiment which was described by Mr. Crookes, and I find the reduction of the calcium only takes place when the arc temperature is reached.

The Court adjourned at four o'clock, to meet next day (Tuesday), at half-past ten o'clock.

TUESDAY, MAY 14TH.

The examination in chief of Prof. DEWAR was continued by Mr. MOULTON as follows:

Have you brought specimens of the wooden fibre you used?—Yes. [Specimens produced.]

Uncarbonised?—Yes.

Have you brought the glass with which you rolled the filaments?—I have.

Witness here produced the two plates of glass with which he rolled the filaments. Thereafter he rolled a filament about one-fiftieth of an inch thick, and handed the same to his lordship, by whom it was inspected and handed in turn to the learned counsel. Witness subsequently attached the platinum wires and exhibited the finished article as before.

Mr. MOULTON: What amount of mineral impurity has such a thing as lampblack and tar?—Well, it varies very much.

Would it have more or less than vegetable fibre?—About the same.

The specimens made by witness were then put in, and marked I D 14.

Mr. JUSTICE KAY: Do I understand you prepared that putty yourself?—I did.

By Mr. MOULTON: With regard to the platinum, in your opinion is carbide of platinum formed in the process of carbonisation?—I have never been able to find carbide of platinum formed by igniting carbon of a high heat in presence of lampblack.

Have you tried the experiment of coating filaments with lime and running two lamps, one coated and the other not coated?—I have. [Shown two lamps.] These are two of Edison's lamps made of bamboo filament, one of which I opened last night and coated the filament with magnesia. I ran the two lamps at the same time thereafter for an hour. There is a deposit in one of them. There is a difference in luminosity; the radiation from the magnesia differs from the radiation from the carbon; it looks more luminous in some parts, but generally it looks darker relatively to the carbon. That optical effect depends upon the thickness of the coating. I ran the lamps about an hour. [Lamps put in and marked.] The blackness is probably due to opening the lamp. The filament is severely tortured in putting the coating on. I have had occasion to observe the behaviour of lime in presence of carbon. In conjunction with my colleague I made experiments at the highest temperature we could produce in a furnace, and at that temperature we could get no evidence of the production of calcium by the action of carbon on lime.

Cross-examined by Sir HORACE DAVEY: You told us yesterday of the chemical action of carbonisation which was older than the time of Du Bois Reymond, and you took us back to the middle of last century; what I want to direct your attention to is this question: Prior to 1880 for what purpose was carbon used, in what trades or manufactures?—It was used, of course, for gunpowder, for every process in which carbon was wanted in combustion; it was employed in every chemical laboratory.

I am asking you in what trades or manufactures was the process of carbonisation employed?—Do you mean wood carbons?

I am saying what I mean, the process of carbonisation; in what trades or manufactures was the process of carbonisation used?—I say it was used for gunpowder making, it was used for the production of charcoal, it was used in every chemical laboratory, and especially in connection with blow-pipe works.

For the purposes you have described, was it or was it not necessary to provide against the deterioration of the carbon—I must not say destruction, I believe, but the deterioration or consumption of the carbon—in making these small carbon filaments?—I say no, it is still carbonisation whether a big substance or a small one.

Was it so important in carbonising for the purpose of gunpowder manufacture and the other manufactures you have mentioned to exclude the oxygen as it is in making these small filaments?—I think so, if you wanted a good result.

Then you do not agree with the gentlemen who have already given evidence?—I say no one would carbonise in presence of air.

Mr. JUSTICE KAY: Do you know any trade or manufacture in which ordinary workmen are employed in which the same precautions are taken as are now taken?—I do not know of any manufacture previous to that unless the use of gunpowder for blow-pipe purposes.

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Mr. JUSTICE KAY: The effect of your evidence on my mind is this. Except in chemical laboratories, and by people who have a knowledge of chemistry, no such precautions were taken in any ordinary trade or manufacture?—I do not think there was any use for them except for blow-pipe work, or work of that kind.

I think you told us yesterday that in your opinion nothing had been added to the special knowledge with regard to the carbonisation of these filaments since the November of 1875?—I said the abstract principle of carbonisation remained the same.

The abstract principle. I understood you to mean the method of carbonisation?—I am using the word method as to heating in a close chamber or heating in a large vessel.

Have you directed your attention to Edison's specimens and the patent dated 15th December, 1879, entitled the "carbon patent," and, if so, did that add anything to the existing state of knowledge on the subject?—No, that patent is simply a patent of detail.

I am aware of that; but I am asking you if this method of carbonisation added anything to the existing state of knowledge?—I say nothing to the method.

Edison did not think that, did he?—No; he did not.

I will refer you to the claim. Did not Edison conceive himself, rightly or wrongly, to have taken precautions against distortion in carbonisation?—I have no doubt he found it an advantage of detail to use a mould; but I say that added nothing to the knowledge of the method of carbonisation.

I am afraid we are using method in a different sense. I mean carbonisation as a process for the purpose of making carbon conductors for lamps?—Probably he found that this was an advantage; but that did not prevent another method from giving perfectly satisfactory results.

I will refer you to Edison's next patent, which is what we call the bamboo patent, and is so long that none of us have been able to read it. Having quoted from page 50, book 3, Sir HORACE DAVEY asked: Would a lampblack and tar carbon be a carbon that is purely structural?—I think he uses the word structural there as a word relating to vegetable fibre.

Would a carbon formed by carbonising tar and lampblack be expressly structural in the sense in which Edison uses the word there?—I think not. I take it he means vegetable fibre.

Passing on to page 54, line 7, was it known before that date that in carbonising those small things there was danger of rupture or distortion?—I say yes. It was well known in the case of the carbonisation of wood that there must be a large amount of contraction—20 per cent. of the original wood.

Was there any necessity prior to this time for taking measures for the purpose of preventing that distortion, and to provide for the contraction that takes place?—I say in the case of packing filaments in wood, charcoal, or lampblack, that forms a mode itself which allows for contraction. But the mere fact that a filament is distorted does not prevent its being used in a lamp. They do not look quite so well, that is all.

Can you refer me to any prior publication of any sort or kind in England in which measures had been indicated for the purposes of preventing the inconvenient results which Edison here points out?—I do not think there was any demand for it. Do you include any scientific Paper?

Yes, I will take a scientific Paper.—I say it was well known in the year 1868. It was published in the *Philosophical Magazine* in 1868, and there were then set forth details on the relative contraction of wooden fibre in carbonisation and the production of tubes of small filaments complete. That Paper was by Dr. Gore, of Birmingham. There the carbonisation was done simply in a glass vessel.

Then in your opinion did this passage to which I have referred, and the means pointed out by Edison to get over these difficulties, add nothing to the stock of knowledge at that date?—I say they added to the improvement of the manufacture, that is all.

Then do you dispute the statement "During the process of carbonisation there is sometimes danger," or do you say that that was well known?—I say so most decidedly.

You told us in your experiments you packed your crucible in sand and put it in another crucible?—I did.

What proportion in bulk before carbonisation did the filaments bear to the whole contents of the crucible?—A very large ratio. The vessel had 40 times the volume of the filaments, which I consider enormous.

The rest was sand?—Yes.

Referring to the experiments of Mr. Crookes as to packing filaments in dry sand, so far as the details of the experiment spoken of by Mr. Crookes are concerned, you have no objection to make?—So far as they are recorded here, all I say is, I made similar experiments. His were burned out, mine were not.

Some of yours were?—Not that I am aware of.

Did you mix any carbonate of lime in it?—Absolutely nothing.

I think you say you produced lamp I D 5—the lamp made of this putty wire. Do you call that a filament?—I do. It was the best one I could make at that time.

What is the diameter?—I should think it is half a millimetre, about the 30th part of an inch.

I would ask you again whether you call it a filament?—I do not say it is a filament as I understand Edison's specification, because it is not so fine as he intended to roll them.

What do you understand by a filament?—A very fine thread.

I think you told us you tried that lamp, running it for a certain time. There is some distillation of the tar?—There is some slight distillation.

Would that distillation of tar inside the lamp produce gases of some kind?—If the temperature was high it might.

Would not the presence of tar in any form in the lamp *pro tanto* be a disadvantage?—Undoubtedly; I do not think anyone in repeating the manufacture of a lamp would allow tar to appear again.

You told us coating would not do any harm in a lamp. Would it do any good?—That I am not prepared to say.

Do you see the slightest utility from it?—Yes, I think I do. Lane-Fox first suggested coating with these bodies, or, at least, simultaneously with Edison, from an excellent idea, viz., of endeavouring to get more light for the same expenditure of energy; but whether or not that is the result I cannot say.

The cross-examination of this witness had not concluded at half-past one o'clock.

Mr. ASTON, for the purpose of interpreting the word "moistened," as used in the case, quoted from the book of Job, "His bones were moistened with marrow."

The Court then rose.

WEDNESDAY, MAY 16TH.

The cross-examination of Prof. DEWAR was resumed by Sir HORACE DAVEY, as follows:—

Have you made any calculation, on the basis you told me, of the electrical energy employed by Deprez, assuming he used 600 Bunsen batteries arranged in the most favourable manner?—Yes, and the result of my calculation is that it was from 30 to 100 amperes.

In making that calculation what did you assume to be the electromotive force of each cell?—I took it roughly as two volts.

And the internal resistance of each cell?—Less than one-tenth of an ohm.

What size did you assume the cell to be?—I took the largest cell which we used in the laboratory at that time—pint size.

Do you say it would be only about one-tenth of an ohm?—Yes.

As to Cheesborough's patent and impossible substances non-conductors of electricity, what have you to say of the list of Mr. Crookes?—I think the reference is to bodies which would be impossible under the conditions of Cheesborough's experiment. These are bodies which you may say are not easily fusible, but they are, many of them, easily fusible under the conditions of Cheesborough's experiment.

Apart from Cheesborough's experiment, are not those bodies such as you would, as a man of science, describe as infusible substances, non-conductors of electricity?—I should not. I say a great many of the silicates would fuse at the highest temperature.

Did you require much practice in rolling out the lampblack and tar filaments successfully?—I required no practice.

You succeeded the first time you tried?—Yes.

Re-examined by Mr. ASTON, the witness said he had made many experiments in 1886 with the Cheesborough process, but never at the time tried coating non-conducting substances with carbon and treating them in Cheesborough's way. Since the suggestion had been made, however, he had tried it, had mounted the burner in a lamp, and had run the lamp for some time. A prior publication of the means of preventing the inconveniences indicated by Edison was to be found in a paper in the *Philosophical Magazine* for 1868, on "Details in Relative Contraction of Woody Fibre in Carbonisation, and the Production of Tubes in Small Filaments," by Dr. Gore. This Paper contained the same things as Edison described. Distortion of filaments in carbonisation did not affect their efficiency necessarily; the appearance only would be objectionable. Distortion, short of rupture or of short-circuit in the spiral form, would do no harm. Rubbing fine clay into the putty, as done by Mr. Crookes, would not, in his opinion, be a proper mode of coating a filament. He had carbonised filaments in a closed crucible with and without putty. There was no difficulty in manipulating lampblack, and the filaments by carbonising in a closed chamber without packing; that was, in fact, the best way to carbonise these filaments.

A small crucible was produced, handed to the witness, who said: In that crucible I have, with Mr. Gimingham, carbonised filaments in the precincts of the court, using no packing and no luting of any description. The filament was a thread, so far as he could remember.

Sir HORACE DAVEY urged that this did not arise out of the cross-examination.

Mr. JUSTICE KAY said it should have been produced in the examination in chief. If it were pursued Sir Horace Davey would be entitled to ask any questions upon it.

Sir HORACE DAVEY, cross-examining: About what heat was this produced at?—It was a mere experiment. It was a spirit lamp that was used.

Do you suggest that this coil, or whatever you like to call it, has been heated to a sufficient heat for use as a conductor in an incandescent lamp?—Not at the present time.

Then it is not completely carbonised?—It is carbonised; but it does not conduct well enough. It wants to be heated for a longer time at a higher temperature.

Has it been heated to a degree at which the oxygen would combine with or attack the carbon?—That I cannot say. I think it is probably at a low red heat.

Mr. JUSTICE KAY: I am very much disgusted. I am here trying all I can to understand the case, and this is clearly an attempt to mislead. I am greatly disgusted.

Prof. DEWAR: I have no desire to mislead your lordship. I have stated that this was a mere experiment. I did not produce it. It was put to me.

Mr. JUSTICE KAY: You may stand down.

Dr. JOHN HOPKINSON, re-examined by Mr. MOULTON, deposed:—I have heard the evidence given on behalf of the defendants in this case, and have made experiments on various points arising out of the evidence. I have seen experiments made with regard to the possibility of carbonising a tar and putty filament in a close chamber without any packing at all. The filaments were carbonised and subsequently

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mounted into lamps and tested. I have seen the same thing done with linen and cotton thread carbonised in like manner without any packing. In that case I should say the platinum wires passed through a glass mounting. The platinum wires had been attached before mounting. There was only one filament in the tube, it was thoroughly well carbonised, mounted in a lamp and the lamp exhausted. In the former case of the putty filament it was wrapped upon a cylindrical rod of wood before carbonising, after the attachment of the platinum wire. That rod had to be supported in the cylindrical chamber. From the results of these experiments there is no doubt carbonisation can be successfully performed in a closed chamber without packing. The temperature was kept at full heat about half an hour, at first the blow pipe was put on rather lightly, and afterwards increased. With regard to the process of carbonisation, the heat need not be as high as that at which carbon would unite with oxygen.

Mr. JUSTICE KAY: What heat would this be, compared with furnace temperature at which filaments are now carbonised?—It would be below furnace temperature.

Would it be higher or lower than the heat at which filaments are now carbonised?—I should think below.

How much lower?—I cannot say. I can only define it by saying the temperature was just over that which would melt brass.

In one case the substance was tar and putty, in the other thread, and there was a little bamboo as well. There is no doubt the filaments were perfectly carbonised; they were put in lamps, which lamps, so far as I could judge, were perfectly good. We measured all the lamps. [Shown lamp.] That is the lamp with the lampblack and tar and the very fine thread rolled into it. It was carbonised in the way I have described. [Shown another lamp.] This was made from a cotton thread carbonised in the longer cylinder, attached first of all by tar putty platinum wire. It was carbonised in a tube without any packing in the way described. That was measured at 6½ candles, and it then took 67 volts ·85 amperes, which also works out to little less than 8 watts per candle-power. [Shown thread.] This is just like the thread that was used to roll in the tar putty for I H 6. [Thread marked I H 8.] I have seen carbonisation in sand. [Shown box.] That box contains the materials that were used—the crucible and platinum cover, also some of the sand, and one or two bits of broken filament. There were pieces of cotton thread, paper, and bamboo put into that. They were heated in the gas furnace to a bright furnace heat for about a couple of hours. They were then taken out, and in this box are some samples of the filaments which resulted.

Witness was further examined as to other lamps similarly produced. Continuing, he said: I have seen experiments made to see whether a lime cylinder subjected to Cheesborough's process can be raised to incandescence. I have satisfied myself on the point. We tried the experiment twice; the first time we failed, in the second we succeeded. The cause of failure in the first case was that the means of controlling the current were insufficient, consisting of plunging a metallic substance into a greater or less depth of a liquid, and so leading the resistance. The result was that the current suddenly sprang up to an exceedingly high degree of intensity. We repeated the experiment with better means of control, and succeeded. A little rod of carbon was thrust through a cylinder of lime. The ends of the carbon were supported by larger pieces of carbon, and the lime stood between the two pieces of carbon. It was then placed under a receiver, and coal gas was introduced in place of the air. It was then heated by the passage of the current, carbon was deposited, and here is the result. [Specimen produced.] The lamp now exhibited, if filled with nitrogen, would be very similar to Fig. 1 of Cheesborough's specification. The differences would have nothing to do with the behaviour of the conductors.

Mr. JUSTICE KAY: What am I to gather from this? I do not understand the object of these questions. This is only a carbon treated according to Cheesborough's process.

By Mr. MOULTON: Did that compound conductor stand incandescence?—Yes, it was heated for the better half of half an hour to a bright yellow, while the deposit was going on, but no further gas had been admitted during the latter portion of the time.

Are you by that experiment able to say oxygen will reduce the lime at such a temperature?—I see no signs of reduction there.

Assuming it was desired, would a conductor so made in an incandescent lamp stand?—I see no reason to doubt it.

Examination continued, and witness asked as to the instructions in Edison's patent for the making of lampblack and tar filaments, he said the instructions given to make the substance of the consistency of thick putty were the best that could possibly be given. He did not see that the instructions as regards rolling would prevent success. The filaments in the lamps put in were rolled in his presence between brass plates. The finest he had seen was about a hundredth of an inch, sufficiently fine to make practicable lamps of high resistance. At the date of the patent the knowledge of the present day with regard to carbonisation was in existence. The method of making the connection with lampblack and tar was perfectly practicable. He had seen many tar-putty joints successfully made. An experiment was tried in his presence as to heating lampblack in contact with platinum. The description given by Prof. Dewar was complete. The platinum wires in the upper part of the crucible in lampblack alone were to his eye uninjured, whilst those in lampblack and sand had become very brittle. As to the filament with the non-conducting non-carbonisable substance, he agreed with Prof. Dewar regarding it.

In your opinion are the directions as given in Edison's specification for making a lamp, sufficient to enable one willing to make the process succeed to make a practical lamp?—Yes.

And, in your opinion, would the various methods there described succeed in making a practical lamp?—I think so. I have seen a large number of them.

Now, with regard to the Cheesborough. Are the directions in Cheesborough sufficient to enable any practical person wishing to perform the process to do so successfully?—Yes. I think they are all really very explicit.

In your opinion, is the effect of Cheesborough's process to improve the carbon of an incandescent lamp?—I think there is no doubt whatever of that; it does improve it.

As to efficiency and duration?—Yes; I think almost everybody uses it.

The Court then adjourned for luncheon. On the Court resuming,

Dr. HOPKINSON was cross-examined by Sir HORACE DAVEY as follows:—

Do you seriously suggest to the Court that any workman in the year 1879, or any other time, if he wanted to carbonise a material, would use one of these brass tubes and a blow-pipe?—I think it is very likely.

As a commercial way of carbonising?—Whether it would do or not commercially I do not know.

I am speaking of a man engaged in the manufacture of lamps from carbons to be used, and I am asking, do you seriously suggest to my lord that such a man would use a brass tube and a blow-pipe?—I think if he were making one filament it would be the most natural thing he could do; if he were making a great many, he would probably introduce some material into the chamber.

Would any man in his senses do that?—I would not put it so strong as that; but he might adopt a more economical way of doing it.

You put that forward as what Edison tells you to do?—Yes.

Where do you find anything about a blow-pipe?—I find nothing about a blow-pipe, I only find a high temperature.

Did you put your brass tubes into the furnace?—No; I would not like to melt the tubes.

Before the bulb was closed you passed the electric current through the conductor so as to let it run the lamps?—No; I think in the case of those that were flashed that might be said to be done.

I am talking about running on the pumps?—No; I did not.

You put the platinum wires into these brass tubes?—Yes.

With a piece of glass between them?—No; the only cases in which glass was used were in one or two of those experiments where the platinum wires were through the glass.

You put the glass and all into the brass tube, closed the tube and exposed it to the heat?—Yes.

Was the glass melted?—No.

What is the melting point of glass?—It varies considerably according to the composition of the glass.

But is it considerably below red heat?—No; glass becomes softer and softer till it is quite soft. For thoroughly melting glass you require a bright white heat.

Does it take to become soft considerably below red heat?—It begins softening somewhere about red heat; but that, again, depends upon the quality of the glass.

In your experiments you used sand, I observe, very fine white sand?—Yes, it is the white sand they use for making the first quality of glass.

Is not that sand pure silica?—Yes.

And does it not contain any water or moisture?—That depends on circumstances. It is generally washed and dried. Generally it contains a good deal of moisture.

As compared with other sands, would that fine sand contain a very much larger amount of moisture or water?—I do not think so.

Will you show me, from one end to the other, one single line in Edison's specification which tells you you are to get rid of all the tar?—He calls your attention to that specially, so far as I remember.

In reply to further questions, witness said distortion *qua* distortion is harmless; it is only a matter of appearance.

Prof. FLEMING, examined by Mr. ASTON, said: I remember in 1879 a Mr Johnston, assistant to Mr. Edison, coming over to England. In 1880 he brought with him a box containing some half-dozen carbon incandescent lamps. He left those lamps in my charge. At that time I was acting as the scientific adviser of the Telephone Company, whose offices were at 11, Queen Victoria-street. Mr. Johnston requested me to make arrangements to run these lamps. They were put up in a room and operated on by galvanic batteries. They were arranged in parallel. I examined the lamps, and I can state they were carbon incandescent lamps, with bulbs made entirely of glass, and platinum wires sealed therein. The platinum wires, so far as I can recollect, were united to the carbon with little clamps. The carbon conductor, to the best of my recollection, was a very thin strip of paper in a horseshoe shape. I was told the glass bulb was exhausted. [Shown lamp.] To the best of my recollection this lamp is very similar to those exhibited in Queen Victoria-street in the beginning of 1880.

Sir HORACE DAVEY said that was the worst form of a leading question.

Mr. ASTON: I am only sinning in the same direction as my learned friends.

Mr. JUSTICE KAY: No man excuses himself by another man's errors.

Examination continued: I had no doubt the lamps I tried were good efficient Edison lamps. They gave an excellent light. They were exhibited on and off for several weeks from time to time. Sometimes they were run for some hours; the current was turned off, the battery renewed, and the current turned on again. Since that period I have been familiar with the manufacture and working of incandescent lamps. Those were efficient lamps that Edison sent to me through Johnston. A number of persons were brought to the rooms from time to time to see the lamps. There was no secrecy about them at all. The two gentlemen who arranged the batteries saw them regularly. I have witnessed experiments upon carbonising filaments in a close chamber. They were the experiments which Dr. Hopkinson has referred to. The filaments were made, as described by Dr. Hopkinson, in the brass tubes, at a temperature given by a blow-pipe

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flame, at a heat a little below the melting point of brass. The heat carbonised the filaments very thoroughly. I agree with the evidence of Dr. Hopkinson as to carbonising these filaments. If put on the pump and flashed, they would be quite equal to filaments in ordinary use. I co-operated with Dr. Hopkinson in taking the electrical measurement of those lamps, and on that point I agree with him. With reference to carbonisation in sand, the sand taken was a fair sample of ordinary silver sand.

Mr. JUSTICE KAY: Have you tried the experiment of carbonising a filament in damp sand?—No.

Do you think anybody would use damp sand?—I should think it improbable that anybody would use damp sand.

Examination continued: Prior to 1879 I was familiar with the literature on carbonising. I cannot say positively whether before 1879 I knew about carbonising with charcoal.

Mr. JUSTICE KAY: When did you first learn that?—Several years ago, but not before 1879.

Was it 1880 or 1881?—I should think it would be somewhere about 1881 or 1882.

By Mr. ASTON: Previous to 1882 I had no experience of carbonising filaments. I have seen the process of rolling out lampblack and tar filaments by Prof. Dewar. I have tried the same thing and succeeded very well indeed. I rolled out one to the diameter of about $\frac{1}{1500}$th of an inch. The material was a mixture of lampblack and coal tar which Mr. Gimingham gave me. The material was of the consistency of thick putty. The operation of rolling requires nothing but a little manual dexterity. The filament I rolled is one of the exhibits. W C 20 is the filament made from the tar putty which Mr. Gimingham gave me, and is rolled out to the $\frac{1}{1500}$th of an inch. None of the filaments I rolled were put into lamps. I saw filaments rolled by Mr. Gimingham put into those lamps of which Dr. Hopkinson has spoken. It is marked I H 6. It is a good serviceable lamp; it has a fine thread rolled in it.

Did you see any filament rolled in your presence and afterwards put into a lamp that had no thread in it?—No; I do not recollect having seen a filament without any thread, and afterwards put into a lamp.

Have you seen a filament made and introduced into a lamp in which camphor was used?—I measured such a lamp with Dr. Hopkinson.

Examination continued: It was run for about ten minutes; the result was 53 volts 2 amperes and 27 ohms hot. We had no record of candle-power. The lamp was run to a bright white incandescence. During the time we saw it run it was an efficient lamp. There was a little tarry matter at the top of the bulb from the joint. That occurred in five minutes. That discoloration is caused by a little tar driven out from the clamps when the lamp is run. The clamp is made by putting over the carbon and platinum wire tar putty paste. It was from that that the discoloration was evolved. It was evolved almost as soon as the running began. The discoloration does not impair the efficiency of the lamp, because it does not appear round the illuminating part, but only round the face.

Shown lamp produced by Dr. Hopkinson, in which the platinum filament was attached to carbonisation, witness was asked—

Are those platinum wires injured so as to destroy the efficiency of the lamp?—Not in the slightest.

Shown another lamp, and asked, What do you think about that?—I recognise this as one of the Edison lamps made in America, and delivered over in this country within the last few months. This lamp I know from the examination of precisely similar lamps, but with the same bulb and by the bamboo filament, and I know that by microscopic examination. The filament is attached to the leading wires by plastic carbonisable material.

Examination continued: As to impurities, if an impurity is uniformly distributed through a filament, and does not exceed a certain amount, it does no harm. An ordinary cotton thread will do for a filament. We do not use at the present time ordinary cotton thread, but cotton thread which is parchmentised. I have made a filament of cotton thread without being parchmentised, and have tried it in a lamp. The lamp is marked I H 7. The thread has not been purified in any way. Woody fibres might be used without being purified. One of the lamps put in this morning was so made. It is I H 1, and made from bamboo filament.

Cross-examined by Mr. FINLAY: You said you do not now use cotton thread unparchmentised; did you ever see a lamp made of cotton thread unparchmentised before I H 7?—Yes.

When?—Two years ago.

For what purpose was that lamp made?—A good many of these lamps were made for the purpose of the Woodhouse and Rawson action.

May I take it that so far as your knowledge extends there never has been a lamp made with cotton thread unparchmentised, except those made for the purposes of litigation?—Not so far as I know.

Take I H 10; has that got 10½ watts per candle-power?—Very nearly that.

Is not that an enormous expenditure of energy?—It is enormous as compared with some, very small as compared with others.

Three or four is about the usual thing, is it not?—Three or four is, I think, given for lamps that have had all the modern improvements applied to them.

When did Mr. Johnston bring the lamps to this country?—Mr. Johnston brought over the lamps in February of 1880.

Are you familiar with the specification taken out by Mr. Edison in 1879 for making filaments out of carbon?—I am, generally speaking.

Have you any doubt that these lamps brought over in 1880 had been made in accordance with Edison's specification?—I do not know in accordance with what specification they were made.

Did they look as if they had been made according to the directions of that specification?—I cannot say.

Were the clamps such as are described in that specification?—I cannot recollect the exact details of the clamps.

Look at the figure in book 3, page 37; were not the lamps exactly like that figure?—I cannot say they were exactly like it; they were similar.

Was there any point in which you can suggest they differed?—I do not think the bottom part of the lamp was finished in the way this is.

Am I to take it that they were generally the same as this drawing?—They were not very dissimilar.

With regard to the experiments with the brass tubes, have you ever known filaments prepared for commercial purposes by such means?—No; I do not know that I have ever seen filaments prepared for commercial purposes in brass tubes.

Is it not utterly unsuitable for the purpose of commercial manufacture?—It is not, perhaps, the best arrangement that could be devised for manufacturing them on a large scale.

Mr. JUSTICE KAY: Do try and answer like a witness, not an advocate. You know what the question is.

Witness: It is not the way that would be adopted on a commercial scale.

Mr. JUSTICE KAY: Would it not be much too costly to use it for commercial purposes?—It would be much too costly.

By Mr. FINLAY: Was the sand you used free from clay?—I did say it was pure sand.

By that you mean it was free from clay?—I did not analyse it.

Have you ever tried a lamp made with tar-putty filament for duration?—I have seen lamps tried that were made with tar putty.

By whom and when?—They were made by Mr. Edward Gimingham two years ago.

For the Woodhouse and Rawson litigation?—Yes.

Was any evidence given with respect to these in that case?—I think not.

Do you recollect what the results of the experiments were?—So far as I recollect the lamps were very satisfactory.

Do you represent that a lamp which darkened in that way in five minutes would be a good commercial lamp?—Yes, I say it would.

Blackening is produced by decomposition of the tar?—By the tar driven out of the clamps.

Have you any doubt that the decomposition of the tar when the lamp is running would impair the vacuum?—No, I do not think it would.

Re-examined by the ATTORNEY-GENERAL: I was a witness at the last trial. The defendants were Woodhouse and Rawson. They are still manufacturers of lamps. I recollect no such suggestion as that a competent workman could not make a lamp from this specification of Edison's. I could lay my hands on plenty of lamps in London which are now running at not less than ten watts per candle-power.

Dr. HOPKINSON re-called, examined by the ATTORNEY-GENERAL, and shown lamps: I received these lamps on or about 23rd March, 1880, from Mr. Waugh. They were sent to me by Mr. Edison. One has a filament broken and the other unbroken. In the unbroken one the vessel is entirely of glass; the leading wires pass through it, and I have no doubt there is a vacuum. The conductor is a carbon, and I believe is made from paper. The other one is identical, though the filament happens to be broken. I measured the resistance of the lamp; it is 170 ohms. So far as modern improvements are concerned, probably it would not be as good as a modern lamp.

Cross-examined by Sir HORACE DAVEY: It is very like the lamp Dr. Fleming described as having been sent to him. The joints are made by mechanical clamping, similar to what Mr. Finlay read from Edison's subsequent specification to Dr. Fleming. The filaments, I have no doubt, are made from paper.

Can you tell me whether or not prepared in the manner we describe as the cardboard pattern?—No; I cannot tell.

The ATTORNEY-GENERAL, addressing his lordship, said in the interests of his clients he would like the brass box for examination, as there had been some mistake about it. Neither he nor his learned friends would appear in the case if it could be suggested there was any desire to mislead. He asked that his side should be allowed to have the crucible. He thought Prof. Dewar had been misunderstood.

Mr. JUSTICE KAY: You must ask your opponents. Prof. Dewar made a very unpleasant impression on my mind.

The ATTORNEY-GENERAL: Your lordship was good enough to say so; and we are entitled to have the crucible returned, in order that the experiment may be tried again.

Sir HORACE DAVEY: It puts me in a very awkward position. The evidence has been given.

Mr. JUSTICE KAY: I will not do it unless you consent.

Sir HORACE DAVEY: I will not consent.

The application was accordingly refused.

The ATTORNEY-GENERAL intimated that he would not be able to finish the evidence this week.

The Court adjourned at four o'clock.

At the commencement of the proceedings yesterday (Thursday), the ATTORNEY-GENERAL mentioned that he would not be able to finish the evidence on that day. With respect to the evidence of Prof. Dewar, he found he had attached undue importance to the remarks that passed. He was very sorry he did not mention to Sir Horace Davey the application for the box before he did so.

Mr. JOSEPH WILSON SWAN was then called, and his examination and cross-examination occupied the whole of the day. At the termination of the proceedings (which will be fully reported in our next issue), the Court adjourned till Wednesday, the 30th inst., at 10:30 a.m.

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THE DIFFERENCE OF POTENTIAL BETWEEN CERTAIN METALS, &c., IN SOLUTIONS OF DIFFERENT STRENGTHS.*

The question of how strength of solution affects the potential difference or (using Prof. Ayrton's abbreviation) P.D. between metals is of importance in making solutions for batteries, also in electro-plating. In this short Paper only a specimen of results can be given, as the space is limited. The solutions used in the experiments now being described were of potassium cyanide (K C N), the ordinary commercial substance being used containing about 60 per cent. of pure K C N. In order to determine the potential difference, a galvanometer was used with a high resistance in series with it. This galvanometer consists of a coil of wire suspended between the poles of a permanent magnet. To the coil is attached a mirror, which reflects light on to a graduated scale. When a current passes through the coil it moves out of its usual position, and the spot of light moves on the scale. The instrument is dead beat, which is a great advantage.

The current from a standard cell (Latimer Clark's) was passed through the galvanometer, and the deflection noticed. There being a high resistance in the galvanometer circuit, it was thus arranged as a voltmeter, and therefore the deflection was proportional to the P.D. between the terminals of the cell. Next, the cell was replaced by the two metals experimented upon, which were dipping into the solution under test. The corresponding deflection was noticed, and, by comparing this with the previous deflection, the P.D. in volts was obtained. Carbon was always used in conjunction with another metal, and the P.D. between them observed when they were in the solutions under examination. The following are a few of the results obtained, the P.D.'s being in volts assuming the standard cell to be correct, *i.e.*, with an amount of 1·435 volt. The figures at the top of each column are the number of pounds of commercial K C N per gallon (1lb. per gallon is equivalent to about 100 grams per litre).

	·005	·025	·25	·5	·1	·2	Saturated Solution. 5·16
Zinc	·925	1·13	1·35	1·395	1·45	1·52	1·615
Copper	·25	·39	1·215	1·27	1·295	1·425	1·535
Brass	·29	·58	1·13	1·21	1·295	1·4	1·46
Platinoid	·435	·535	8·25	·9	·945	1·03	1 185
German silver.	·36	·5	·86	·92	·91	1·05	1·18
Silver	—	·39	6·55	6·95	·76	·845	·97
Lead	·46	·44	·59	·585	·61	·64	·7
Iron	·23	·3	·395	·45	·43	·47	·455

From the above results it will be seen that as the solution increases in strength there is a gradual rise in the P.D. between carbon and the above metals. This is shown better if curves are drawn, having for abscissæ the number of lbs. of K C N per gallon, and for ordinates the corresponding P.D.'s. Other solutions than the above were used—for instance, those of potassium thiocyanate.

It will be seen that the P.D.'s between zinc and carbon and copper and carbon are very nearly alike, so the P.D. between zinc and copper is very small. This is different to what we find in the case of sulphuric acid, where the P.D. between zinc and copper is much larger.

* From the *Journal* of the City and Guilds of London Institute, Finsbury Technical Institute, and Old Students' Association.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

This Society met on Thursday evening, May 10th, at the Institution of Civil Engineers, Mr. Edward Graves, C.E., the President of the Society, in the chair.

The PRESIDENT: It is my painful duty to have to mention to you the death of the first designer of the Atlantic cable, Sir William Bright, our immediate Past-President. He was known to everyone by the reputation he early acquired in connection with the enterprise of crossing the Atlantic, and of proving that there was no limit of distance to the success of submarine telegraphic connection. His cable had a short life; faults of construction and other circumstances led to its early abandonment, but it showed what could be done, and it taught those who persevered in the same field afterwards both what was necessary and what they should avoid. Associated with the commencement of the Electric Telegraph Company at an early period in his career, he was an active agent in securing its development, and for it he invented the Bell telegraph and other apparatus of great use. In India, in Persia, in South America, in the Mediterranean, in the West Indies and other parts of the globe, he laboured to spread submarine telegraphy throughout the earth. On the morning of this day week he died suddenly; on Monday last he was buried. In him we lost not only a member of much eminence, whose name will be for ever associated with one of the greatest achievements of electrical engineering, but those who were personally acquainted with him, as I was for more than 30 years, lose also a genial and kind-hearted friend. I think, therefore, I am justified in asking you to vote a resolution of condolence, and I beg to move

"*That an expression of our deep regret for his loss, and our sympathy with Lady Bright and the members of Sir Charles Bright's family in their bereavement, be agreed to, and that the Secretary be instructed to convey an expression of the same to Lady Bright.*"

The resolution was carried.

The Risks of Fire Incidental to Electric Lighting.

Mr. W. H. PREECE, F.R.S. (Past-President of the Society), in opening the discussion on this subject, said: We, as electrical engineers, cannot shut our eyes to the fact that the various practical applications of electricity are surrounded with dangers which become of serious moment if neglected, while on the other hand we are perfectly aware that they can be made harmless if we take care to direct the agency we employ in proper and direct channels. We, as electrical engineers, cannot endorse the oft-repeated statement that the electric light is an absolutely safe light. All systems of artificial illumination are dangerous; but of all systems of artificial illumination there is no question whatever about this, that electricity can be made the least harmful. Now, I was one of the first to sound the alarm of the danger of electricity in a letter to *The Times* in the year 1880, and the result of that letter was to bring about my head all those busy promoters of electric lighting that were then so prevalent in this country. Now, the elements of safety are—first, the knowledge of the dangers; secondly, the character of the dangers; and, thirdly, the antidotes to those dangers. The first question that I propose to ask and to answer is this: Where we have systems of this kind full of danger are rules and regulations necessary? There is danger connected with the burning of a candle; but no insurance office has ever issued a rule that you are not to burn a candle at both ends at the same time; nor has any insurance office told us that cats must not be allowed to knock over petroleum lamps, and that it is foolish to place them under the bed. As regards gas, we are not told that pipes must be large enough to convey the necessary quantity of gas, and that gas is leaky, offensive, and dangerous. All these things are self-evident, and nobody would for a moment dream of issuing rules to meet self-evident dangers. But even gas is accompanied with certain dangers. There is a great personal friend of mine living not very far from Wimbledon, who, whenever I have suggested that he should have his house lighted by electricity, has always objected on the ground that it was too expensive. Just recently an explosion of gas occurred in his house, and caused damage to repair which will cost twice as much as if he had had the place lighted by electricity in the first instance. Now, the reasons why rules are necessary for electricity are these:—The agency we use is novel; it is invisible, it is mysterious, it is inodorous. There are very few people—there is not a man in this room knows what it is. We only know how to handle it, but all the world at large feels that there is something in it that they know nothing at all about, and they fear to tread upon it. Electricity is singularly open to fraud. There is nothing so easy as to deceive a person ignorant of electricity of the character of the apparatus and of the materials used to employ it. It is a field for ignorance, and it is, above all things, one in which what our American friends call Cheap Jack-ism is rampant. The result is that rules and regulations are absolutely essential to protect the users of electricity from the rapacity of those who supply it. Now, in 1881 our American friends, the Edison Company of New York, issued a series of rules, and the Fire Insurance Board of New York followed their example. In 1882 the rules that were introduced in New York formed the basis of rules that were issued by the Phœnix Office, under the guidance of Mr. Heaphy, and it is a very curious thing that these rules of Mr Heaphy, with which we are all so thoroughly acquainted, contain even to the present day an American brand upon them in one particular rule, and that is the use of the word *ground* as applied to an earth-current. Now, the Society of Telegraph-Engineers, at the same time, in 1882, took up this subject, and we brought out rules that are familiar, no doubt, to many of you; and, also at the same time, the Franklin Institute of America did the same thing. From 1882, or 1883, things in England had been going on very pleasantly indeed. The rules that were issued by the Society of Telegraph-Engineers were virtually an assertion of certain principles. The rules that were drawn up by Mr. Heaphy were drawn up in the interests of the fire offices, and they are virtually detailed rules that have been the guidance of I think nearly every telegraph-engineer amongst us. Personally I can say that I have never used any others. But last year an alteration was suggested. Someone started a hare, and that hare has been running rather fast since then. Not only has the Society of Telegraph-Engineers been carrying out the work that it is my duty to detail to you to-night, but others have stepped into the breach. We have at the present moment rules issued by three independent offices, and the cry is, "Still they come." Nevertheless, with numerous rules before us, and the prospect of rules to come, we are not so badly off as they are in the United States. In the United States there are the rules drawn

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up to which I referred just now by the New York Board of Fire Underwriters. Those rules, originally drawn up by Mr. Woodbury, have from time to time been revised, and they have kept pace with the advances in electric lighting; they are short and concise, and, as far as the practice in New York is concerned, they meet every requirement. At Boston the Fire Underwriters' Union have done the same thing; there is a capital series of instructions drawn up there. But in New England there happens to be another insurance body, with head-quarters at Boston, who have drawn up rules and regulations, and these rules and regulations number as many as 72. At Philadelphia there are again rules and regulations drawn up by the Franklin Institute, and there is scarcely a town of any size or consequence in the States, with the exception perhaps of Chicago, that has not got its own rules and regulations. So that these poor Americans are considerably worse off than we are. In the spring of last year it was suggested to the Council of this Society that the time had arrived when the rules and regulations of the Society should be revised, and a committee was formed to deal with the subject. I may tell you that the rules and regulations of this Society were prior to that in very considerable demand. Some thousands of copies had been issued, and at the very time when we were asked to reconstitute the committee a demand had arrived from one of the large provincial offices for 200 more copies. Indeed, from inquiries I have made I have not the least doubt that there have been a greater number of installations in this country put up under the rules and regulations of this Society than under those of the Phœnix Fire Office. Of course, in London the Phœnix Fire Office has been paramount, and I think no other rules have been used; but it is not so altogether in the provinces. In May last this committee was formed, and I may tell you at once that the re-formation of this committee did not meet with my personal approval. I was not present when it was discussed, but the committee did me the honour to elect me as their chairman, and as I had been chairman of the previous committee I felt bound to take the matter up, although I was perfectly satisfied with things as they were, and we had found that the rules issued by the Phœnix Fire Office were very complete. We had found that the well-known inspector of the Phœnix Fire Office was always and ever ready to meet us on every occasion. I have been brought into intimate connection with him in connection with the exhibitions, and especially with the Colonial Exhibition. But still, there was a demand that their rules should be revised, and our very first action was to get our secretary to call upon the fire offices' committee to see how far any movement on our part to reconsider these rules would meet with their support and approval, and to intimate that this Society had no desire to move in the matter unless they could be assured that their doing so would be of service to the insurance companies generally. It having then been decided that some steps should be taken, it was perfectly evident that there ought to be only one set of rules in existence; and there being as it were two powers in existence—that is, the Society of Telegraph-Engineers and Mr. Heaphy—I came to the conclusion that the only satisfactory method of bringing matters to a crisis and settling them satisfactorily was to get Mr. Heaphy to act in conjunction with our committee. Mr. Heaphy joined the Society. We had numerous meetings; all through the months of May and June and July we were at work. We formed a small sub-committee of Mr. Crompton, Mr. Siemens, General Webber, and myself, and we met Mr. Heaphy, and matters were going on as swimmingly as one could wish. But, unfortunately, there was a little cloud in the horizon that we had not anticipated. We found, when we brought these gentlemen connected with the fire offices together that it was like an attempt to mix oil and water. It was the signal for a storm, and the result was general electrical disturbance (laughter). We had arranged that the original rules drawn up by the Society of Telegraph-Engineers should be revised to date, and be simply generalities; that they should be followed by detailed rules to be called the Fire Office Rules, which were, as a matter of fact, the rules drawn up by Mr. Heaphy. But there were certain points connected with these rules that did not quite meet the approval either of myself (as chairman) or of the members of the committee. There is not one word to be said against the matter of these rules; the objections were to the phraseology, to the mode in which they were drawn up, to the fact that after a rule had been defined clearly there was the proviso that it might be departed from "with the approval of the inspecting officer." In fact, the inspecting officer was made too much of an arbitrator in the matter, whereas we rather desired that the rules should be hard and fast rules, only to be departed from under very exceptional circumstances. But the *crux* that we broke upon was this. It was proposed that the rules should be preceded by words to this effect: "The following detailed rules having been drawn up by the Phœnix Fire Office for electric light and electrical power installations, and having been laid before this Society for its approval, are recommended for general use." Now, we had not been through these rules. Mr. Heaphy insisted that we should come to a decision that these rules were approved by us before we had examined them; and, as chairman of the committee, I decisively and decidedly declined to put any such proposition before the committee. Mr. Heaphy thereupon left the committee, I am sorry to say, and we came to grief. Now, when you are in trouble the best thing to do generally is to adopt the policy of masterly inactivity. At this time very conveniently the holidays arrived. But in December we had to commence again. It was necessary to carry out our determination to draw up rules of our own, and accordingly we set to work, and in March our rules were issued. Now, certain offices object to these rules even as they are, and we have not yet succeeded in convincing all the fire offices either that they would be wise to accept our rules or that they would be wiser to accept those of the Phœnix Fire Office. Mark you, this question of rules and regulations is entirely a question between the insured and the insurers. We can only act in the capacity of "guides, philosophers and friends": we cannot attempt to force rules upon anyone, and there is no such thing, in drawing up rules of this kind, as (what has been sometimes complained of) either professional dictation or the interference of busybodies. It cannot be said for one moment that the action of this Society in this business has been anything but one dictated by their sense of duty. The work of the committee is an extremely difficult one. Our committee was formed of the strongest men that we could find, representing science, the consulting element, the contracting element, and the users. We had Prof. Adams, Prof. Ayrton, Mr. Crookes, Prof. Foster, Dr. Hopkinson, Prof. Hughes, and Sir William Thomson. We had representing the consulting interest Sir Charles Bright and his brother, Prof. Forbes, Mr. Gordon, Mr. Massey and others. We had Mr. Crompton, Dr. Fleming, Mr. Siemens and others. You could not have had a stronger committee. I will just give you a few instances of the work we had to do. Take, for instance, the first rule drawn up by the Guardian Assurance Company; I am not quite sure whether it was drawn up originally by the Guardian or by the Westminster. The rule is, "The dynamo machine must be placed in the engine room or in a compartment separated from and not communicating with any room in which inflammable material is manufactured or stored." Now one member will get up and exclaim, "Where is the idiot who would do such a thing?" Another member will want to know where the dynamo should be placed except in the engine room. Another member will say, "Why, this rule is clearly drawn up to avoid plagiarism;" and he will call attention to Mr. Heaphy's rule, which runs, "No dynamo, motor or any apparatus for generating electricity to be placed in any working room of any cotton, woollen, flax, jute, or corn mill, or in any mill or factory of a like description, or in any working room or place where any hazardous process is carried on, or in which any hazardous goods are stored, or where there is special risk, unless permission to the contrary be given." Gentlemen, that rule at any rate, without the last addendum, is written evidently by somebody who knows what he is writing about. Now let me read you our rule—Rule 29. "Dynamos should always be fixed in dry places, and they must not be exposed to dust flyings or any other industrial waste products carried in suspension in the air; they should not be permitted in the working rooms of mills, where the liability to such danger exists, or where any inflammable manufactures are carried on, or inflammable materials are stored." So that after expending, perhaps, one day over a rule like that, we at last get phraseology that satisfies everybody. I have here all the rules,* and perhaps it would be well to print them in our *Proceedings*, but it would take up too much time for me to refer to them in detail.

Let me take first of all a few cases that we want to legislate against. A short time ago there was a paragraph in all the papers that Lord Brassey's house was on fire, and that it was due to a secondary generator. Now, there is no doubt that the alarm of fire was due to a secondary generator; but that secondary generator was fixed in a fireproof box; it was new; it warmed up a little bit, and smoked a little; the smoke was seen to issue out of the fissures of the box. You have heard that when Sir Walter Raleigh was first seen smoking the servant threw a bucket of water over him, and I have no doubt in Lord Brassey's house the servant poured water over this box; but there was no fire at all. And yet that simple little fact has done more mischief than anything that has happened in the mind of those who were contemplating using electricity. At Boston there was a theatre, the Temple Theatre, lit by electricity. From some cause a short circuit was formed between two wires of cotton; the spark was seen; the people in connection with the theatre at once took up the boards and discovered the flame, but before they could do anything the flame rushed through the flooring owing to the extremely inflammable character of the place, and the theatre was burnt down. Not very long ago, nearer home, at Derby, in the stores of the Midland Railway, a short circuit took place through using a tin shade to a lamp; it was one of those wretched old wooden holders, which I hope now are entirely out of date: this burned, the wire caught fire, and it took some trouble to put it out. Then there was a case at the Parliament House at Brussels, fortunately trifling. There was another case of the Star Theatre at New York. There was another case at the Porte St. Martin Theatre in Paris. But while the numbers of accidents due to fires can be counted on our fingers as regards electricity, the list of fires in the year 1887 in theatres and places of amusement which were entirely destroyed and where there was terrible loss of life averaged two or three per month. Now, wherever we have electric lighting there are serious risks that we must protect ourselves against—risks little anticipated by the users. For instance, in stables, who would imagine that the ammonia issuing from the excreta of the animals will attack the wire and the metal staples that are used, and produce accidents? Who would think that the mere washing of the floors would lead to a fire unless attention were strictly called to it? And among those who are not in the habit of using electricity, who would think that rats and mice are perhaps the greatest enemies that we have to contend with? Then again, there is another convenient and useful mode of fixing wires in houses whilst the houses are being built, and that is to bury the wires in the cement, but there is no more foolish and dangerous practice. Again, moisture in any shape or form must in houses, sooner or later, become a danger. In underground work, in cable work, in crossing streams and oceans, water is our safeguard; there is not an instance I know of where gutta-percha has deteriorated in water; but where you come to place india-rubber or gutta-percha indoors, where it is subject to changes of temperature and attacks of moisture, cracks are sure sooner or later to occur in the insulating medium; moisture enters; leakage takes place; the water is decomposed by the current; we have electrolysis; we have the conductor attacked, and sooner or later there is a breakage in the conductor; we have an arc formed, the insulating medium takes light, and fire will result. It is very doubtful, indeed, whether we are adopting a wise practice in encasing our wires in wood. It is dangerous to use a wood casing anywhere where the wood is subject to moisture. I have on the table a most

* See *The Electrician*, April 13, 1888, p. 638.

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interesting example of this taken from a ship. There have been three or four cases where the wood has taken fire on board a ship. The specimen on the table is well worth your serious examination. The wire undoubtedly is very poor wire; nevertheless, moisture fell from it; leakage took place; a short circuit of a kind was formed; the fuses did not act, but the fire occurred. Where you have a steady leakage through moist wood of that kind it is a current of low intensity; the fuse does not act, a fire takes place, and the mischief is done. There is another cause of danger I cannot too strongly urge and put my veto upon as far as I possibly can—not so much on account of its danger as on account of the accidents, sooner or later, sure to be inflicted on the lighting, and that is the use of mercury. In an experience of thirty-five years I have never known a single instance where a mercury contact did not sooner or later create mischief. Unless mercury can be renewed every day or every week, or frequently, it must sooner or later lead to mischief; and I have even seen fires (at least, I remember, at any rate, one fire) due to a mercury

FIG. 1.

contact. There is another very serious cause of accident in houses fitted up with electric light installations, and that is the temptation which the charm and the comfort of the light gives to those using it to extend their system, to take their wires to extra rooms, and eventually to call upon their conductors to carry more current than they were originally designed to carry. But of all sources of accident there is nothing so serious and dangerous as bad joints and bad connections. On this point of joints the practice is very careless. All old stagers will say that no joint can be perfect unless it is soldered. Yet I find in one of the Boston rules these words:—"Joints in wires to be securely made and wrapped with tape; *soldered joints are desirable, but not essential.*" I take that to be fatal to those rules. Again, with soldering, there is a very curious difference of practice with regard to the flux to be used. In one of the American rules, the New England rule, it says, "Resin must not be used as a flux." In Mr. Heaphy's rules, he says, "Resin should be

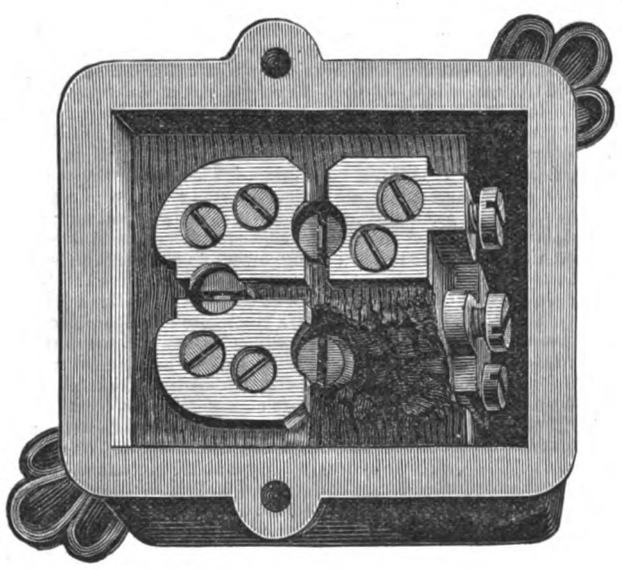

FIG. 2.

This figure shows the base of a damaged switch, which nearly set the Houses of Parliament on fire.

used when soldering." In our rules we say, "When soldering fluids are used in making joints the latter should be carefully washed and dried before insulation is applied." As a matter of fact, in these points we must be guided a good deal by experience, and we have found by experience that the fluids make better joints than resin. In the Post Office service we make it a rule that all joints on aerial copper wires should be made with what is known as Baker's fluid, which I believe is zinc chloride. I have never had it analysed, but it is an admirable flux, and one that certainly makes a better joint than resin or than anything else I know. The next great source of trouble is loose connections. I mentioned in this room once before that in an installation that I had something to do with there were no less than 6,000 places where sooner or later, owing to the vibration of the building, the screws must shake out and the joints become loose. Every one of these 6,000 connections sooner or later is bound to generate heat and to do harm. Cut-outs have formed the subject of a paper so recently that I need scarcely refer to it; but we know very well from experience that cut-outs are a source of danger rather than a source of safety unless they are properly looked after. Switches are a source of danger if they are not properly looked after from these very loose connections. I have here (Fig. 2) an extremely interesting switch; it is one of the Edison pattern. It was put up in the House of Commons, I think in the year 1882, and it was very nearly the cause of another fire in our Parliament Houses. A connection at the back became loose, and heat was generated; fortunately it happened during the time people were about, and it was seen in time. It is a case that merits your careful examination. Another great point is the question of the character of the insulating medium. What we want is something that shall act as an insulating medium, and at the same time be non-inflammable. Now, it unfortunately happens that gutta-percha, india-rubber, paraffin in all its forms, resin, resin oil, bitumen, nearly everything is of an inflammable character. I have recently been trying some wire that is used to a very large extent in America by the Westinghouse Company. That company use a wire known as Waring's. Now, the material that is employed as an insulating medium is one of the distillates of the petroleum oil. This residue is a hydro-carbon, but you will find that it is hardly possible to set it on fire. I have some samples of it here. I have been experimenting with it with currents, with flames, and I have not in one instance succeeded in setting the stuff on fire. It is the least inflammable material that I have come across.

These, gentlemen, are the principal dangers that we have attempted to meet. We cannot say that altogether we have met with very great success. The value of a man's work is very often estimated by the amount of criticism that it engenders, and where it is the fashion, as, unfortunately, it is in this country, to criticise everything that is done by a Government department or by a corporation like ourselves, we do not estimate the value of our work by the number of criticisms, but by their value. During the whole time that this rather heavy and arduous work was going on letter after letter appeared in the press. These silly and senseless and foolish letters were of course always anonymous, and I do think that the anonymous letters in our papers, especially our technical papers, is a very unfortunate practice. All these letters were written on the assumption that the existing rules were put forward as perfect. I say the existing rules were very good; I cannot say too much in the praise of the work that has been done by the Phœnix Fire Office. I think the way in which the Phœnix Fire Office rushed into the breach and accepted transformers before we electricians did speaks very highly for the pluck of that office. There is nobody who has had such fortunate opportunities to acquire experience as Mr. Heaphy has, and he has taken advantage of them; his rules are revised month after month and year after year, and all Mr. Heaphy's experience is embodied in them, but still, they are not perfect. The committee of the Society is virtually broken up; but speaking for myself personally, I should be very glad indeed to see the work that we have tried to do started afresh from the point where we broke off. I think there ought in this country to be only one set of rules, which rules shall embody the general principles enunciated by this Society, and also the detailed rules which have been accepted by all the fire offices. I do sincerely hope that something will be done to have only one set of rules. I look upon the rules brought out by the Westminster Office and the Guardian Office as a disgrace to those offices; they have been drawn up with an amount of ignorance that is most regrettable. For instance, there is one of those rules which would admit into our buildings the very worst description of wire that I have ever seen; and there are several other rules that ought to be expunged. I hope that those offices will reconsider these rules, and abandon them as soon as possible. I should like to call your attention to our own rule which specifies the insulation resistance. I will read it to you:—"(16.) The installation of a system of distribution should be such that the greatest leakage from any conductor to earth does not exceed one five-thousandth part of the total current intended for the supply of such lamps." If you specify that the capacity of your conductors shall be 150 megohms per mile, who is to find that out, and who is to test it? If you say that your leakage from all causes shall be one five-thousandth part of your maximum current, you have something you can examine, something to work to, and something that every man can test. If he has 5,000 lamps one lamp is a capital detector; if one lamp is illuminated by leakage, the rule is not complied with, and you must see where the fault is. But the chief precaution, and the last precaution I shall bring to your notice is this—the proper education of our coming electrical engineers. I want the education of our young engineers to be very carefully watched, so that they do not grow up with false ideas and false notions. The chief element of danger is ignorance, and another danger is the terrible competition that exists in electric lighting. The curse of electricity is the jerry builder, the man who puts in a tender for a contract at a price which he must know will not pay him, and which obliges him to use imperfect materials, in the hope of getting his reward by having to put in "extras." These are the sort of people we want to meet by issuing rules and regulations. We want to put a stop to cupidity and bad work, and to see that everything is properly carried out. In drawing out these regulations I think the Society of Telegraph-Engineers has only done its duty, and I hope and trust that while this meeting will not for one moment withhold any just and fair criticism, it will not be imagined that the Society has been actuated by anything else than a desire to put electric lighting on a proper footing. The Society has not stepped forward to bring out these rules with the idea of securing notoriety. The healthy and charming luxury we all wish to see in everybody's house has so far been retarded by a struggle for existence, especially on the part of those who wish to earn a living by erecting structures. If they will only follow these rules and regulations, then whatever fear there may be at the present moment that electricity is dangerous will disappear entirely, because all source of danger will have ceased. Mr. Heaphy has told me that there never has been one single instance of a fire in any installation that has

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been carried out under his rules, and I believe that to be absolutely true; and I am perfectly certain that if the rules and regulations of this Society be followed in the same way, and the work of inspection is done with the same care, there will be no accidents in this country to lead people to imagine that electric lighting is dangerous.

Mr. HEAPHY, after thanking Mr. Preece for the kind and flattering way to which he had referred to the rules of the Phœnix Office, said that he would next week enter into an account of the differences that had arisen between himself and the Rules and Regulations Committee of this Society. As to Mr. Preece's suggestion that the committee should recommence their work, he would point out that during the long negotiations that had been gone into no difference had arisen upon one single point in the rules themselves, but the whole dispute had arisen about the mention of the word "Phœnix." If that word had been adopted there would have been no trouble, and none of this issuing of rules in all directions, whether by competent or incompetent men. With regard to transformers, they would all remember the fear and timidity that were aroused in this country when transformers were about to be introduced. The matter came before the Phœnix Fire Office, and that office did not adopt any hesitating policy, it did not wait to see what other offices would do, but it decided the matter for itself; it took the risk, and a very great risk it was. It stated publicly that transformers and high-tension currents might be admitted into buildings under certain regulations, and that without any extra charge to the consumer. That policy had been thoroughly successful, and the old ideas as to the danger of transformers were exploded. It was all very well for other people now to come and bring out rules about transformers, after the Phœnix had borne the brunt of the experiment, and had risked a considerable amount of money as well as reputation. However, he felt assured that the Phœnix Office would be only too happy and willing to meet the Council of this Society in every way, and resume the work that had been interrupted, provided that the point upon which they had differed was amicably settled.

Mr. HEDGES said that the rules drawn up by Mr. Heaphy seemed to be very admirable; but he could not understand why the Phœnix Office should put on them the extraordinary word "copyright." There could be no copyright in those rules. A Paper was read at the Society of Arts in May, 1882, by Mr. Thomas Bolas, at which the risks incidental to the electric light were discussed. At the very time he had received from America a set of rules which had been drawn up by Mr. C. J. Woodbury, which were in substance the same as those now put forward by Mr. Heaphy. There could be no copyright in rules which had been imported into this country, and which were the work of another engineer who had done good service on that side. He would like to see one set of rules framed which should be adopted by the Fire Risk Committee governing all the insurance offices.

Mr. NEWMAN, as one who had had a great deal to do with the preparation of the Guardian and Westminster Office Rules, observed that whatever merit or demerit attached to those rules they had been brought out for a specific purpose, and they had to a certain extent answered that purpose. Things had arrived at a very unsatisfactory state. For a long time they had been hoping and waiting for a set of rules from this Society which would guide the insurance offices in framing their own regulations, and at last it was felt that the matter would be best brought to a head by issuing a set of rules for use in their own offices. In some quarters it seemed to have been thought that no office had a right to issue rules of its own, but was obliged to adopt rules which bore the stamp of another office. He trusted that the rules which had lately been issued by this Society would pave the way to a better understanding amongst the offices generally, and that before long a set of rules would be issued and accepted by all the offices; but whatever might be the fate of the rules prepared for the Guardian and the Westminster Offices, the gentlemen who had to do with the drawing them up would feel that they had done something towards putting an end to what was an intolerable state of things.

Mr. SWAN thought that Mr. Preece's enumeration of the dangers incidental to electric lighting was a very useful one. He remembered that when incandescent lamps were first shown in that room Mr. Preece, who was in the chair, sounded the alarm about fire risks, and at that time he (Mr. Swan) considered the note was pitched too high; but he was bound to say that he did not think so now. He quite agreed that one of the principal dangers to be guarded against was ignorance.

Mr. JOHN VERITY said that the matter of these rules was essentially one for the insurance companies; all the Society could do was to frame a set of rules, and endeavour to influence all the offices to adopt them. There was naturally some rivalry between the insurance companies, but it seemed to be undisputed that the Phœnix Office had led the van. After all the trouble they had had about transformers, they at last began to understand them, and it would be very regrettable if some means were not found of arriving at a set of rules which should be adopted by the Phœnix and the other offices. After what had fallen from Mr. Heaphy and from the surveyor to the Guardian Office, he trusted that the committee would meet again and amicably settle all their differences.

Mr. MANVILLE pointed out that on the committee there were only two contractors. As this was eminently a matter between the contractors and the insurance companies, the contractor element ought to be strengthened. He quite agreed with Mr. Preece that all joints should be soldered, although a consulting engineer of the first standing had told him that he disbelieved altogether in soldered joints.

Mr. PREECE: I hope he was not on the committee.

Mr. CROMPTON referred to the work which had been done by the contractors on the committee in preventing uselessly stringent regulations from being embodied in the rules. As to Mr. Heaphy's position, it seemed to him that after all the hard work that gentleman had done, and after his taking the risk of countenancing transformers and high-tension currents, there was some ground for his claim to, at any rate, a sort of moral copyright in these rules. He was perfectly certain that if a poll were taken of the electric lighting contractors, 95 per cent. would be in favour of adopting Mr. Heaphy's rules and no others, and any little advertisement which would be given to the Phœnix Office by the general adoption of their rules would only be what they had well earned. It was a matter of common fairness that the other offices should give way in this matter.

Mr. SIEMENS said that the main defect which existed in Mr. Heaphy's rules was the saving clause which applied to nearly every rule, giving the fire office inspector power to grant permission for the rule to be departed from. So far, of course there had been no complaint to be made as to the working of that proviso, because Mr. Heaphy himself was so perfectly fair to the contractors, and open to meet them in every legitimate way; but who was to say that Mr. Heaphy's successor would be equally fair and conscientious? What was wanted was definite and hard and fast rules.

The discussion was adjourned till the following Thursday.

STUDENTS' MEETING.

At a meeting of the students of this Society, held on May 3, Mr. W. M. Mordey in the chair, Mr. E. J. RYVES read a Paper on "Electric Welding," of which the following is an abstract:—

Some attention has lately been drawn to the subject of welding by means of electricity. In America Prof. E. Thomson uses an exceedingly heavy current at a low potential, and his method of obtaining it is by means of a transformer, by the use of which he can reduce the heavy current-circuit to a foot or eighteen inches in length, thus making a large saving in copper as well as avoiding the great loss in conductors, from which it is so difficult to escape when using large currents. In this system an alternate-current dynamo is connected to the primary coil of the transformer, while the secondary circuit is completed through the two pieces of metal to be united. The primary circuit of a welding set with which I assisted in making some experiments not long ago consisted of 30 yards of No. 16 B.W.G. c.c. wire, wound in a coil 6 inches in diameter, around which and in the same plane was bent a thick copper bar about an inch and a-half in diameter, and which terminated in massive pole-pieces which held the pieces of metal to be joined; these could be made to approach each other by means of a hand screw so as to bring pressure to bear on the heated join. Both the primary and the secondary coils were completely covered by a quantity of iron wire. We managed sometimes to obtain very fair welds, though the majority of the attempts we made were failures, due probably to want of experience. The joins looked very good from the outside, but were easily broken. The specimens which Prof. Forbes has kindly lent show, however, what can be done by this process. Another method of welding by means of electricity is that of M. Benardos, which I have had better opportunity of examining. Last summer I went to St. Petersburg for the purpose of seeing what his welding was like, and I am sorry to say that I was rather disappointed with what he could do. I unfortunately let him know this, which brought my visit to an end sooner than I intended, as he would not show me anything more. On first entering his works I was shown specimens of welds done by his process, which, as far as external appearances went, were perfect; some of these were of fair size, the area of join being in some cases six or eight square inches. As I had not seen these made I could not bring them home as specimens of his process, but I had taken the precaution before I left London of having several pieces of wrought iron, mild steel, &c., cut for me, in order that I might have them welded and afterwards tested; these were all stamped to prevent others being substituted for them. The current necessary for his process was derived from 150 Benardos accumulators, arranged in three parallel groups of 50 each, and which were charged at about 60 amperes for 10 hours a day. The dynamo was a shunt-wound Siemens pattern, and was capable of giving a maximum output of 18,000 watts (150 volts, 120 amperes), and was driven by a 25 horse-power steam engine. The total capacity of this battery was 360 ampere-hours, at a potential of about 100 volts. The welding table consisted of a massive iron slab resting on wooden supports, and which was connected to the negative pole of the battery; the pieces of metal to be welded were laid on this table. A carbon rod varying from 13mm. to 26mm. in diameter (according to the size of weld to be made), and fixed in a suitable holder, was connected by a flexible cable to the other pole of the battery. The required temperature is obtained by starting the arc between the carbon rod and the metals to be joined, which are on the welding table. The current must have been very great, as there was seldom any resistance in circuit, and except when welding small pieces of metal four-fifths of his battery were switched on. The different experiments which were done for me included the welding of wrought iron to wrought iron, cast iron to cast iron, mild steel to mild steel, wrought iron to tool steel, drilling holes in iron and steel, &c. None of these welds were really good, as the specimens on the table show. His method of going to work is briefly this: the ends of the metals to be joined are first of all melted down, then (if steel or wrought iron is being operated upon) pieces of wrought iron are placed on the join and melted in by the action of the arc. If welding cast iron or copper the process is the same, except that cast-iron and copper scraps are added respectively. When welding steel or iron, M. Benardos used a mixture of sand and lime as a flux; when copper was one of the metals the flux used was borax. In nearly every case the metal was badly burnt and spoilt by the excessive heat. This seems to be unavoidable, and is the great fault made in welds made by M. Benardos' process; in Prof. E. Thomson's method, of course, the temperature can be regulated to a nicety, and it thus has a great advantage over the other process.

Mr. MORDEY said the Paper, although a record of failures, was not less interesting or useful on that account. He thought that many of the failures made by persons who had experimented with electric welding were probably due to the fact that they were not sufficiently acquainted with

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ordinary welding, in which, perhaps, they would not have been much more successful. The amount of power used by M. Benardos was out of all proportion to the effect sought, and on this score the process of Prof. Elihu Thomson has a distinct advantage. A probable application of the latter method would be in heating and soldering—not welding—the joints of large conductors for street mains. He knew of no other process by which such an operation could readily be carried out. By this method it was possible to heat up a joint very quickly and to localise the heat.

Mr. G. H. HUME drew attention to the fact that electric welding had been used some three or four years ago by Messrs. Siemens for jointing rails at the Ryde pier.

After some remarks by Messrs. MARSH and HAYNE, Mr. RYVES replied.

Specimens of Thomson's electric welds were lent by Prof. Forbes, to whom the thanks of the meeting are due.

A vote of thanks to the Chairman concluded the meeting.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *May 5th*, 1888.

The New York newspapers are amusing themselves just now by working up a scare on the subject of arc light wires. The basis of their clamour is an accident which happened last week in the Bowery, which, as may perhaps be known to some of your readers, is a very busy thoroughfare, combined in equal proportions of Ratcliffe Highway, Tottenham Court-road, the Upper-street, Islington, and the Borough-road. This great artery of traffic glitters every night with hundreds of arc lamps, and without a question there are more arc lights, many times over, to the mile than can be found in any other street in Christendom. Some of the stores and music halls have lights dangling in front of them from roof to street a dozen at a time, and the eye is positively wearied with the brilliancy of the scene. All the small storekeepers, too, indulge freely in arc lighting as a means of advertisement, and as a number of these stores are low pitched, it happens that the lights in some places come much nearer the level of the passers by than is prudent. In one of these stores a young German was in the playful habit of flipping the arc lamp with his finger every night as he left the place, his object being, as he was accustomed to explain to his less daring friends, to secure the benefits of "a free shock." What happened exactly on this particular occasion is not known, but on reaching up to touch the lamp he was instantly thrown back, and when picked up was dead. This suicidal performance has been followed by a howl for the burial of the arc light wires, though how the undergrounding of the wires will prevent such occurrences is more than I or any other electrician can make out. It would, of course, be better to have the lamps so thoroughly insulated that nobody could trifle with them, even if he insanely wished to do so, and it would also be better to have the lamps at a greater height above the sidewalk, though here, again, the efforts of the lighting company to maintain a proper altitude for the lights are frustrated by the desire of the storekeepers to have the beams penetrate to the innermost recesses of their various places of business. I mention the details of this affair because it is probable that distorted versions from the daily papers may reach you, and be made the text for very absurd moralising. If our friends in England have any means of preventing lunatics from trying to use arc-light currents, directly applied, for therapeutic purposes, we shall be glad to know it.

The introduction of electric motors is proceeding apace, and one hears of their being installed on every hand. The rapidity of their introduction in some Western towns is really remarkable. In Des Moines, Iowa, there are now twenty-five in use, and as many more are expected to be put in this year. At Oskaloosa, Iowa, every printing press in the city is run by electricity. At Topeka, Kansas, the Edison Company has thirty-one motors on its circuits, averaging 120 horse-power, and several new business blocks that are being built are having 10 horse-power motors installed for operating their elevators. At Los Angeles, California, a big power plant is being erected, with a telegraph engine power, it is said, of one thousand horse. At Davenport, Iowa, a plant of 100 horse-power for stationary motors is to be put in, in connection with the new electric railway, and the same is also being done at Lafayette, Ind. One of the most striking Western installations of electric power is that in the new flour mills at Laramie, in remote Wyoming. This mill has been built without any engine or boiler-house, and the sole provision for power consists in two Sprague motors of 25 horse-power each. The capacity of the mill is 100 barrels of flour per day. One motor drives all the purifying and wheat cleaning machinery, and all the elevators and conveyers, which, strung out in a line, are over a mile in length. The other drives seven double sets of rolls and the flour packers. The current is supplied from the local Edison station, on the three-wire system. The manager of the mill maintains that he has a lower percentage of loss of engine power this way than he would have with an engine placed directly in the mill, and having to deliver its power by long lines of shafting and heavy belts. This mill has now been in operation some little time, and the success has been so great that another has been ordered for another Western city. At Laramie, too, a 20 horse-power motor has been placed in the rolling mills. It runs about 120ft. of 3in. shafting, with many heavy pulleys, driving 4 spike machines, 2 boltheaders, 2 nut pressers and a large quantity of thread-tapping and other machines. It is said that before this motor was placed the power had to be transmitted nearly 300ft. by belts and shafting, and that nearly 50 horse-power was required to do the same work; while, on the other hand, the men are doing one-half more work than they did under the old system, owing to the fact that very often through low steam the speed was so slow that the machinery had to be shut down. It will be seen that in the West, where several of the places which have introduced electric light never expect to see a gas plant, the use of the current for power as well as light is gaining at a tremendous pace. Here in the East, however, we are not at all remiss in this respect, as new installations of moters are recorded daily. The Thomson-Houston Company this week, for example, has received an order for an electric power plant of 50 horse-power for New Bedford, Mass., the motors to range from $1\frac{1}{2}$ to 7 horse-power. Here in New York the call for motors is quite brisk.

The American Bell Telephone Company is now enjoying the effects of the recent decision in its favour by the Supreme Court in the shape of one or two minor victories. At Little Rock, Arkansas, Judge Brewer, of the United States Circuit Court, has granted an injunction shutting up an opposition exchange, on the ground that the decision of the Supreme Court was final and conclusive in this matter, and it was needless to consider or discuss the subject from any other point of view. At Baltimore, also, a perpetual injunction has been obtained against the Pan Electric and the Washington Telephone Companies. Meantime, there are various mysterious reports as to the activity to be shown in pushing the Bonta and other "make and break" apparatus; but, so far, the talk seems to be done very much for the purpose of booming stock.

A very interesting evening was spent on April 27th by the New York Electrical Society at the Stevens Institute of Technology, when Prof. A. M. Mayer demonstrated by some exceedingly novel and simple apparatus the laws of static electricity. The apparatus he employed he had contrived himself with accustomed ingenuity, and it consisted of a pendulum suspended from the ceiling, employing gravity as the opposing force instead of torsion as employed in the Coulomb torsion balance. This pendulum swung in front of a scale, and by very simple calculations one was thus able to see and measure the attractive and repulsive force exerted between charged bodies. The same apparatus demonstrated the law of the dispersion of electricity, which was shown to agree with that of heat. Prof. Mayer gave also ocular demonstration of the specific inductive capacity of different bodies. This he did by taking plaques of the various substances, such as glass, paraffin, rubber, &c., placing them between two charged plates, and measuring the difference in distance between the two necessary under such conditions to bring about equal attrac-

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tion. The lecture was delivered with all Prof. Mayer's well-known ease and charming manner, and with the suggestiveness which some of your readers may perhaps remember in his address which has long had a great reputation here on "The Earth as a Great Magnet." The guests of the evening left the Institute with a far more vivid idea of the law of inverse squares, of the value of the dyne, and of other points than they ever had before, and many of them were impressed with the fact that there was still a great deal to be done and observed in the neglected field of static electricity.

Turning to matters of gayer import, I may note the formation here of the Magnetic Club, which affords evidence of the strong fraternal feeling existing among the telegraphers in this city. This club sprang out of a little dinner held recently by a number of the prominent members in the various co-operative associations of telegraphers, and has now started on its career with bright prospects. The club presents one or two novelties in its plan. It is proposed to have four social gatherings a year. The dues are only nominal, but the expenses at each of the four meetings are to be shared *pro rata* among those who actually attend. In this way no member is burdened unless he participates actively, and then his enjoyment costs him no more than it costs anybody else. There seems to be a good point in this, and I have no doubt that the quarterly gatherings will be extremely pleasant and well attended. The first president of the club is Mr. C. P. Bruch, who has done so much to make the success of the Telegraphers' Mutual Benefit Association, of which he is secretary—a body which has now paid out in death claims to the *beneficiaries* of its members the sum of nearly £75,000. The first vice-president is Mr. W. J. Dealy, whom, no doubt, many English visitors to this country remember as the suave and energetic manager of the big operating room of the Western Union Company, 195, Broadway, where, according to Dr. Norvin Green, the staff is in such excellent condition under private management that it does nearly twice as much work as it would do under a Governmental *régime*.

CORRESPONDENCE.

THE MALTA-ALEXANDRIA CABLE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the letter I addressed to you last week, I find that through inadvertence I omitted the word "electrical" when referring to the Malta and Alexandria cable of 1868, thus making it appear that I had sole charge of that expedition on behalf of the manufacturing company, instead of the electrical charge only. The cable was successfully laid under the personal superintendence of Sir Samuel Canning, I being responsible for the testing and working. It may not be generally known that this cable passes through a depth of over 2,700 fathoms, giving another illustration of the practicability and superiority of deep-sea telegraph cables over those laid in comparatively shallow water—a subject which was being much discussed in those days. I believe the cable is still in the same condition electrically as when first laid.

Perhaps you will permit me to say in reply to the letter of Mr. Graves, in the same issue, that his version of the meaning of the word "touch" may be the correct one; but, unfortunately, all the readers of the "Papers of Fleeming Jenkin" are not so well up in our technical terms as he is.—Yours, &c.,

May 12th, 1888. WILLOUGHBY SMITH.

ELECTRIC OSCILLATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Dr. Fleming's valuable communication on this subject owes a good deal of its interest to the manner in which it completely accounts for a number of well-known phenomena, such as those of demagnetisation and the unpleasant discharge from a Leyden jar when a glass handle is not used for the discharger. Prof. Hughes drew attention some time ago to the "period variable" during which the resistance of a conductor is much higher than its ordinary ohmic value. Some further information on the actual period of the oscillations would be interesting, for it appears that they are by no means so small as to be negligible. A dynamo with a commutator of 120 sections, running at 1,100 per minute would have a period of $\frac{1}{2200}$ second for each section. This would correspond to one and a-half periods of $\frac{3}{10000}$ second, or the instant corresponding with the first minimum. The fact that the brushes cover more than one section would prevent this from having any material effect, but it is worth noticing that the periods are not so small as to be entirely neglected. I have noticed on several occasions that a shunt dynamo will not excite if one brush be removed and contact with the commutator be made with the end of a wire; no doubt in this case other considerations are introduced.

A good deal has been written of late on lightning conductors, and not only does their original purpose seem to be overlooked, but they very frequently fail in their proper function, which is to tempt a silent discharge and not a "stroke." Indeed, they are said to act when they are struck, which itself is a proof that they are not doing their duty.

Franklin's suggestion in 1749 was "Would not these pointed rods probably draw the electrical fire silently out of a cloud before it came nigh enough to strike, and thereby secure us from the most sudden and terrible mischief?" I am informed there is a town in South Africa where every house is compelled by law to be provided with a lightning conductor, and that when a thunderstorm passes over it the numerous points fulfil their proper duty, and the whole of the discharge passes silently to earth; and that when the storm has passed beyond the protected region the lightning begins again.

Have any measurements of the current of a silent discharge been made? and is it known whether the discharge is continuous? Information is needed on these points before a thoroughly reliable lightning conductor can be designed.—Yours, &c, A. P. TROTTER.

LIGHTNING DISCHARGES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The explanation which Dr. Fleming has given of phenomena connected with lightning discharges cannot, I think, be considered very satisfactory. In order to explain the remarkable experiments brought before the Society of Arts Dr. Fleming throws out two suggestions, each of which is originally due to Dr. Lodge. The first is that the time of discharge is so short that the iron conductor has no time to be magnetised, and therefore possesses very little more self-induction than a copper rod of the same size. The second is that the greater specific resistance of the iron rod makes its time-constant less than that of the copper rod, and the discharge takes place more rapidly through the former in consequence. But the time-constant of discharge does not depend only on the self-induction and resistance of the rod. If the only advantage an iron rod possesses over a copper one is due to its greater resistance, it should be possible to improve it still further by giving the lightning conductor a bad earth. A flash of lightning is the sign of the discharge of a condenser formed by a cloud and the surface of the earth, the discharge circuit consisting partly of the lightning conductor, but chiefly of the air gap between the lightning conductor and the cloud.

Although Dr. Fleming has said a great deal about the resistance of the lightning conductor, he has entirely ignored the resistance of the air gap, and has said nothing about the capacity of the condenser. The two latter quantities have probably far more influence in determining the time of discharge than the other has. A lightning conductor has to discharge a given quantity of electricity quickly; it has nothing to do with the rapid establishment of a steady current. The potential to which the condenser is charged is so extremely high, that if it were maintained after the breaking down of the dielectric the current produced in the conductor would be enormous. A very small current for a very short time is, however, quite enough to discharge the condenser. It is therefore

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only necessary to consider the initial rate at which the current rises, and this, although inversely proportional to the self-induction, is directly proportional to the E.M.F. producing the discharge. It does not depend in the least on the time-constant, and is quite independent of the resistance of the circuit. When the E.M.F. is practically infinite, as in the case of lightning discharges, the current rises to a small value instantly, whatever the self-induction may be. The influence of self-induction is, however, very important when the discharging current begins to fall. If there is no self-induction the current falls very rapidly, while if there is any the current is more or less maintained, according to the value of the time-constant. The condenser may in consequence discharge more rapidly when self-induction is present, because the average current discharging is larger. If the self-induction is very large the current may be maintained so long that it will discharge the condenser before it can fall to zero, and oscillatory discharges will result. This is perfectly illustrated by the analogy which Dr. Fleming has given. The inertia of the gas does not prevent the sudden rush from the first reservoir at high-pressure to the second one at low-pressure, but it does maintain the flow which results, and may produce oscillatory currents if the reservoirs are sufficiently small.

The time a condenser takes to discharge is actually diminished by inserting a moderate amount of self-induction into the circuit. This fact was first pointed out in a Paper I read before the Physical Society recently. It throws considerable doubt upon the general opinion that self-induction in a lightning conductor is a disadvantage. If the coefficient of self-induction L is less than $\frac{1}{2}$ K R^2, where K is the capacity of the condenser and R the resistance of the discharge circuit, the time of discharge will be less than if L were absolutely zero. If L is only $\frac{1}{4}$ K R^2, the time of discharge is halved. Now, if the resistance of the atmospheric circuit only consisted of the resistance of the lightning conductor itself, the product K R^2 would possibly be smaller than the coefficients of self-induction of ordinary lightning conductors. If, however, the resistance of the air gap is taken into account, this product may far exceed them, and, in the absence of experimental evidence, there seems to be no reason for believing that the insertion of a huge electromagnet into the circuit of a lightning discharge would be any disadvantage at all. Is it quite certain that lightning discharges are oscillatory in character? If they are so, it is not because the current is prevented from rising by the self-induction, but because it is prevented from falling. If they are not oscillatory, there seems every reason for believing that the self-induction could be more than doubled without causing the time of discharge to be greater than if there were no self-induction at all.

It may, I think, be questioned whether the important experiments of Dr. Lodge are really miniature representations of lightning discharges. The two outer coatings of his Leyden jars were connected, firstly, to the ends of the wire experimented upon, and, secondly, to the two knobs of a spark gauge. The ease with which the wire transmitted the discharge was estimated in terms of the corresponding distance between the knobs of the spark gauge. It seems reasonable to suppose that there should have been another air gap in the circuit to correspond with the air gap between the lightning conductor and the cloud. If the outside of one of the jars, instead of being directly connected with one terminal of the gauge and one end of the wire, were only connected to them by a large air gap, the arrangement would form a better representation of a lightning discharge.

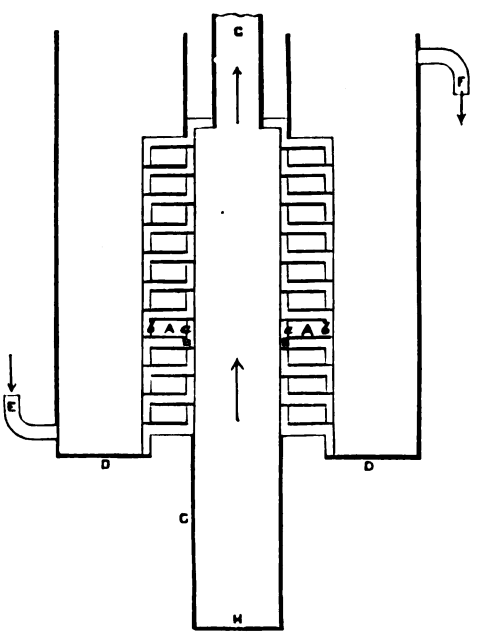
The problem is one which requires to be solved experimentally. If its solution is attempted mathematically, the portions of the solution which are not pure assumption are likely to be very vague. Dr. Fleming has objected on more than one occasion to the use of such "loose" expressions as instantaneous resistance; Mr. Oliver Heaviside has implied that such expressions are "utterly misleading." The word impedance, which has been used instead, has, however, no better claim to represent a physical quantity, and unless very carefully used is far more likely to be "utterly misleading." Resistance functions are very fine things when the coefficients of the different terms are constants, and where the quantities operated upon are simple sine functions. In such cases the word impedance can be exactly defined, and is very convenient to use. When, however, the coefficients of induction are functions of the current, and where the electromotive forces are no longer capable of being expressed in simple mathematical form, resistance operators are of little or no use, and the word "impedance" is one of very uncertain meaning. Dr. Fleming feels some of this difficulty when he considers the effect of magnetic lag, and invents the expression instantaneous impedance. If this means nothing more than the ratio of the electromotive force impressed on a conductor to the current flowing through it at the same moment, it is difficult to see what advantage (except a change of name) this phrase has over the corresponding phrase "instantaneous resistance," to which Dr. Fleming so much objects. If this is to be the definition of impedance, it will be necessary to abandon the one usually adopted; and if it is not to be the definition, it is hard to see whether the expression "instantaneous impedance" has any meaning at all.—Yours, &c. W. E. SUMPNER.

Central Institute, May 16th.

THERMOPILES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A description has recently appeared of a thermo battery constructed by E Raub, which is claimed to be something new. I may mention that I have made such a pile in



1885 at the machine shop of Mr. Ciriack in Bucharest, Roumania, which fact Mr. Ciriack can certify, as he aided me in the casting of the elements. The sketch herewith is taken from the original drawing which I handed to Mr. Ciriack at that time. I made a good many experiments then with thermopiles, and wanted to make a standard of E M.F., and in which I succeeded. After various shapes of elements I came upon the ring form, as the drawing shows. A represents one alloy or metal of an element, which was simply cast in the shape of a disc, while the other metal, B, takes the shape of a ⌐. At the points *a* and *b* each metal was well tinned with solder, and then both metals were well heated and joined together.

The insulation consisted of mica discs placed between them before they were joined together. I also made some that had threads cut, and screwed the elements upon each other.

At the bottom element was secured a tube, C, which was closed at its end, while another tube, G (open), was placed at the top of the pile. In this tube oil was poured, and then heated at the bottom H. Around the whole pile was a vessel, D, which had two opening taps at E and F. At the tap E

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cold oil entered, and thus filled up the vessel, while at F it went out. Thus the cooling fluid could circulate. It will be seen that this form has one great advantage over others, inasmuch as the resistance is very low and the heating uniform.

It will also be seen that a good standard of E.M.F. could be obtained if the elements were made of pure metals, as the difference of temperature can be easily maintained. For practical purposes this form is very well adapted, as it is very compact, and large columns can be built which may receive their heated liquid from a boiler.—Yours, &c.,

Am Kiosk F, Brünn, May 11th, 1888. F. JEHL.

COMPANIES' MEETINGS.

West India and Panama Telegraph Company (Limited).

The twenty-second ordinary general meeting of the members of the above Company was held at Winchester House, 50, Old Broad-street, on Wednesday last under the presidency of Mr. C. W. Earle.

The SECRETARY (Mr. R. T. Brown) read the notice convening the meeting and the minutes of the last general meeting, which were approved by the present meeting and signed by the Chairman as correct. The report of the Directors was taken as read.

The CHAIRMAN: Gentlemen, the report and accounts refer to a half year which, considering that it is the poorer half of the two, has been the most successful we have had except one in 1883. Those who are old shareholders, no doubt, know that the sugar crop matures in the first six months of the year. That creates, in comparison with the second half, a certain amount of telegraphing business in connection with the crop, its out turn, shipment, &c.; therefore, the second half is not so successful in the way of revenue as the first half. They are both poor enough; and when I tell you that the gross revenue we receive per mile is not equal to one-half of the average gross revenue of other trans-ocean telegraph companies, it will be clear to you why I say that both half years are very poor. In the year 1883, with which I have been comparing our present condition, we had, as we have had in the last half year, certain windfalls. First we had an increase in the traffic over that of the corresponding period of 1882. In the next place we had done, as we have done in this half year—succeeded in chartering our ship. In the last half year we had the opportunity of chartering her to the International Ocean Telegraph Company for the repairs of their cable. On that operation there is a profit, and it also relieved us of the maintenance of the ship during the time she was engaged by the other company. This last half year the ship was away 29 days, which means a considerable relief in expenditure on the vessel. Besides these two circumstances there has been a profit on exchange. Generally, almost invariably, we lose in bringing our money home from the West Indies, but this half year we had a profit. Then there was a profit on the cable which we sold to the International Company for effecting the repairs for which our ship was chartered. We also had a saving of £250 on the debentures being issued at 5 per cent. instead of 6 per cent. Those conditions combine to enable us to pay 4s. a share on account of the arrears of dividend on the First Preference shares, besides the dividend on those shares; and in this respect we are in a very different position from what we were in 1883. In that year, in regard to the depreciation fund—a fund that is set aside to meet the depreciation that goes on every year in your plant—we were rather in the position in which the country now finds itself in the way of national defences, much behind, and instead of on that occasion giving an increased dividend on the First Preference shares, we felt it our duty to add the whole £15,000 that was over to the reserve fund. On the present occasion our reserve fund is in a much better position. After charging against it £7,000 odd, the value of the cable used in the further repair of the original Jamaica-Porto Rico section, and adding to it the contribution of £3,000 from the half year's revenue, our reserve fund for the depreciation of our cables is about level with the calculated depreciation for the year ended December 31 last. While I am speaking of the reserve fund it is satisfactory to point out that it is pretty nearly all invested in easily realisable securities, and that the market value of those securities is about £8 000 in excess of what they cost us. I am glad to be able to report the repair of the Jamaica-Porto Rico cable, which, however, has cost a great deal of money—£31,000 odd on cable alone, taking no account of the ships that have been employed for weeks and weeks in doing the work. It is a most important cable for us, because the greater part of our revenue-producing field, except Jamaica, lies east of Porto Rico; therefore, until we had repaired the cable between Jamaica and Porto Rico, we were dependent for the great bulk of our traffic on a single cable. Whatever, therefore, it cost us to repair was money well spent. I thought when our report was drawn out that we were going to have a meeting, for the first time in the history of the Company, with all our cables in order; but I am sorry to say that since the publication of the report there has been a break notified in the St. Vincent-Barbadoes cable. That is an important cable, because it connects two of our principal Colonies, and it has been several times interrupted lately. This question of the interruption of these two parts of our system that are not duplicated—that is the line between St. Vincent and Barbadoes, and the line between Trinidad and Demerara—brings me to another point. In both those Colonies they are moving for a duplication. I say, in reply, with a system that is not paying any revenue on three-fourths of its capital how can you, as commercial men, ask us, in view of the unfortunate terms that were originally assented to, to throw more money into the sea in order to make your communications more perfect? If we can obtain some modification in those conditions, I say that the Company will be ready to meet the Colonies fully half way, but until they do see their way to grant us some little concession I should myself feel very much indisposed to sink any more capital in so unremunerative an undertaking. I hope that that policy will have the support of the meeting. With reference to the accounts themselves, I do not think there is anything to necessitate my taking up your time; but I shall be very happy to answer any question. Before moving the resolution, I wish to refer briefly to the loss which I think we shall all feel in this room in the absence of a former very conspicuous member of our Company—a man who took a very important part on several occasions in our debates. I refer to the late Mr. William Abbott, who brought forward at our last meeting a very intelligent and clever measure for the re-arrangement of our capital. It was not my fate to meet Mr. Abbott anywhere except in connection with meetings of our Company, and I always found him a very able and fair man, and a fluent speaker. He did not always agree with me, but generally he took a very comprehensive view of our affairs. You know what has happened to his proposal. It was fully considered by us, and it was submitted to most able counsel—to Sir Horace Davey and Mr. Palmer—and it was found impossible to carry out. We asked Mr. Abbott to come and see us after we had obtained their opinion and he at once bowed to the superior views of legal authorities. The e the matter dropped. I can only say that I am very sorry we shall never see Mr. Abbott again among us. It is now my duty to propose:—

"*Resolved, that the Directors' report and accounts to 31st December, 1887, submitted to this meeting, be and the same are hereby received and adopted, and that, as recommended by the Board, a payment of 10s. per share on account of arrears of dividend on the First Preference shares be and the same is hereby declared.*"

Mr. WM. FORD: I have great pleasure in seconding that.

Mr. A. MORTEN said that the accounts of the half year scarcely gave a correct account of the value of the year's working, and with their permission he would lay that view of the case before them. The interest on the investments did not figure in the revenue account, where he maintained it ought to appear, amounting to £4,248, showing with the earnings from messages, subsidies, &c., £96,297. The entire expenses including interest on the debenture capital for the whole year amounted to £50,427, leaving a net revenue of £45,800 for the year. That would be sufficient to pay the First and Second Preference dividends in full, and there would be 5s. a share on the Ordinary shares. He challenged any one to controvert a single one of these figures, for they were perfectly correct. With respect to the scheme put forward by the late Mr. Abbott, he would not say there was any negligence, but something was overlooked by the Directors, probably in putting the case before Sir Horace Davey. He (the speaker) maintained that the Preference dividends had been earned for many years past, but that by the magnanimity of the shareholders the money had been put to reserve fund, and he held that it would be distinctly unfair to say that the interest had not been earned on those shares. The paucity of the attendance showed what little interest was taken in the affairs of the Company, and why was that? Because for eight or ten years the Second Preference and Ordinary shares had not received a penny. They had had the very life ground out of them by the treatment of the Directors. They were earning, as he had said, 5s. a share on the Ordinary shares, which were selling in the market at 2s. in the £; they had accumulated a reserve fund of £130,000, and the value of the securities was quite £10,000 in excess of that amount.

The CHAIRMAN: £8,000. We worked it out yesterday, and that is the result, taking the selling price of the securities.

Mr. MORTEN said that he also had made a calculation, and he repeated that the value of the investments was £10,000 in excess of the sum shown in the accounts. The whole of the arrears only amounted to £53,000, and he believed that any Board who took the question up with the view of settling it could do so in three months, and there would be no difficulty in getting a short Act of Parliament, which had been done in scores of other cases. If the arrears were paid off, the £10 shares would, he believed, be selling at £5 each instead of at the miserable 2s. in the £. He held 1,000 Ordinary shares and 180 Second Preference shares. Fortunately, he could afford to wait, but there were hundreds of poor shareholders throughout the country who could not afford to do so, and who when they required money were obliged to sell their shares and to make a severe sacrifice. He maintained that they were now in a state of prosperity, and that if the Board would only meet the shareholders' views the Company would rank as one of the commercial successes of London instead of one of the greatest failures ever seen. If the Company was so poor as seemed to be regarded, why did they pay 2,000 guineas a year for Directors' fees? If the Company were a bankrupt concern they ought not to pay such a sum. He was probably one of the largest shareholders in the Company, and he would never cease to speak at their meeting, as long as the present treatment of the Directors was continued. He concluded by moving the following resolution:—

"*That until the arrears of dividends on the First and Second Preferences have been paid off, no further sums be added to the reserve fund, and that the Directors be requested to confer with three of the largest shareholders as to the best course of paying off such arrears.*"

Mr. WM. FORD said that the motion was out of order.

The CHAIRMAN endorsed that statement, and said that no notice had been given of it.

Mr. MORTEN said that he knew enough of company law to know that he could move his proposal as an amendment, and he did so.

Mr. FIRTH, who said that he had paid £9 for his shares, thought there

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was some strength in the suggestion that had been made that the reserve fund had now arrived at a sum where for a time it ought to be left. If the other half year should be like the past half year, there would be a net amount available for dividend of £40,000. The First and Second Preference dividends took £23,500, and there remained £17,000 a year practically if the present revenue continued for the purpose of paying off the remaining arrears on those shares, and then paying a dividend on the Ordinary shares. If that was a correct statement of the case the Company was certainly in a sound financial position. They only owed £53,000 for arrears, and if £17,000 a year was available for that purpose the arrears would be cleared off at the end of about three years. He asked the Chairman to state whether that was not so, and whether at the end of that three years there would not be £17,000 a year left, which was equivalent to 2 per cent. on the Ordinary shares. If that were so he thought they might look forward to the position of the Company with some satisfaction in the future. He felt that the Directors were doing the best they could for the shareholders.

Mr. ODELL said that he had been a shareholder in the Company for 16 years, and held 1,000 shares, for a large number of which he had paid £7 each. During those 16 years he had received about £20 in dividends. He asked whether it would not be possible to pay off the arrears out of their investments.

The CHAIRMAN: What is to become of the reserve fund in that case?

Mr. ODELL: We should then have a good reserve fund.

The CHAIRMAN asked whether it was right for a company using depreciating plant not to set aside out of its profits such a sum as was calculated to represent the depreciation that was going on in that plant. That was the real crux of the question. They had many cables, which had been down for seventeen years, and they went on depreciating. They could not specify exactly what the depreciation was, but they had taken a very liberal term for the life of their cables. That was one factor in their calculations. Another factor was the rate of interest they were likely to get on first-class securities; and the third factor was the cost of the cable to renew their system. With those three factors they made a calculation, and that calculation had given them almost within a shilling of what they had that day. But at the next half-year they would have again to add to the reserve fund, because another half-year's depreciation would have occurred in their plant. Was there any shipping company or any company using a wasting and depreciating plant which did not provide for depreciation every year? The fund was called a reserve fund, others called it a renewal fund, which was a better expression; but, as a matter of fact, it consisted of what ought to be written off before they ever began to talk of profits. He could not see his way to hold out any hope of the cessation of the depreciation fund. He did not think they wrote off too large an amount, and as he had said they took a very liberal view of the life of their cables. He might add that they had estimated to receive 3½ per cent. on their investments, but he doubted if they would be able to get 3½ per cent. on first-rate securities any more. That was a point which would seem to suggest a little increase to the reserve fund in order to meet depreciation.

Mr. MORTEN asked whether it was not the case that they had doubled nearly all their cables in the last few years out of revenue?

The CHAIRMAN said that that was not the case, and that the cables which had been duplicated were also depreciating.

Mr. JOHN GRIFFITHS (the auditor) stated that the Directors and the auditor were in a position of responsibility to the shareholders, and they were bound to make the reserves which they did. He regarded it as a personal responsibility. He looked with great care into the matter every half year, and he knew that the Directors most carefully watched it. The duplication of the cables to which Mr. Morten had referred as having been made out of revenue had been made out of capital. He was sure the reserve that was made for depreciation was only a fair and proper one.

Mr. MORTEN wanted to know out of what capital the cables had been duplicated if that work had been done out of capital.

The CHAIRMAN said that Preference capital had been raised for the purpose and Ordinary capital as well.

Mr. GUESDON: And debentures also.

Mr. GRIFFITHS stated that something like £500,000 in all had been raised for the duplication of the cables.

Mr. GUESDON regretted the attack that was made every year on the reserve fund, which he held it was indispensable for every company to have. He did not believe that they could have floated their debentures at 5 per cent. if they had not had a solid reserve fund, nor did he believe that they could have made a contract for their cable on the satisfactory conditions which he believed they had secured. He had heard nothing in respect of the Ordinary shares he had held for the last 15 years; but the position of an Ordinary shareholder was very well known. If the profits were very large he took them, but if they were not sufficiently large, and the business could not be carried on without pledging the property, the property was pledged in order to save the shareholders from being absolutely sacrificed. It was nonsense for the shareholders to complain of the reserve fund unless they could see that there was some unworthy motive on the part of the Directors in accumulating a fund out of proportion to the ascertained necessities of the Company. The life of the cables depended on their make, and also on the character of the ground on which they lay, and he believed that some of them lay in an unfavourable position.

The CHAIRMAN: Very unfavourable.

Mr. GUESDON, continuing, said that the Directors must provide for depreciation, or they would fail in the engagements which they had undertaken. He was unable to be present at the last meeting, but he regretted the moral obliquity which suggested that the arrears of dividend should be capitalised in order to promote the interests of the junior securities. He desired to know at what rate the ships were insured.

The SECRETARY: Six to seven guineas per cent.

Mr. GUESDON considered that that was a very high rate, and he suggested that the Board should calculate the whole sum which had been paid, not only by this Company but by other companies, for insurance, and see what the amount would come to as compound interest at 5 per cent.

The CHAIRMAN said that they had lately reduced the amount which they insured upon.

Mr. GRIFFITHS said that they had always taken into consideration the question of insurance and the amount set aside for the depreciation of ships.

Mr. GUESDON maintained that the reserve fund was a distinct fund, and that it had no right to be interfered with at all, and that everything which belonged to that fund ought to go to its credit. When, however, they had to renew a cable, it was quite legitimate to take money out of the fund.

The CHAIRMAN: That is what we do do.

Mr. GUESDON afterwards asked the Chairman to state what advantages the Company had derived from the late contract. He was pleased that they had departed from the principle of dealing with only one company, and in seeking for tenders, and he desired to know what benefit they had derived from that course.

The CHAIRMAN said that they had called for tenders, and they took the lowest one, but he did not think it would be fair to state the exact figures. They had taken the lowest tender, and as long as they were satisfied in regard to the question of quality that was what they would do.

Mr. GRIFFITH said that as a holder of Ordinary and Preference shares he sympathised with the arguments which had been adduced on both sides. He thought it was necessary for the interests of all classes of the proprietors that there should be a sufficient sum to enable them to have ready money in the event of any defect occurring in the cable. They must remember that the cables depreciated every year, and if the depreciation resulted in breakage there must be a reserve fund to come upon. He was not in favour of reducing the Directors' fees, but if he held as many Ordinary shares as some of the other speakers he would press the Directors to see that the greatest economy was observed in the working of the Company. With regard to the suggestion of Mr. Morten as to obtaining an Act of Parliament, he thought it should commend itself to consideration. He did not agree with Mr. Guesdon that the shareholders had no right to capitalise the amount of the arrears either on the First or Second Preference shares. If the Preference shareholders were willing to capitalise their arrears no injustice would be done to them, and a great benefit might be conferred upon the other classes of proprietors. At the last meeting he believed that the Directors were in favour of capitalising the arrears, according to the scheme brought forward by the late Mr. William Abbott. The only objection to it was that it could not be carried out by ordinary legal process, but there was nothing to prevent the Company from applying for an Act of Parliament.

Mr. GUESDON said that it ought not to go forth, as Mr. Griffith had argued, that there was a unanimous feeling at the last meeting in favour of capitalising arrears.

Mr. CUFF said he had always approved of the policy of building up a reserve fund.

Mr. HIBBERT said he had never attended a meeting where there had not been some discussion respecting the accumulation of arrears, and he thought it was a pity that the Directors did not try to adopt some middle course.

Mr. VEARS hoped that a limit would be put on the amount of the reserve fund. The Ordinary shareholders at present had to look upon themselves as benefactors to black people, sugar planters, and others; but they themselves were shut out from all the benefits of the working of the Company.

A SHAREHOLDER inquired what was the amount to which the reserve fund was to be increased. He thought that some Directors had reserve fund on the brain.

The CHAIRMAN: Broadly speaking, the reserve fund ought in the fulness of time to be such a figure as would enable us to practically relay your system.

A SHAREHOLDER: All the cables are not going to die at once.

The CHAIRMAN: But they will in time.

A SHAREHOLDER said that he believed the cables had exceeded the life which the Directors had anticipated for them.

The CHAIRMAN: We have given them a very liberal life in our calculations.

Mr. WILDING said that the reserve fund had been somewhat decreased during the half-year. He thoroughly objected to any "watering" of the capital.

The CHAIRMAN in reply said that Mr. Griffith was in error in believing that the proprietors were unanimously in favour of capitalising the arrears of dividend. With regard to the First Preference shareholders, the assents were 37·17, the dissents 12·91, and 49·92 did not reply at all. Of the Second Preference shareholders, 26·39 assented, 17·35 dissented, and no replies were received from 56·76. Of the Ordinary shareholders 58·82 assented, nearly 1 per cent. dissented, and 40·26 per cent. did not reply at all. When it was suggested that they should promote a Bill in Parliament, he must remind them that they must have the practical consent of the constituents, otherwise it was no use incurring expense. They had once before capitalised arrears, and the course taken on that occasion had given them a great deal of trouble. They did not pay income-tax on the reserve fund. The reserves on the ships were calculated on the balance of the cost after taking off previous reserves. The Chairman then proceeded to put the resolution.

Mr. MORTEN demanded that his amendment should be put first.

The CHAIRMAN: I have ruled that out of order. He then put the resolution in the usual way, and declared it carried by a majority.

A SHAREHOLDER asked whether the proposed cable from Halifax to Bermuda would affect the Company.

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The CHAIRMAN replied in the negative.

Mr. GRIFFITH asked whether the shareholders might not expect as good a dividend for the current half year as they had had in the past half year.

Mr. FORD said that the traffic returns were published regularly.

The SECRETARY said that there had been a slight increase in the receipts compared with those for the corresponding period of last year.

On the motion of Mr. FORD, seconded by Sir JAMES ANDERSON, Mr. Earle was re-elected a Director of the Company, as was also Mr. Ford, on the motion of the CHAIRMAN, seconded by Mr. WM. ANDREWS.

Mr. CUFF proposed, and Mr. WILDING seconded, the reappointment of Mr. J. G. Griffiths as auditor of the Company, which was carried unanimously.

Mr. VEARS inquired whether the meeting could not authorise the Directors to convey to Mr. Abbott's widow some words of condolence.

The CHAIRMAN said that he had alluded with regret to the decease of Mr. Abbott in his opening remarks, and he thought that, without putting it into the form of a resolution, if a copy of what he had said were sent to Mrs. Abbott, it would have the same effect as the resolution.

Mr. HIBBERT then proposed, and Mr. WILDING seconded, a vote of thanks to the Chairman and Directors, which was unanimously agreed to.

The CHAIRMAN having briefly replied, the proceedings terminated.

Western and Brazilian Telegraph Company (Limited).

An extraordinary general meeting of this Company was held in the Great Hall of Winchester House, at noon on Tuesday, the 15th May, for the purpose of considering, and if thought fit, confirming the resolutions passed at the extraordinary general meeting of the Company held on the 26th April last, intended to modify the Articles of Association of the company, and to carry into effect the proposed arrangement with the London Platino-Brazilian Telegraph Company (Limited), referred to in the Directors' report submitted to that meeting. Mr. W. Andrews was in the chair.

The notice convening the meeting having been read by the Secretary.

Mr. W. PAYTON, the Chairman called upon him to read the minutes of the last extraordinary general meeting, which the Chairman signed.

The CHAIRMAN then said: Now the first resolution which I have to put to the meeting is the one altering the Articles of Association. It is, I am sure, quite unnecessary for me to trouble you with any remarks before doing so, as the matter was fully gone into at the last meeting. I beg therefore to propose that

"*The 6th and 7th Articles of Association, and so much of the 26th Article of Association as includes and follows the words 'but notwithstanding any rule of law or equity to the contrary, shall be cancelled.*"

This was seconded by Mr. WEAVER, and carried unanimously.

The CHAIRMAN: Resolution No. 2, which I now beg to move, is:—

"*That Article 50 shall be modified by expunging the words 'an ordinary meeting shall be held yearly,' and substituting the words: 'The ordinary general meetings of the Company shall be held half-yearly.'*"

Mr. WEAVER seconded this, which was put to the meeting and also carried unanimously.

The CHAIRMAN: That disposes of the alterations which it is proposed to make with regard to the Articles of Association. Before moving the next resolution respecting the agreement with the Platino Telegraph Company I am sorry to say that it is necessary to trouble you with the reading of it throughout. I know it has all been read before, but it seems that technically it is necessary that this meeting should hear it read before dealing with the resolution relating to it.

The agreement having been read, the Chairman said: Well, gentlemen, those who were present at the previous meeting have heard all that before, and as the whole matter was then fully discussed I am quite sure you do not wish me to trouble you with any further remarks on the subject. I therefore beg to propose the confirmation of resolution No. 3, viz.:—

"*That the agreement dated 18th April, 1888, between the Western and Brazilian Telegraph Company (Limited), of the one part, and the London Platino-Brazilian Telegraph Company (Limited), of the other part, be and the same is hereby approved and confirmed, and the Board are authorised to carry the same into effect.*"

Seconded by Mr. WEAVER.

Mr. PETO then addressed the meeting. He said: Mr. Chairman and gentlemen—I was not able to remain and see the result of the last extraordinary general meeting. I am not going to discuss terms in any shape or way, but I see by the report of that meeting that you were good enough to state to the shareholders that in consideration of the agreement being authorised, your Board were willing to give your services for five years gratuitously. Well, now, it does seem to me, and I have a substantial stake in the Company, besides representing a large number of shareholders, as Mr. Cunningham will tell you, that if, as we are given to understand, this agreement is so beneficial to this Company, it is most unreasonable for us to expect that these gentlemen are going to work for nothing; every labourer is worthy of his hire. Our Company is now in a very prosperous way, and we ought not to ask our Board to work for nothing. I recollect the day when the Western and Brazilian Telegraph Company was in very low water indeed. Your exertions have brought about the present state of prosperity, and I hope you will receive fair remuneration for your services. I do not know if it is necessary for me to move any resolution on the subject, but if it is I shall be very pleased to do so, and I am quite sure my friends here will support me.

The CHAIRMAN: It is very good of you to express your views with regard to the Board so kindly, but we have fully considered the question that was put before us as to our fees, and we were of opinion that it would be hardly consistent for us to suggest that you should compensate the Board of the other company for a period which embraces the future, if at the same time this Board, in working the undertaking for the future, should charge you. They thought you would be making under these circumstances a kind of double payment. That was the view we took—a view taken deliberately and after full consideration; and, so far as we are concerned, we have no desire to see any modification in reference to this matter. Of course the Board are entirely in the hand of the shareholders, but that was the *bonâ fide* intention of the Directors, and the same remarks, of course, apply to the other branch of the subject. I would therefore ask you to be good enough not to move the resolution you propose, but to allow me now to put the confirmation of the resolution I have just read to the meeting with respect to the agreement.

Mr. PETO: I may, I trust, ask this question, Do you wish to give your services? If so I, of course, have nothing further to say. I do not, however, think that the remuneration and compensation of the Platino directors has anything to do with the matter.

The CHAIRMAN: I am very pleased to hear these remarks, only, so far as we are concerned, we cannot interfere in the matter. We relegate it to the dim and distant future.

The Chairman then put the resolution, which was carried unanimously.

The CHAIRMAN: The next resolution which I have to put is—

"*That for the purpose of the said agreement and other the purposes of the Company, the capital of the Company shall be increased to £1,500,000 by the creation of 30,000 shares of £15 each, to rank pari passu with the existing ordinary shares of the Company.*"

Mr. WEAVER: I beg to second that.

The CHAIRMAN: It has been moved and seconded that this resolution shall be confirmed; those in favour please signify the same in the usual way. Carried unanimously.

The CHAIRMAN: The next and last resolution which I have to move is—

"*That the Directors may issue the shares required for the purposes and on the terms of the said agreement. The residue of the said shares may be issued by the Directors at such times, in such manner, and upon such terms as they determine.*"

This was also seconded by Mr. WEAVER, and carried unanimously.

The CHAIRMAN: Gentlemen, I beg to thank you for your attendance here to-day, and to say that the business of the meeting is now concluded.

London Platino-Brazilian Telegraph Company (Limited).

The tenth ordinary general meeting of the shareholders of the above Company was held at the offices of the Company, Winchester House, 50, Old Broad-street, on Tuesday last, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. Wm. Payton) read the notice convening the meeting and the minutes of the ninth ordinary general meeting held on May 23rd, 1887, as well as those of the extraordinary general meeting held on the 27th April last. These having been confirmed and signed by the Chairman as correct, the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN: I have now to move—

"*That the report and accounts for the year ended March 31st, 1888, submitted to this meeting, be and they are hereby received and adopted, and that a dividend of 3s. per share be declared, payable this day, free of income-tax.*"

Before asking you to approve of this resolution I have a few remarks to make. Twelve months ago when I had the pleasure of addressing you I gave you a very full account of the Company's position and its progress. I stated at that time that negotiations were going on with the Brazilian Government and also with the Western and Brazilian Company with a view to their taking over the management of the affairs of this Company. As you are aware those negotiations are terminated, and meetings have been held confirming the resolutions arrived at. After I addressed you at the meeting the other day on the subject of the bargain we proposed to make with the Western and Brazilian Company, it was unanimously agreed by the shareholders that the management of this Company should be placed in their hands under certain conditions. Now, gentlemen, as those arrangements are likely to be carried out, probably this is the last meeting of the London Platino-Brazilian Company under the present directorship. I have no doubt they will hold their meetings as usual, and those who become interested in the Western and Brazilian Company, or who still continue with the London Platino-Brazilian Company, will have an opportunity of knowing how the new management succeeds. So far, I think I may say, without any hesitation, that when we took this Company into our hands, we took it in a very unsatisfactory state indeed. I think we leave it now in a thoroughly prosperous condition. We are going to pay you to-day, not it is true a very large dividend—probably you may say a small dividend—but we are leaving it in a progressive state. Our submarine cables during the year have earned considerably more than they did the previous year. At the same time, as I said the other day, the Western and Brazilian Company is equally progressive. It is a larger system altogether. This is a comparatively small one, and it ought to be worked more economically and quite as efficiently by the Western and Brazilian Company as it would be worked by the present

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Board. Therefore, I repeat, we are now about to retire from the management of this Company and hand it over to the Western and Brazilian Company in a highly satisfactory condition. So far as figures show anything the change will be for the benefit of the London Platino-Brazilian Company, as I can say that the Western and Brazilian dividend is likely to be one per cent. more than that of this Company. I think this is a reason, gentlemen, which should satisfy you that the transfer is a wise one, and although it is with great regret that the Directors leave the position which they have occupied—a position in which they have received the very cordial support of the shareholders during the many years they have held it—at the same time I feel that, in the interests of telegraphy generally, which has become a large international system, the more we can contribute towards unity the more we shall contribute to the success of telegraphy all over the world. You may say that it is concentrating the control too much. But you must bear in mind that this leads to increased dividends, and the more we can bring the management into great centres the greater force will be given to it. Therefore, it is part of my policy—it has always been—in telegraphy, to bring it as much as possible under the control of a concentrated power, and a power which, whilst looking to the progress of the great work of telegraphy, also sees that it is done on sound commercial principles, so that the shareholders connected with it will be benefited alike with the great telegraphing public. I beg to move the resolution.

Mr. FRANCIS PAVY seconded the motion.

Mr. YOUNG supposed that the dividend warrants were not made up. If so he would like to move an amendment increasing the amount of the dividend, seeing that they were going to put £1,000 to the reserve fund, which he did not think absolutely necessary.

The CHAIRMAN replied that it was too late to move such an amendment. They must now look to the Western and Brazilian Company for increased dividends.

Mr. YOUNG expressed his satisfaction with the proposed scheme of amalgamation, against which, he said, he could see no possible argument.

The CHAIRMAN having given explanations of various points in the accounts raised by Mr. Cunningham and Mr. Fry, the resolution for the adoption of the report and accounts was passed unanimously.

On the motion of the CHAIRMAN, seconded by Mr. HOLLOCOMBE, the retiring Director, Mr. Francis Pavy, was unanimously re elected, as were also Messrs. Deloitte, Dever and Co., the auditors of the Company, on the motion of Mr. FORD, seconded by a SHAREHOLDER.

An extraordinary general meeting was afterwards held for the purpose of confirming a resolution approving an agreement dated 18th April, 1888, entered into by the Directors of the Company, with the Western and Brazilian Telegraph Company (Limited).

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said that he had explained so fully at the last meeting the nature of the agreement in question that he thought there was no necessity for opening up the subject further than to ask the shareholders for their approval of the resolution. He was very careful when he spoke at the last meeting to explain everything fully, and he said then that a one-sided bargain was not a good one. He always liked to make a bargain so as to be a little on the right side, and he thought he might say without fear of contradiction that they were a little on the right side by the scheme they proposed—not so much, however, as to make those who bought them in the slighest degree uncomfortable. In further reply to a shareholder, he added that the Board had taken legal advice, and were quite satisfied that they were doing the right thing. The resolution was as follows:—

"*That the resolution passed at the extraordinary general meeting of this Company, held on the 27th day of April last, such resolution being in the words following: 'Resolved that the provisional agreement, dated the 18th day of April, 1888, made between the Western and Brazilian Company (Limited) of the one part, and the London Platino-Brazilian Company (Limited) of the other part, be and is hereby approved, and that the Directors are hereby authorised to do all things necessary to carry the same into effect,' be and is hereby confirmed, so as to make the same a special resolution.*"

Mr. PAVY seconded the motion, which was carried unanimously.

The CHAIRMAN wished to be allowed to express his regret that this was the last time he was likely to preside at their annual meeting, but, at the same time, he desired to assure the shareholders that though their interests would be merged in the larger Company, he would consider it a matter of duty as well as of pleasure to follow the working of the Company under its new management.

Mr. YOUNG proposed a vote of thanks to the Chairman and the Directors, again expressing his belief in the wisdom of the amalgamation scheme.

Mr. CUNNINGHAM having seconded the motion, it was carried unanimously.

The CHAIRMAN briefly acknowledged the vote, and the proceedings terminated.

Woodhouse and Rawson (Limited).

An extraordinary general meeting of the shareholders in this Company was held at the City Terminus Hotel, on Wednesday, the 15th instant, under the presidency of Lieut.-General Sir John Stokes, K.C.B., R.E.

The SECRETARY (Mr. J. Shurmur) read the notice calling the meeting, which stated that the Board would thereat announce the interim dividend which it had been decided to declare, and explain the steps that it had been resolved to take in order to cope with the increasing business of the Company.

The CHAIRMAN: Ladies and gentlemen, it was competent to your Board to declare an interim dividend, and to make a further issue of shares without convening you in a general meeting, but the Board have considered it more fitting while making known to you the amount of interim dividend which they find themselves able to announce, to present you with a balance-sheet for your information, which will justify our decision and enable you to form an opinion on the position of the Company. We have much satisfaction in announcing that the first half-year's working has given a profit of over 40 per cent. per annum, but we do not propose to declare an interim dividend of more than 12 per cent. per annum on the amount paid up or credited as paid up on the several shares. We think it more prudent to carry the remainder—a sum of more than £3,000—to the current half-year, especially as it consists principally of shares in other companies which are growing in value, and which it is therefore better to retain than to sell now in order to declare a higher interim dividend. The Board have been fortunate enough to acquire since the formation of the Company some valuable patents at a merely nominal price, from which a very large return may very soon be expected; indeed, a license for one application alone in three different countries had been provisionally disposed of for over £4,000 and a royalty, a deposit having been paid for the same; but unfortunately the purchasers, for reasons quite independent of the patents, were unable to complete their arrangements, and forfeited the amount paid on deposit. As I have just now said, part of our profits consist of fully paid-up shares which we hold in the Universal Automatic Machines Company, partly in payment for patents that we sold to that Company, and partly in payments for work done for them. We instructed our auditor to value those shares, and to employ a professional man accustomed to valuations of the kind. He valued the shares at par, but we have only taken into account 85 per cent. of their par value, being the price at which a large number have lately changed hands. These shares were acquired shortly after the formation of the Company, and at the time the balance-sheet was taken, on the 31st December, 1887, they were only worth half their present value. At about that time we had offers for them at that price. We refused, however, to sell, believing that the shares would rise con-

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siderably over par, and we preferred to borrow money from our bankers for increasing our business. It is well we have done so, for we have lately sold some of the shares at only 15 per cent. discount, and I hope before the end of the year to see their value very much enhanced. We therefore consider our valuation of them in the balance-sheet as fully warranted. As you see by the balance-sheet the actual amount of working capital put into the business on its being turned into a limited company was only £2,855. We considered it advisable on the formation of the Company to begin with a small capital, and show what we could do, gradually extending the business as we saw fit, the interest paid for advances from the bank being nominal compared with the profit made. As regards the increase of capital which we propose to make to further develop the business of the Company, I may mention that large contracts for lighting, the pushing of patents abroad, and the manufacture of plant at home, require us to lie out of our capital for considerable periods, and we have taken advances from the bank on account of our increasing business, though we make a large profit for giving such facilities. We have therefore come to a resolution to issue 6,000 ordinary shares, on which we only propose to call up the same amount as has been called up on the first issue—that is, 35s. per share by the 1st July, from which we shall derive £10,500, and £30,000 in Six per Cent. First Mortgage Debentures of £100 each, of which £15,000 will be paid up by the 1st of July, and the remainder by the end of the year. With this increased capital we confidently expect to show you even more brilliant results in the second year of our existence than in the first. The present shareholders have a prior right to the shares now to be issued, in the same proportion as they at present hold. We have much pleasure in announcing that very important negotiations which have extended over many months, and which will lead to a very great and lucrative extension of our business, have been brought to a satisfactory conclusion; but I cannot give you the details of this transaction, as there are heavy interests involved which cannot now be divulged. If any gentleman wishes to ask any questions we shall be very glad to answer any that may be put. After a pause he added: There is no further business to bring before you, and unless any one asks questions I shall consider the business terminated.

Mr. HAYES asked if the 14,100 shares, on which 35s. had been called up, represented the actual number that had been issued out of the 39,980, and whether it was to be inferred from that that all the shares were not taken up in the first instance.

The CHAIRMAN: Only 14,100 were placed at the disposal of the public. We thought we would not begin with a large capital. We reserved a certain number of shares to issue from time to time as we wanted the capital.

Mr. HAYES assumed, then, that what the shareholders were now asked to do was to confirm a further issue of original capital.

The CHAIRMAN: The Directors have full power to issue those shares without further confirmation, but they thought it would be pleasant to the shareholders to meet the Directors and to hear from them the state of the business. That was why we called you together.

Mr. HAYES: Before we part, may I ask if you declare the dividend?

The CHAIRMAN: Yes; I do declare it, at the rate of 12 per cent.

Mr. HAYES then proposed a vote of thanks to the Chairman for presiding, and said he regarded the statement which had been made by Sir John Stokes as very satisfactory.

Mr. PHILIP RAWSON seconded the motion, which was carried unanimously.

The CHAIRMAN briefly acknowledged the compliment, and the proceedings terminated.

NEW COMPANIES REGISTERED.

CITY OF MEXICO JUNCTION AND PACHUCA RAILWAY COMPANY (LIMITED).—On the 9th inst. this company was registered, with a capital of £570,000 in £20 shares, to construct and equip railways, tramways, telegraphs, telephones and other means of communication in Mexico. The subscribers are:—

	Shares.
F. Chapple, Claremont-road, Highgate, solicitor	1
H. P. Gilbert, 51, Bassein Park-road, N.	1
E. T. Botwright, 23, Sutton-place, E.	1
E. S. Harper, East Dulwich	1
W. C. Horton, 298, Crystal Palace-road	1
G. Smallman, jun., Philip-lane, Tottenham	1
J. Stevenson, jun., Richmond, solicitor	1

Registered without special articles.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended May 11th, 1888, amounted to £4,312.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended May 11th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,561.

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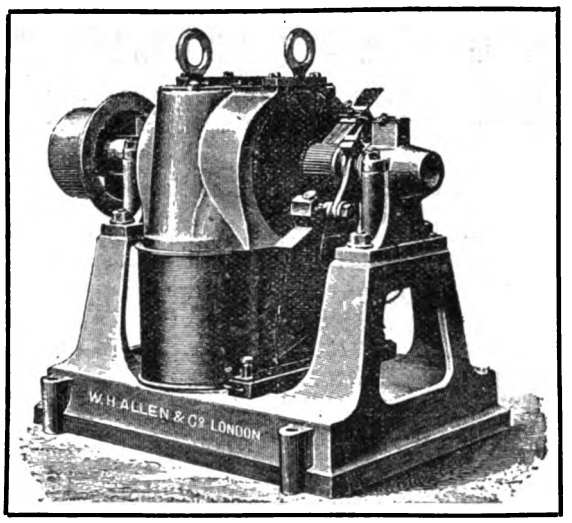

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, May 16, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending May 16, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American	38 39	3 9 6	Jan., Apr., July, Oct.	...	...
2,614,820	Stock	20/0	Do. Preferred	64 65	4 4 0	,, ,,	65½	64¼
2,614,820	Stock	nil.	Do. Deferred	12¾ 13½	...	February	13¼	...
130,000	£10	3/0	Brazilian Submarine	12½ 12⅝	5 12 0	Mar., June, Oct., Dec.	12 9/16	12⅝
16,000	10	8/0	Cuba Submarine	12¾ 13¼	6 1 0	February and August	...	...
6,000	10	10/0	Do. Preference	18¾ 19¼	4 2 1	,, ,,	...	...
12,931	5	2½%	Direct Spanish (£4 paid)	3¾ 4¼	3 10 0	March & September	...	...
6,000	5	5/0	Do. Preference	8½ 9½	4 4 3	April and October	...	...
60,710	20	2/0	Direct United States	8⅝ 8¾	4 10 0	Jan., Apr., July, Oct.	8⅝	...
380,000	10	2/6	Eastern	11⅝ 12	4 12 9	,, ,,	11 1/16	11⅜
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜ 15¼	3 19 0	,, ,,	14 1/16	14⅜
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅜ 13	5 0 9	Jan., Apr., July, Oct	13	12 13/16
22,050	10	5/9	German Union Telegraph and Trust	9 9½	7 7 4	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅞ 6⅛	5 1 0	Jan., Apr., July, Oct.	6⅛	5⅞
178,992	10	3/0	Do. 6 per Cent. Preference	13⅝ 14⅛	4 5 0	,, ,,	14 1/16	13⅝
150,000	10	5%	Great Northern	14⅛ 15	5 0 0	Jan., July, and April	14⅞	14⅝
17,000	25	5/0	Indo-European xd	36 38	6 11 7	April and October	...	...
38,348	10	3%	London Platino Brazilian	6 6½	5 0 0	May and November	6⅛	6
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	...	...
338,225	Stock	12%	Submarine	140 150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America	5⅝ 6¼	8 0 0	January and July	6¼	6⅛
150,000	100	8%	Do. Debentures	112 117	6 16 2	June and December	...	...
88.321	10	nil.	West India and Panama	7/8 1⅛	...	...	1 1/16	...
34,563	10	9/0	Do. 1st Preference	10¾ 11¼	8 8 9	April and October	11¼	...
45,181	15	3/9	Western Brazilian xd	10⅜ 10½	6 4 6	March & September	10 1/16	9½
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 10	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	6 6⅛	5 0 0	Yearly	...	...
220,000	£1	...	Oriental (11s. paid)	⅞ 1	...	...	⅜	...
80,000	5	5/0	United	15 15½	4 3 10	June and December	15 9/16	15
50,000	5	2/6	United River Plate	4⅞ 5⅛	...	April and October	5	...
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb.'86	Anglo-American Brush (£4 paid)	2⅜ 3½	...	...	2⅞	...
23,692	5	nil.	Do. (fully paid)	3½ 4	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2½ 2¾	...	...	2 7/16	...
312,000	¼	0/1¼ '86	Maxim-Weston	1/16 1/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	39½ 40½	6 1 0	March and July	40½	39¾
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 3	February & August	17⅞	17

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FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

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LORD CLAUD J. HAMILTON, M.P., *Deputy Chairman.*

Hon. EVELYN ASHLEY.
J. SPENCER BALFOUR, Esq.
MICHAEL BIDDULPH, Esq, M.P.
W. P. BOUVERIE, Esq.
ARTHUR CLARKE, Esq.
Sir WILLIAM FORWOOD.
EDWARD LAWRENCE, Esq.
ERNEST NOEL, Esq.
Sir JOHN PENDER, K.C.M.G.
J. DENISON PENDER, Esq.
The Right Hon. LORD SUDELEY, P.C., F.R.S.
LEOPOLD SALOMONS, Esq.
JOHN C. SALT, Esq.
C. A. WHITMORE, Esq, M.P.

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2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the duties of the family solicitor.

The Corporation acts as Trustees for the Debenture Holders in Public Companies.

For terms, &c., application should be made to the General Manager at the Company's Office.

GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

The *conversazione* of the Master and Wardens of the Honourable Company of Salters is not usually regarded as one of the leading events of the scientific year; but this year, at any rate, it will be remembered as affording one of the most interesting and valuable exhibitions of novel electrical appliances which has yet been given. This was chiefly due to the co-operation of Profs. Ayrton and Perry, who exhibited several new or improved instruments. There was, first, the new type of secohmmeter, which has now been reduced to a very practicable and convenient form, and which, as soon as standards of self-induction are ready, will be independent of a speed-counter. Next there was a Maxwell-Ayrton-and-Perry-Deprez-D'Arsonval galvanometer, which, for shortness, will be called a Maxwell galvanometer. This instrument combines the well-known practical advantages of the D'Arsonval type, with a remarkable freedom from the permanent magnet error which has hitherto militated against its use as a calibrated instrument. We anticipate that the small cost and great convenience of these instruments will lead to their very extensive employment for testing purposes. A full description both of this apparatus and of the new secohmmeter will be found further on. Lastly, we must find room to refer to the well-known "magnifying springs" of the same inventors, for which, by means of an ingenious combination, further uses have recently been found. We have always regarded this spring as the most remarkable and the most beautiful of the very numerous discoveries and inventions of Profs. Ayrton and Perry.

From a report in another column it will be seen that the Leamington Town Council are unable to come to a decision whether or not to give notice to terminate the contract with the local Electric Lighting Company. The one redeeming feature in this unhappy business—and even this has only a negative value—is to be found in the fact that the promoters are spending their own money and not that of other people. But, even so, it is impossible not to feel that either the extraordinary bad luck or the equally extraordinary bad judgment of the contractors has inflicted a very serious blow upon the prospects of electric lighting in the Midlands. The chances of undertaking central station lighting are not so plentiful in this country that we can afford to overlook a single failure. Those who embark upon such schemes would do well to realise that they will certainly be held "morally responsible" to the whole profession for the success of their undertaking. Electrical engineers, however much they may disagree amongst themselves, have nevertheless too much good sense not to know that their interests are far better served by the success than by the failure of every central station that has been or will be started in this country for some years to come, no matter what system may be employed. We feel sure that the failure, or, if that be too harsh a word, the incomplete success, of the Leamington installation has been a source of sincere regret to all electrical engineers and contractors. But, on the other hand, however much we may sympathise with Messrs. Chamberlain and Hookham, it is very difficult indeed to understand why a tolerably simple and straightforward undertaking, such as the distribution of a few hundred lamps on a three-wire system of mains, can ever have been allowed to fall into so lamentable a condition. We think it only due to the profession, which has sustained involuntary injury at their hands, that Messrs. Chamberlain and Hookham should, at the proper time, make public the history of the whole affair. If there be any mysterious and hitherto unsuspected difficulties in the three-wire system, certainly the sooner we know them the better.

Meanwhile we shall only now refer to one point of detail. In our own opinion a great mistake was made when it was first decided to use 16 candle-power incandescent lamps for street lighting at Leamington. No doubt a 16 candle-power lamp is as good as an ordinary street gas flame; but then the public expects from the electric light something a great deal better. If arc lamps are objected to, then we believe it to be bad policy to employ anything less than about 100 candle-power incandescents for street lighting. At Leamington we understand that it is proposed to remedy matters by replacing twenty lamps of 16 candle-power by ten of 32 candle-power. This seems mere trifling. We are also sorry to see that Mr. F. Joel is going to light the streets of Barnet with low candle-power incandescents. It appears to us that Mr. Joel will have a good many difficulties to overcome at Barnet, and we think it a pity that he should handicap himself with a scheme of street lighting which can scarcely fail to prove unpopular.

The "Mordey Alternator," which we describe in another column, is not only a strikingly novel, but also a highly successful machine, electrically, mechanically, and economically. In the case of a design involving so wide a departure from conventional types it is also worthy of note that the first

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machine, built without previous experiment of any kind, yielded results within a very small percentage of Mr. MORDEY'S calculations. The Anglo-American Brush Corporation may now be congratulated on having completed their equipment for dealing with alternating current distribution.

A CORRESPONDENT, whose letter will be found in another column, calls attention to the fact that in our issue of December 16, 1887, we reprinted from the *Journal* of the Franklin Institute a paper by Prof. E. J. HOUSTON describing the Tavener coulomb meter, which was patented in this country in the year 1884. This meter consists of a double-bulbed glass tube, like a differential thermometer. The tube is poised at its centre of gravity, and each bulb contains a wire spiral. The current being passed through the wire in one bulb expands the air, which drives a mercury column into the other bulb. This, now being weighted, descends and closes a switch, which sends the current through the opposite bulb. An alternate see-saw motion is thus produced, which is measured by suitable counting apparatus. Now, in our American letter dated April 28th, and which appeared on page 26 of the present volume, Prof. ELIHU THOMSON is credited with the invention of what certainly appears, on the face of it, to be an instrument "substantially as described" by Mr. TAVENER. It seems to us highly probable that a perfectly successful meter, suitable for continuous or alternating currents, can be made on these lines, and we shall be glad to have the question of priority of invention settled at its earliest stage. No doubt Prof. THOMSON can explain the circumstances under which he patents an invention recently ascribed by his own colleague to some one else.

THE "ten minutes" rule announced at the last meeting of the SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS will be recognised as a well-meant effort on the part of the Council to meet a growing difficulty. The difficulty has arisen both from its growth in numbers and the increased interest in the proceedings of the Society, and it is not an easy one to deal with. We are unable to feel quite confident that the experiment which is now to be tried will prove entirely successful. It is not that we think the rule too stringent; what is to be feared is that the younger and more modest Associates or Members, dreading to listen to the tones of the warning bell, and still less prepared to face an appeal to the mercies of the audience, will content themselves with a scant five minutes or relapse into silence altogether. A far more convenient, more effectual, and certainly more dignified course, would have been to leave the matter absolutely in the hands of the Chairman, who each evening could be guided as to what limit of time he should fix for the speakers by the character of the Paper that has been read and the amount of discussion it is likely to provoke.

THERE is another subject of even greater importance which, we trust, will speedily engage the attention of the Council. The status of the Society as a Scientific Institution has not yet become a matter of unconcern to the majority of the Members, however much the action of certain individuals might be held to prove the contrary; and that status is not, unfortunately, so high at present that the Members—especially Members of the Council—can afford to neglect the *lex non scripta* which should govern the proceedings of an assembly having pretensions to the position of a scientific body. It is no doubt a healthy sign that a very strong feeling has been roused on the subject, and we trust that sufficient has been said to prevent the examp'e from being followed up. If not, then, when we next have a Paper on the Leclanché cell we shall expect the author to tell us that he will be happy to supply them at so much a gross, with 12½ per cent. off for prompt cash.

THE problem of the alternate-current motor continues to receive a great deal of persistent and not altogether unsuccessful investigation. From our knowledge of experiments in progress in more than one quarter, we had hoped that the first thoroughly practical solution would be announced from London. But if this is to be the case our friends ought apparently to lose no time in completing their experiments. In another column will be found an account of a highly interesting and ingenious device of Prof. FERRARIS, who, by means of the combination of two alternating fields displaced by a quarter-phase, obtains the practical equivalent of a rotating field. That the device will readily lend itself to the construction of an alternate-current meter is almost certain, but whether it will make a practicable motor it is as yet too early to speak with confidence. There can be little doubt, we think, as to the absolute novelty of the idea, so far as regards previous publication; and yet we hear this week from America of a device, which, so far as our information at present goes, seems to bear a good deal of similarity. This latter invention is due to Mr. NIKOLA TESLA, and he was to have read a paper on the subject before the American Institute of Electrical Engineers on the 16th of the present month. One of the Transatlantic journals has already published an article based evidently upon the patent specification, but we must confess that we are unable to make head or tail of the details.

THE French technical journals are full of lamentation and sorrow. The obnoxious and absurd electric lighting regulations imposed twelve months ago have been re-issued and confirmed by the Prefect of Police, and their authority has now been extended by the endorsement of the "Conseil d'Hygiène," the "Commission Technique," and the "Commission Supérieure des Théâtres." We published the full text of these regulations in our issue of March 25, 1887, p. 446, and as the alterations seem to be unimportant it will scarcely be worth while to reprint them. While many of the provisions are, as may be supposed, such as will commend themselves to the English electrician, there are some others which cannot be read without a feeling of impatience, and to which the description above applied to them will not seem one whit too strong. Such, for instance, are the rules which require that the chimney shaft of all boilers used for electric lighting must be carried to a height of 15ft. above that of any other chimney within a radius of 650ft.; that if batteries are used a special air shaft must be built for ventilation, and must open above the roof; that the maximum

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difference of potential with alternating currents must not exceed 120 volts. This last is of course a fatal blow to transformers in Paris. It seems as if London may even now escape from the ignominious position on the list of capital cities lit by electricity which it has hitherto seemed likely to occupy.

AMONGST the heterogeneous multitude of crude, worthless, or exploded ideas for which "Her Majesty's Letters Patent" are solemnly issued year by year—a farce from which, indeed, no inconsiderable portion of the revenue of the Patent Office is derived—many of our readers will no doubt recognise an old acquaintance in the description of an electro-magnet, which is built up of concentric iron tubes alternating with coils of copper wire. It is scarcely necessary to remark that, since each sheath more or less magnetically short-circuits the one next within, such a design is only advantageous if it be required to construct a bar magnet having the maximum weight of material with the minimum external field. This is not exactly the condition required for the field-magnet of a dynamo; yet it is for dynamo machines that the "inventor" usually considers his design chiefly valuable. This, for instance, is the idea entertained by the latest patentee of the "compound magnet." We refer to the specification filed by Mr. H. WATT, No. 9,853, dated July 13th, 1887. Surely this is not the secret of the famous Watt dynamo, upon which the shareholders of the MAXIM-WESTON COMPANY have learnt to place their hopes?

THERE was a severe thunderstorm in Glasgow last week, and a local journal seizes the occasion to instruct the ignorant multitude upon the relation between the electric light and lightning. We quote the following from the *Glasgow Evening News*:—"There is no danger whatever. The current from the time it leaves the motor is protected by strongly insulated wires, and lightning, therefore, cannot touch it there. Should the natural electric fluid find its way to the dynamos it might cause the light to flare up momentarily, but that is all. The current which drives the lights is quite strong enough to absorb the lightning." From the same journal we learn with considerable interest that a display of globular lightning was witnessed in the city during the same storm. This sapient scribe, however, knows far better than to believe in "the palpable absurdity of such stories," and proceeds in the approved style of the penny-a-liner to show his own total ignorance of a well-established phenomenon. We should be very glad to have further information as to this alleged appearance of globular lightning on the 19th inst.

Weston-super-Mare.—The Weston-super-Mare Town Commissioners have at length instructed the Finance Committee to report upon a proposal for the adoption of the electric light. The cost is estimated at £20 per lamp per annum, equal to a rate of 1d. in the pound.

Electric Light v. Gas.—General Festing, in a report to the Science and Art Department of the Privy Council, says the working expenses in connection with the lighting by electricity of South Kensington Museum amounted to £1,224. If the same portions had been lighted by gas the cost would have been £2,845. There was thus a saving of £1,621, which is 50 per cent. on the cost of machinery and apparatus.

Berlin.—According to the *Elektrotechnische Zeitschrift* the Anglo-American Brush Corporation has submitted a contract for lighting some of the streets of the town to the municipal authorities of Berlin. The contract is for 150 arc lamps and four 40-light dynamos. There are to be four separate underground circuits, the lamps are to be run, one half all night and one half up to midnight; the charge is to be 3½d. per lamp-hour, and it is estimated that there will be 400,000 lamp-hours per annum.

The House-to-House Electric Light Supply Co. (Limited).—We are informed that the directors of this company have ordered for their Central Lighting Station at West Brompton the following plant:—Three horizontal coupled compound steam engines, from Messrs. John Fowler and Co.; three water-tube steam boilers, with heaters and feed pumps, from the Babcock and Wilcox Company; and three sets of alternating-current dynamo-electric machinery, from Messrs. Elwell-Parker (Limited), of Wolverhampton.

Barnet.—The Barnet Local Board have affixed their seal to a contract for the lighting of their town by electricity, the contractor being Mr. Henry Francis Joel. The price which the Board formerly paid for gas supplied to the public lamps was 4s. 6d. per 1,000 cubic feet. Since the commencement of the negotiations with Mr. Joel the price has been reduced to 4s. 3d. The contractor undertakes to light the streets by electricity by August 29th, to use underground wires, and to make a charge based on 4s. per 1,000 cubic feet for gas. He also offers to supply private consumers at a similar rate, or, if they prefer it, at a charge of £2 per light per annum. The Board have had their choice of arc or incandescent lights, and have decided to have the latter. The contract is for three years.

Kensington Vestry.—At a recent meeting of this Vestry, Mr. Tisdall moved that the Town Hall be lighted by electricity, and that the Special Purposes Committee be requested to advise the Vestry as to the tenders referred to in their report (dated April 24th) for running mains and wires for supplying electricity to light the Town Hall and offices, and for the supply of the necessary fittings.—Mr. Braye moved as an amendment that the matter be deferred one year.—On Mr. Braye's amendment being put 25 voted it, and for Mr. Tisdall's motion 27.—Mr. Braye called for a division, which resulted in 27 voting for his and 30 for Mr. Tisdall's motion.—Mr. Moss moved a further amendment on the first motion, "That the matter be deferred for three months."—Mr. Broom seconded.—This was carried by 33 to 20.

American Institute of Electrical Engineers.—The annual meeting of this Institute was announced to be held in New York, on Tuesday and Wednesday, May 15 and 16. The following Papers were to have been read:—"On a New System of Alternate-Current Motors and Transformers," by Mr. Nikola Tesla; "The Possibilities and Limitations of Chemical Generators of Electricity," by Mr. Francis B. Crocker; "Underground Electrical Systems in Europe and America," by Prof. G. W. Plympton, of the Brooklyn Subway Board; "On Compensated Resistance Standards," and "On Prof. Moler's 'Swinging Arm' Galvanometer," by Prof. Edward L. Nichols, of Cornell University; "The Patent Court and Uniformity in Patent Practice," by Mr. George H. Stockbridge; "Protection of the Human Body from Dangerous Currents," by Mr. P. B. Delany.

Paris Exhibition, 1889.—The executive council of the British section announce that they are prepared to receive

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applications from intending exhibitors up to the 9th of next month, at which date it will be absolutely necessary to commence the allotment of space. It appears that very little, if any, more space can be given to this country, which already has a large proportion of the amount allotted to foreigners, the demands made by native exhibitors having been unexpectedly large. As regards the industrial departments, it is now certain that an excellent representative display will be provided; some of the classes are practically filled up, though in others there is still room available for allotment. Nearly all the outside space available has been disposed of, so that any exhibitors wishing to show in the open air, or to erect small pavilions for themselves, must apply at once, and it is even now doubtful whether any more can be accommodated.

Earth Connections for Lightning Conductors.—The German electrician and his friends, the gas and water engineers, appear at present to be much exercised in their minds as to the advisability of lightning conductors being in metallic connection with the gas and water pipes. Opinions, it would appear, differ very much on the subject; one gentleman apparently thinking that if they were so joined the lightning might get from a house to the water mains and thence find its way into other houses in the neighbourhood. The general consensus of opinion, however, seemed to be that they should be in connection, but that the conductor must, in addition, have a thoroughly good independent earth-plate, as, failing this, the connection would be a source of danger. Should any of our readers wish for further information on this subject they will find a Paper by Prof. W. Kohlrausch in the *Elect. Tech. Zeits.* for May, and a long discussion in the *Centralblatt*, No. 12.

Electricity in the Navy.—The Engine Room Telegraph Committee, which have been sitting at Portsmouth for more than a year, have now prepared their report. As a consequence of their experiments and deliberations it has been determined to fit the whole of the ships of the Admiral class with electric, in addition to the usual mechanical, telegraphs for communicating between the bridge and the engine room. As the ventilation of the dynamo flats in these ships is so bad that it is well nigh impossible for the men to live in them for any length of time, it has also been resolved to provide them with peace fittings in the shape of additional dynamos. These will be placed on the main deck, and will be of 100 ampere power. In time of war the service dynamos, which are below the water-line, and are protected from shot, will be used for the search lights and glow lamps. Another innovation is to be introduced, whereby four projectors will be fixed in each of the "Nordenfelt" projections at the corners of the superstructure deck, so that in case of an expected torpedo attack the ships will be able to surround themselves with radial beams of light.

Bournemouth.—At a meeting of the Bournemouth Improvement Commissioners held on Tuesday morning, under the presidency of Mr. W. Fisher, the committee of the whole board reported the receipt of a draft licence under the Electric Lighting Act, 1882, and that after considerable discussion as to the application of Messrs. Phillips, Harrison and Hart for sanction to their application to the Board of Trade for a licence to supply electricity for public or private purposes within the district, it was resolved at a meeting of the committee held on the 8th inst, "That this committee recommend the Board not to give their sanction to the application at present."—The Chairman said the committee did not feel disposed that the Board should give any monopoly in this matter.—Mr. Hankinson said he thought that if they refused this application they would have to refuse to accede to other applications.—Mr. Cutler said he thought that the electric light had not yet arrived at such a state of efficiency as would warrant the commissioners in giving their support to any particular company, and so handing themselves over to a monopoly such as the gas and water company.—Mr. Ridley said he also felt that it would be unwise for them to tie their hands to any company to the exclusion of any other better system. He understood that at Leamington the electric light had not been a success, and that a member of the council had given notice that at the next meeting he would move that the contract for the electric light should be rescinded, and that they should "go back to gas."—Mr. Rebbeck said he thought that if any company was started at Bournemouth it should be under the control of the local authorities.—The recommendation of the committee was agreed to.

Bath.—At a meeting of the Bath Town Council on Tuesday, the recently appointed Electric Lighting Committee brought up their report, and the Chairman (Mr. Sturges) moved:—"That the Council instruct the Committee to obtain tenders for lighting a central area by electricity." He said he had ascertained from Mr. Massingham that the probable cost would be half as much again as they were at present paying for gas lighting. Several of the leading citizens were willing if necessary to form a local company for supplying the light at the lowest cost of production. Mr. Radway seconded. Mr. Cox moved an amendment to add to the resolution the following clause:—"And that the Committee invite the Gas Company to tender for supplying a better light than they did at present." Alderman Clark seconded. Several members thought that if the Gas Company would supply gas of 30 candle-power, it would be as great an advantage to the citizens as the introduction of the electric light. Major-General Burn said he should be very sorry to find the question of gas introduced into the resolution, for not only did he look upon the electric light as a much better illuminant than gas, but also as being much safer for the city. If they had their streets lit with it, they would get it introduced into the theatre, hospital, and other public buildings. Several members thought that even if the Gas Company could be induced to raise the illuminating standard of the gas supply to 30 candle-power, it would still be unable to compete with electricity, and fail to satisfy the requirements of the citizens. On the amendment being put, only six voted for it. The resolution to advertise for tenders for electric lighting was then put and carried unanimously.

The Electric Lighting of the Birmingham Library.—In our last issue we quoted a paragraph from the Birmingham *Daily Post*, stating that a scheme had been set on foot for the establishment of a central lighting station at Birmingham, in connection with an installation for lighting the public library. From a letter which has since appeared in the same paper we gather that the paragraph was of a somewhat misleading character. We therefore subjoin the letter in question, as follows:—"Sir: I notice in to day's issue of your paper [the *Daily Post*] a paragraph under the above title, in which you state that the committee had consulted Messrs. Chamberlain and Hookham as to the practicability of lighting the library by electricity. From this it would appear that the question had only recently been considered by the committee, but as a matter of fact it had been under their careful consideration for the past two years. It is only fair to state that at least eighteen months ago the committee consulted Mr. Henry Lea (of the firm of Henry Lea and Thornbery, consulting engineers),

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one of the proprietors of the library, who in a report dated January 24, 1887, clearly showed that the library could very conveniently be lighted by electricity at a moderate cost. Mr. Henry Lea gave a considerable amount of time and attention to the subject, and the committee are indebted to him for the very valuable information they received. Messrs. Chamberlain and Hookham have recently been consulted on another side of the question—the renting of plant, or the purchase of light by meter. The question is still under consideration, but the committee have not yet determined whether or not to adopt any system of electric lighting.—JOHN ANTHONY, M.D., president of the Birmingham Library, Greenfield-crescent, Edgbaston."

Thunderstorms in the North.—A severe thunderstorm broke over Glasgow and the neighbourhood on Saturday last, with fatal results. The following is *The Times* account:—At about a quarter to 5 o'clock three boys were walking across the green, when a vivid flash of lightning struck down two of them. The bodies were at once taken to the Eastern police office, where they were examined by a medical gentleman. The names of the boys are Charles M'Dougall and William M'Lederas, both residing in the East End. M'Lederas' hair was singed and his head and chest badly scorched. Externally the only injury that M'Dougall appeared to have was a black mark round his throat. The ground where the boys were killed was very much torn up by the lightning. A later account states that the three boys were sitting in a row on the grass, and that the boy in the middle escaped injury, his companions on either side of him being killed. W. Sharp, a joiner, residing in Govan, and a man whose name is believed to be George Ingram, engineer, of Cromwell's Plantation, were found lying on the Paisley road, near the Halfway House, between 4 and 5 o'clock. On being conveyed to the Govan police office they were examinied by Dr. Barrie, who found that Ingram had been killed and that Sharp was suffering from severe nervous shock, but that he was not likely to be the worse for the accident. There was a hole in the felt hat worn by Ingram, evidently made by the lightning. A horse in a stable at Govan was also killed by the storm.—A violent thunderstorm broke over the village of Allonby, Cumberland, on Saturday afternoon. Three houses on the sea shore were struck by lightning. The fluid passed down one of the chimneys of each of the three houses. The furniture was smashed to pieces. An almanac hanging in a kitchen was torn into shreds, the paper was stripped from the walls, the glass of a picture was shattered nto fragments, leaving the picture itself uninjured, plaster was torn from the walls, and plates were thrown off a dresser. The gilding of a picture frame hanging in another of the houses was taken off as though it had been scraped away. Mrs. Carruthers, who was standing in one of the porches, had a very narrow escape. The lightning knocked her down and rendered her insensible. She soon recovered, however, and is not seriously injured.—A violent thunderstorm broke over Dumfriesshire on Saturday. At Closeburn, about twelve miles from Dumfries, a man who was driving a pair of horses in a field was struck by lightning and instantly killed. The horses were also killed. Many large trees have been torn up by the roots, and much damage is reported from various parts of the district.

Leamington Central Station.—At a meeting of the Leamington Town Council held last week, the Mayor (Mr. J. Fill) presiding, Mr. Crowther Davies moved, "That the Town Clerk be instructed to give forthwith, on behalf of the Corporation, twelve months' notice, under clause 4 of the agreement dated the 10th day of August, 1887, and made between the Midland Electric Light and Power Company (Limited) of the one part, and the Mayor, Aldermen, and Burgesses of the Borough of Royal Leamington Spa, of the other part, to determine the supply of the electric light." He had named twelve months' notice, because that was the only notice that could be given under the agreement with the company, and he did not object to it, because that would allow the company ample time to make any experiment they liked, and if they could bring the electric light to a satisfactory position he would be willing to let the motion lapse; but he did not think they would be able to do anything of the kind. The present state of the lighting by electricity was not so good as the former system of lighting by gas, nor was it so cheap. On the 2nd of May there were not fewer than eleven electric lamps out, and that was not an exceptional state of things. While desiring to be just and generous to the Midland Electric Light and Power Company, he could not but conclude that they had made a mistake, and that they never would be able to make the light satisfactory.—Mr. Herbert Stanley seconded the motion, which he believed to be in accord with the public wish.—Mr. Harvey said the light was not satisfactory even to the residents in the parade. It was a good light for shops, but in the streets it was not sufficiently diffusive, and in his opinion the lights were not more than eight candle power, although they were to be sixteen candle-power.—Mr. Barter White said the glowing promises of the promoters in this matter had not been fulfilled, although the cost of the new light was 100 per cent. more than the gas.—Dr. Thursfield said he thought that the Council had acted unwisely in removing their old gas lamps, which he believed they would have to put up again. He sympathised with the company, because they had been experimenting with their own money; but still he regarded the electric light as a dismal failure. Still he would not support the motion, as he should like the company to have an opportunity of offering the town something better than they had at present.—Mr. Waring announced that he looked upon the electric light as a failure, and should vote against it.—Mr. Salmon said he was not satisfied with the light, but he could not endorse all that had been said against it. In his opinion, it was neither a success nor a failure in the extreme sense in which the terms were used. He could not vote for the motion that day, but if the light continued as at present, at some not very distant period such a notice would have to be given.—Mr. Orton said one could not go down the parade at night without finding from ten to a dozen lights out, and on one occasion he counted twenty-six lights that had gone out between Bath-street Bridge and the Town Hall.—Mr. Alderman Wackrill contended that the present system of electric lighting was better than the old system, but still it was not what he wished to see it, and therefore he thought the company should have a further opportunity of improving the supply.—Mr. Overell said he was not holding a brief for the Midland Electric Light and Power Company, but he wished them to have fair play. In his opinion they had not had a full opportunity, and as a resolution like this would prejudicially affect the interests of the company, he thought it ought not to be passed without a further trial.—Mr. Purser took a similar view, especially as the company had spent nearly £30,000 in supplying plant for the electric light.—The Mayor said he considered the system had been a success. The resolution, if carried, would send the Electric Light Company out of the town. After the company had spent so much money, it would be most unfair to them to carry such a resolution.—On the vote being taken there were 10 in its favour and 10 against it.—The Mayor refused to give a casting vote.

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NOTES ON ALTERNATE CURRENTS.

BY J. A. FLEMING, M.A., D.SC.

(*Continued from page 736, Vol. XX.*)

Lord Rayleigh has treated the problem of the impedance of branched circuits under the assumption that any number of circuits are connected in parallel, possessing each self-induction, but having no mutual induction.*

The problem is: given the resistance and induction of each branch, to find the compound resistance and inductance, or equivalent resistance and inductance of the system, for simple periodic currents of given frequency.

Let R and L be the resistance and inductance of any branch, and p the pulsation $= 2\pi n$. Let R′ and L′ be the compound or equivalent resistance and inductance of the system of parallel conductors.

The solution of the problem given, for which we refer the reader to the original paper, is

$$R' = \frac{A}{A^2 + p^2 B^2} \text{ and } L' = \frac{B}{A^2 + p^2 B^2},$$

where $$A = \Sigma\left(\frac{R}{R^2 + p^2 L^2}\right)$$

and $$B = \Sigma\left(\frac{L}{R^2 + p^2 L^2}\right)$$

If we take, as usual, $\tan\theta = \frac{pL}{R}$, and write $(I\,m)$ for impedance, where $(I\,m)^2 = R^2 + p^2 L^2$, we can write the above relations

$$A = \Sigma\frac{R}{(I\,m)^2}$$

$$B = \Sigma\frac{L}{(I\,m)^2}.$$

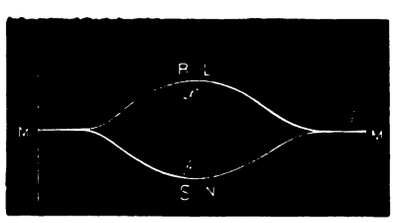

FIG. 33.

Let $R'^2 + p^2 L'^2$ be written $(I\,M)^2$. This is the compound or equivalent impedance of the system of parallel conductors. It is obvious that

$$(I\,M)^2 = R'^2 + p^2 L'^2 = \frac{1}{A^2 + p^2 B^2},$$

when $$A = \Sigma\frac{R}{I\,m^2} \text{ and } B = \Sigma\frac{L}{I\,m^2};$$

hence $$(I\,M)^2 = \frac{1}{\left(\Sigma\frac{R}{(I\,m)^2}\right)^2 + \left(\Sigma\frac{L}{(I\,m)^2}\right)^2}.$$

Consider the case of a pair of conductors in parallel (Fig. 38), having resistances R and S and inductances L and N, but no mutual inductance.

Let $$\sqrt{R^2 + p^2 L^2} = I\,m_1, \text{ and}$$

$$\sqrt{S^2 + p^2 N^2} = I\,m_2, \text{ and}$$

$$\sqrt{R'^2 + p^2 L'^2} = I\,M;$$

then $$I\,M^2 = \frac{1}{\left(\frac{R}{I\,m_1^2} + \frac{S}{I\,m_2^2}\right)^2 + \left(\frac{pL}{I\,m_1^2} + \frac{pN}{I\,m_2^2}\right)^2};$$

or $$I\,M = \frac{I\,m_1\,I\,m_2}{\sqrt{I\,m_1^2 + I\,m_2^2 + 2(R\,S + p^2 L\,N)}};$$

or $$I\,M = \frac{\sqrt{R^2 + p^2 L^2}\ \sqrt{S^2 + p^2 N^2}}{\sqrt{(R+S)^2 + p^2 (L+N)^2}}.$$

The lag ϵ of the main current just before branching, considered with respect to the impressed electromotive force, will be given by the equation

$$\tan\epsilon = \frac{pL'}{R'};$$

hence $$\tan\epsilon = \frac{pB}{A} = \frac{\Sigma\frac{pL}{I\,m}}{\Sigma\frac{R}{I\,m}}$$

generally, and in the case considered will be

$$\tan\epsilon = \frac{\frac{pL}{R^2 + p^2 L^2} + \frac{pN}{S^2 + p^2 N^2}}{\frac{R}{R^2 + p^2 L^2} + \frac{S}{S^2 + p^2 N^2}};$$

hence after reduction

$$\tan\epsilon = \frac{(S^2 + p^2 N^2)\,pL + (R^2 + p^2 L^2)\,pN}{(S^2 + p^2 N^2)\,R + (R^2 + p^2 L^2)\,S}.$$

This is the equation which determines the *lag of phase* of the current i behind the impressed electromotive force in the main branch before dividing into the branch currents x and y in R and S respectively.

Compare this equation with that which determines the angle by which the phase of the branch current y in S is *ahead* of the main current i. It is, as we have seen,

$$\tan\theta = \frac{(SL - RN)\,p}{R(R+S) + L(L+N)\,p^2}.$$

In the expressions for $\tan\epsilon$ and $\tan\theta$ put $N = 0$, and they *both* become equal to

$$\frac{SLp}{R(R+S) + p^2 L^2}.$$

This shows that when $N = 0$ the current y in the branch S is as much ahead of the main current i as i is behind the impressed electromotive force, and hence that y agrees in phase with the impressed E.M.F. acting on the double circuit; in other words, the current in the branch S is entirely unaffected by being joined in parallel with an inductive circuit R; but if N is *not* quite zero, then the current in branch S *is* affected, as regards its lag, by the fact of being joined in parallel with an inductive circuit. The nature of this affection will be dependent on whether $SL - RN$ is positive or negative—that is, whether $\frac{L}{R}$ or $\frac{N}{S}$ is the greater—that is, whether the time-constant of the R circuit or the S circuit is greater. If $\frac{L}{R}$ is greater than $\frac{N}{S}$, then the current y in S is *ahead* of the main current i, but lags behind the impressed electromotive force. If $\frac{L}{R}$ is less than $\frac{N}{S}$, then the current y in S lags behind the main current i in phase, and, *a fortiori*, behind the impressed electromotive force. Let one of these divided circuits, viz., the one of resistance R, be a circuit in which it is desired to measure the *electrical power*. In the ordinary way of using the wattmeter the fine-wire coil, which we will assume has a resistance S, is placed in parallel with the inductive circuit, the thick-wire coil united in series with the inductive circuit. The main current i is thus divided between the inductive circuit R and the wattmeter fine-wire circuit S. The electro-dynamic action in the wattmeter is then one between a current in S, which we have called y, and one in the thick-wire circuit, which is the same as that in the inductive circuit R, which we have called x.

We have above arrived at expressions for the value of x and y.

The question then arises how far the indications given by the instrument, and which are due to the electro-dynamic action of the currents x and y, and proportional to their nume-

* *See* Lord Rayleigh "On Forced Harmonic Oscillations of Various Periods" (*Phil. Mag.*, May, 1886, p. 379.)

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rical product, are proportional to the real power taken up in the circuit R.

The current x is the same as the current in R; hence the error, if any, will result from the current y in S differing in phase or in proportionality from the potential difference between the ends of the circuit R.

In the ordinary mode of calibrating the wattmeter the instrument would be applied to measure the power in a non-inductive circuit traversed by a known current, and having a known potential difference at its ends.

Hence, the real watts taken up in the circuit are known, and since the force required to bring back the movable coil to its initial position is proportional to the product of the currents in the fixed and movable coils, we have at once the desired constant of the instrument.

If a so calibrated wattmeter is applied to measure power in an inductive circuit, there are three different causes of error which may or may not neutralise each other, and which may cause the measured watts as determined by the instrument to be greater than, equal to, or less than, the real watts or power taken up in the circuit.

The first of these causes of error is due to the fact that the fine-wire circuit of the wattmeter always has a sensible inductance—that is, N is not zero. It is true it may be made very small, and can be made small by the device adopted by some makers of arranging the chief part of the wire resistance of the fine-wire circuit as a non-inductive resistance in series with a small inductive resistance which forms the movable coil. It follows that if E be the maximum potential difference during the period between those points to which the fine-wire circuit is attached, that the true average current in the fine-wire circuit is equal to $\frac{2}{\pi} \cdot \frac{E}{\sqrt{S^2 + p^2 N^2}}$, when subjected to a simple periodic E.M.F. of pulsation p. This quantity is not always proportional to E, but depends on p. The effect of the impedance of the fine wire circuit is then first to make the true mean current in it under periodic E.M.F. *less* than it would be if produced by a steady E.M.F. equal to the true mean of the periodic E.M.F. But in addition the impedance causes a lag in phase of the current in the fine wire circuit behind the phase of the potential difference between its ends. This is the second cause of error, and the effect of this lag is dependant upon the nature, whether inductive or non-inductive, of the circuit R. To dissect its action, first let us suppose the circuit R is non-inductive—that is, L is zero. The current x in it will, therefore, coincide in phase with that of the potential difference at the points of junction.

The current in S, viz., y, will, however, lag in phase behind that of the potential difference at the junction. The effect of this lag in S will be to increase the phase difference between x and y, and to diminish the cosine of this angle of phase difference. Hence, to diminish the product $\frac{XY}{2}$, cos δ, which measures the true mean product of x and y, X and Y being their maximum values, and δ their difference of phase. Since by assumption X agrees in phase with E, any reduction of the above product reduces the instrumental reading, and makes it less than the true-power reading. If, however, we have to deal with a circuit possessing inductance, and in which, therefore, there is a current x, of which the phase lags behind that of the potential difference of the junctions, then the lag in the current y in the circuit S, so far from increasing the difference of phase of x and y, may operate to bring them nearer into accordance, and hence to increase the instrumental reading over and above that decrease due to the first-named cause of error.

(To be continued.)

Owens College.—Prof. A. Schuster, F.R.S., has been appointed Langworthy professor of physics and director of the Physical Laboratory at Owens College, vacant by the death of Prof. Balfour Stewart.

CONVERSAZIONE AT THE SALTERS' HALL.

NEW FORMS OF SECOHMMETER AND AYRTON AND PERRY'S "MAXWELL" GALVANOMETER.

On Wednesday evening, the 16th inst., a *conversazione* was given by the Master and Wardens of the Salters' Company, attended by numerous visitors, amongst whom were the Lord Mayor and the various foreign burgomasters and *attachés* who were the guests of the Lord Mayor for that evening. Besides a vocal and instrumental concert, fairly rendered, there was a very fine loan collection of old and modern paintings, antiquities, and other works of art, together with a small collection of scientific apparatus, contributed partly by the City and Guilds of London Central Institution. Dr. Armstrong showed specimens of modern dyes and of fabrics treated with these dyes; Prof. Unwin the results of experiments with his 100-ton testing machine, and apparatus designed by himself for measuring small extensions of the samples under test in the machine. The bars of electro-deposited copper that had been broken in the testing machine were of especial interest to electrical engineers, since experiments showed that they possessed a vastly higher tensile strength than is possessed by ordinary copper. The direct-reading secohmmeter of Profs. Ayrton and Perry, with the recording mercury indicator, intended for absolute measurements of the coefficients of self and mutual induction, was shown. A later and cheaper form, intended to be used in the comparison of the coefficients of induction with one another, or with the capacity of a condenser, was also exhibited. This apparatus, which is constructed for the inventors by Messrs. Nalder, Bros. and Co., of Westminster, is seen, with the cover removed, in the accompanying figure. The wheel-work is driven by a handle at the back, not visible in the illustration; to the right is one set of commutator brushes for commutating the battery, while, at the back, is a similar commutator for commutating the galvanometer connections once between every commutation of the battery connections. To the left is seen a heavily weighted fly-wheel, and still further to the left a lever. On pressing this lever down, the driving spindle can be slightly pushed in or pulled out, which alters the gearing, so that ratio of the speed of commutation to the speed of rotation of the driving handle is increased or diminished fourfold. On releasing the lever, it engages with a flange on the driving spindle, and prevents any change in the relative speeds of commutation and of the driving handle. Both sets of four brushes are stationary, and are pressed by means of springs against the revolving commutators, which each consists of two flat pieces of brass separated by two small pieces of glass. In the position in which the commutator is seen in the figure the two upper brushes are electrically connected with one another, as are also the two lower. The brushes are constructed like the brushes of modern electric light switches, contact being made by the ends of a number of pieces of copper pressing against the moving commutator, since with this arrangement the wear of the brushes does not affect the relative times of commutation of the battery and galvanometer.

In the earlier forms of the secohmmeter only a make-and-break were successively made in the battery circuit and the circuit of a shunt to the galvanometer, but by the use of the double commutator in the new form of secohmmeter the sensibility of the arrangement is increased fourfold. For if there be any want of balance in the coefficients of self or mutual induction that are being compared with one another, or with the capacity of a condenser, the galvanometer receives an impulse in the same direction at every reversal of the battery, which impulse is twice as great and occurs twice as often as if the galvanometer needle received an impulse either only at the making or at the breaking of the battery circuit, as in the earlier forms of secohmmeter. The fly-wheels make 10 revolutions for every revolution of the handle, and, although by the simple alteration of the gearing, previously referred to, the commutators can be driven at will, so as to make either two reversals or eight reversals for every revolution of the handle, the ratio of the speed of the fly-wheel to the speed of the driving handle always remains the same, so that

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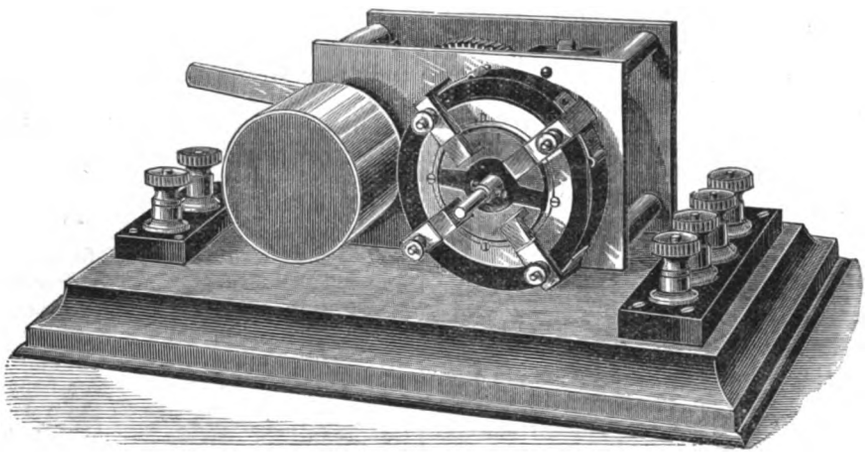
the fly-wheel action remains constant. The driving handle can be conveniently turned by hand at speeds varying from about 60 to 200 revolutions per minute, producing with one arrangement of the gearing 120 to 400 commutations per minute, and with the other arrangement 480 to 1,600 commutations per minute; so that both the battery and the galvanometer circuits can be conveniently commutated from about 120 to 1,600 times per minute, the lower speeds being used for circuits having a large time constant, and the higher for circuits with a smaller time-constant. The exact range of commutation, however, is made different in the various secohmmeters intended for different purposes.

The uses to which the secohmmeter can be put have been fully developed in the Papers written by the inventors and by Mr. Sumpner and Mr. Rimington; and a further Paper, recently communicated by Mr. Sumpner to the Physical Society, and which we anticipate will appear in the *Philosophical Magazine* for June,* shows what valuable use can be made of the instrument for measuring the way in which the coefficient of self-induction of a transformer varies for different magnetising currents. In fact, as stated a year ago, the secohmmeter enables measurements which have hitherto had to be made during the make, or break, or reversal of a battery circuit—and which were, therefore, necessarily unsensitive—to be now made with the same high sensibility as has been accustomed to be obtained by the employment of a steady current in the ordinary measurement of resistances with Wheatstone's bridge.



New Type of Secohmmeter.

When the instrument is intended to be employed for absolute measurements of a coefficient of induction or the capacity of a condenser in terms of a resistance and a time, a speed indicator is attached to the spindle seen projecting from the commutator in the figure. But for comparison of the co-efficients of self or mutual induction with one another, or with the capacity of a condenser, no speed indicator is necessary.

Another use to which the secohmmeter can be put is the measurement of the resistance of a liquid which is liable to polarise with direct currents, but which, as is known, will not polarise with rapidly alternating currents. When the secohmmeter is used for this purpose the galvanometer commutator is adjusted so as to commutate at about the same instant as the battery connections are commutated, instead of one commutation being made between the other, as in the ordinary use of the secohmmeter. If now the secohmmeter handle be rapidly turned the resistance of the liquid can be measured without any error being introduced by polarisation, exactly as a resistance of a wire is usually measured with a Wheatstone bridge, the galvanometer needle steadily deflecting to the right or the left as the comparison resistance in the bridge is too high or too low.

A further exhibit was Profs. Ayrton and Perry's patented modification of the Maxwell or Deprez-D'Arsonval galvanometer, also constructed by Messrs. Nalder, Bros. and Co. In the ordinary Deprez-D'Arsonval galvanometer the deflecting couple for a given current passing round the suspended coil depends on the strength of the magnetic field on which the coil is suspended, while the controlling couple depends on the torsional rigidity of the wires supporting the coil, and which are twisted when the coil is deflected. Hence the sensibility of the instrument diminishes with any diminution in the strength of the magnetic field arising from a slow weakening of the permanent magnet attached to the instrument, or from a temporary variation of the strength of the field from the presence of some neighbouring *very* powerful magnet.

This defect, which renders the sensibility of this instrument as liable to vary as the sensibility of any other permanent magnet measuring instrument, and which has led to their almost entire disuse as *exact* commercial standards of current or difference of potential, has been overcome by Profs. Ayrton and Perry by introducing into the Deprez-D'Arsonval instrument the similar defect which existed in their old form of permanent magnet ammeter and voltmeter. In those instruments the action of the so called permanent magnet on the suspended needle produced the controlling couple; hence as the permanent magnet grew weaker the instrument increased in sensibility. Their improved Maxwell galvanometer is thus a combination of their permanent magnet instrument, having a suspended needle with the Deprez-D'Arsonval instrument with suspended coil, and it consists of a large stationary permanent magnet producing a field in which moves a suspended coil, round which passes the current to be measured. The connections of this coil, instead of having torsional rigidity, are made to have as little rigidity as possible, and the controlling couple is produced by the action of the stationary magnet on a number of little magnets rigidly attached to the moving coil. The deflecting couple, then, for a given current passing round the suspended coil, is, as in the ordinary Deprez-D'Arsonval instrument, proportional to the strength of the magnetic field; but the substitution of the small magnets rigidly attached to the coil for the torsional suspension wires makes the controlling couple also proportional to the magnetic field. Hence, the sensibility of this new form of galvanometer is unaltered for wide variations in the strength of the magnetic field.

In the first instruments on this principle, made by Mr. Jolin, of Bristol, for Profs. Ayrton and Perry, one single magnet only was attached to the suspended coil, but tests of the sensibility of the instrument showed that the compensation for considerable alterations in the strength of the stationary permanent magnet, although beneficial, was not very good. We understand that, although this little magnet was varied in shape and length, and attached successively to different parts of the moving coil, the results were still unsatisfactory, when finally the cause was ascertained by experiments being made by means of a very small exploring coil attached to a ballistic galvanometer to see how the strength of different parts of the magnetic field varied when the large permanent magnet was intentionally

* See also an abstract in *The Electrician*, April 27, 1888.

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much weakened or strengthened. These experiments showed that on altering the strength of the permanent magnet, temporarily or permanently, the strength of the different parts of the field occupied by the suspended coil varied in very different ratios. Hence the application of a single small magnet to the coil generally either over or under compensated for changes in the mean strength of the field. By rigidly attaching, however, a number of small magnets on each side of the suspended coil this difficulty has been quite overcome, as the average controlling couple now varies practically in direct proportion with the average deflecting couple, no matter how the magnetic-field is disturbed. In fact, experiment shows that a 30 per cent. variation of strength of the field, which would of course produce a 30 per cent. variation in the sensibility of an ordinary Deprez-D'Arsonval galvanometer, does not produce more than about a six or seven per cent. variation in the sensibility of the new instrument, even when this 30 per cent. variation on the strength of the field is produced by the presence of a *very large* electro-magnet placed so as to produce much distortion of the fie'd. And five or six per cent. variations in the strength of the field produce no practical change whatever in the sensibility, so that the new Maxwell galvanometer, unlike all ordinary permanent magnet instruments, is compensated for all ordinary changes in the strength of the magnetic-field.

Some measuring instruments using Profs. Ayrton and Perry's well-known magnifying spring were shown, and a model voltmeter or ammeter for lecture purposes, based on the principle of their portable voltmeter for alternating currents, in which the increase of sag due to the small lengthening of the wire by heating produces a small alteration in the length of the spring, and a great rotation of the pointer was exhibited. The wire in this lecture room model was about 30in. long, and the application of the wires from two bichromate cells to its terminals caused the pointer to perform about four complete revolutions over a dial a foot in diameter, while one accumulator made the pointer move through twenty-four right angles.

Their magnifying spring has until quite lately been used mainly for the purpose of converting a small linear motion into a large angular one, but they have now devised a combination of a magnifying spring of large diameter and large pitch, with one of very small diameter and 45° pitch, for magnifying rotatory motions without friction or back-lash, and with a large range of direct proportionality; the specimen of the new combination shown at the *conversazione* magnifying a rotary motion about 120 times.

DISON AND SWAN ELECTRIC LIGHT COMPANY v. HOLLAND AND OTHERS.

THURSDAY, MAY 17TH.

Mr. JOSEPH WILSON SWAN, examined by the ATTORNEY-GENERAL, said: I am the technical director of the Swan Electric Light Company, and have held that post since the formation of the company. I formerly carried on business as a chemist in partnership with Mr. Mawson. My business as a chemist was very varied, but a feature of it was the supply of philosophical and photographic and electrical apparatus and chemicals. My first thoughts as to producing light by electricity were after hearing a lecture by Mr. Stearn at Sunderland and Newcastle in 1845 and 1846. I did nothing in the carbonisation of paper and carbon till about 1848. In 1848 I carbonised strips of paper and coils of paper in charcoal in a potter's kiln. I packed them in charcoal powder. I packed them with charcoal because I had sufficient chemical knowledge to know that would prevent the burning away of the paper. They were carbonised in a fireclay crucible, and sometimes in common earthenware jars. They were carbonised in a pottery kiln belonging to Mr. Wallace, of Newcastle. The strips of paper were not only straight but were cut in the form of flat arches and ringlets. I carbonised those various forms. I made an attempt to render, after carbonisation, the strips incandescent under a vacuum. This was between 1848 and 1850. I did not succeed in raising the strips to incandescence. I do not remember doing anything more at that time that bears upon the question. I remember taking the thing up again about 1860. I did very much the same thing then as between 1848-1850, except that I made the pieces of carbon smaller. I had a better air-pump in 1860 than previously, the best mechanical air-pump that existed at that time. I had also a considerably larger battery power. I did succeed in making a flat carbonised paper arch bright red hot at that time under the receiver. I used a special shaped vessel to put the carbon in. When red hot the carbon bent, and broke on touching, the sole plate on which it rested. I had made a special insulated sole plate which would let the wires go through. I did not go any further at that date. I remember in the autumn of 1877 being introduced to Mr. Stearn. He is in court. He was a clerk in a branch of the Bank of England. I learned that he was very skilful in the use of the Sprengel pump. He was making radiometers and vacuum tubes of various kinds. My connection with Mr. Stearn continued through the years 1877, 1878, 1879, and 1880. He was residing during all that time at Rock Ferry, Birkenhead, and I resided at Newcastle. We communicated by letter when we did not meet personally. I kept all Mr. Stearn's letters to me and have the originals here. Mr. Stearn has told me he has not kept my letters to him. I am able from Mr. Stearn's letters as well as my own memory to fix the dates of certain things that happened between 1877 and 1880. I explained to Mr. Stearn, when introduced to him, my previous experiments. I asked him to mount some strips of carbonised paper for me between platinum wires, put them in a glass bulb, and exhaust it with a Sprengel pump. He agreed to do that. I remember in the end of 1877 sending him some carbonised cardboard strips. They were carbonised at the pottery kiln of Mr. Patterson, Gateshead, in an earthenware vessel. They were packed with powdered charcoal. No moulds were used; they were not necessary for my purpose. They were, in the first instance, simply straight strips about two inches long, and varied in diameter and breadth from one-eighth of an inch to one-fourth, and in thickness from that of paper to thin cardboard. [Shown drawing.] The sketch marked 14 represents the first form of tube with the carbonised strip that came back to me. Mr. Stearn made the first attempt to mount my carbonised paper strip on 30th October, 1877. One or two lamps of that kind came back. To the best of my recollection I was able to make them incandescent; the contact was very bad between the carbon strip and the platinum wires. There were two strips held by one end to the platinum wires and overlapping each other at the other end. That was to get over the difficulty of making a good contact between the platinum wires and the carbon, and also to obtain elasticity. This mode of mounting was really invented by Mr. Stearn's glass blower, who put them in the tubes. It was one of the attempts made at this time. Turning to a straight strip, witness said: I had in 1878 one, or possibly two, mounted forms like that. In it the strip of carbonised paper is mounted in a cleft, and the wires are extended slightly on either side. I had carbonised the strip and sent it to Mr. Stearn, and it came back to me as in the picture. I was not able to raise that lamp to incandescence. Turning to another drawing, witness said: I remember that the lamp represented here was made towards the end of 1878, just before my lecture at Newcastle. It is not quite the same as the Newcastle lamp. My recollection is that I received a lamp of this kind the night before I delivered my lecture in Newcastle. F I B 1 represents my Newcastle lecture lamp. The lecture was in February, 1879, and the night before I received the lamp we are now speaking of. That lamp was a strip of carbonised paper or thin cardboard; it had been completely electrotyped with copper by myself. It had a strip of platinum coil about the same length of the paper brass-soldered to each end. I sent two or three filaments mounted in that manner to Mr. Stearn. He had them mounted in a globe of glass; he then put them in a little bulb, and dissolved the copper away. The object of electrotyping with copper was to make a good contact between the carbonised strip and the platinum. I received two such lamps, one vacuum and the other open. I remember the vacuum having the current sent through it, becoming incandescent, lasting about half an hour, and then breaking. The other one sent me did not turn out a successful lamp. In the end of 1878 I received from Mr. Stearn a lamp like F I B 1. It has a thin, round carbon pencil. I showed that at the lecture in February, 1879. I have a very clear recollection of receiving the lamp the night before the lecture. I obtained the thin, round carbon pencil in the lamp indirectly from M. Carré. I had a lamp exactly like this a few weeks before 26th December, 1878. I sent a very strong current through it, and made it so hot that the carbon bent appreciably, the platinum supports were melted, and the carbon became detached, and fell unbroken, but bent, with a bright appearance of semi-fusion of the carbon. I first showed that lamp at a meeting of the Chemical Society in December, 1878, and then gave it to Mr. Proctor. I had a fire at my establishment on the 17th January, 1880. I have a singularly clear recollection of that date. I first made a thread lamp certainly not before the middle of the year 1880.

Is it true that in the year 1879 you had any thread lamps, either without the second loop or with the second loop, running in your engine room?—No, it is not true.

Prior to the fire had you produced any more successful lamp than F I B 1?—No; that was the most successful lamp we produced.

Examination continued: Through the year 1879 we were struggling to get lamps which would not break down, and our experiments were directed to that object. One great difficulty was the making of a good contact between the carbon conductor and the metallic conductor, and almost all our experiments were directed to conquer that difficulty. B S P 3 was made in 1879. I believe it was made after the Newcastle lecture. The copper spiral arose from our using the thicker carbon conductors, which were easier to manipulate, and required a stronger current than the carbonised strips of paper, and, therefore, the heat was greater. The spiral was used to carry off the heat. The carbon is a straight Carré carbon. In this lamp, because the carbon conductor is somewhat thick, copper and not carbon wires were used, and in order to make a perfect joint between the carbon and the glass the platinum cap was used to mediate between them. [Box produced with broken lamp.] That is the remains of a lamp in which the conductor was a Carré carbon of hairpin form, made in 1879. I produce a model of the hairpin carbon. [Shown letter.] That letter, dated 26th Nov., 1879, from Mr. Stearn to myself

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contains a picture of the Carré carbon, described by Mr. Stearn, which recalls it to my recollection. I now produce a lamp made after the fire. The conductor is carbonised-parchmentised paper. There is a copper spiral inside. That lamp was made before I had made any carbonised thread lamps. Mr. Heaviside and Mr. Proctor made an entire mistake in saying they saw thread lamps in 1879. The outside number of lamps I had in 1879 would be twenty, possibly not more than ten. These we received two or three at a time from Mr. Stearn. Nobody else was making lamps for me in 1879 but Mr. Stearn. As soon as I began the thread lamp I used it always parchmentised. It was always successful. I exhibited them not before the middle of 1880. The parchmentised lamps were almost immediately a success. Towards the end of 1880 I made a considerable number. I ran them chiefly in the engine house at Moseley-street, and there was also one in my own house. The engine was put up in the March of 1879. It was got from Crossley Brothers. There was an extra fly-wheel put up for making the bearing on the axle more equal and also to drive another dynamo. Mr. Ridley's bill for the item is dated September 1st to 11th, 1880:—"Three men, 100 hours, at a countershaft, wheels, &c." In that same account there is a charge for wiring under date August 30th, 1880. The wires were those used in bringing current to the lamps that we did exhibit in the engine room. I remember soon after we began to run a difficulty arising from unsteadiness. A well-known irregularity existing in the gas engine gave us some difficulty, and we corresponded with Mr. Crossley on the subject. There is a letter dated September 4th, 1880, which would be written a month or two after we experienced the difficulty. Mr. Heaviside and Mr. Proctor had probably seen the lamps in my place of business in 1880. I remember Mr. Stearn rendering me his account in the end of the year 1879. All my lamps were blown for me by Mr. Stearn. I never produced a lamp with a double turn in it before I had the thread lamp. I went to Mr. Stearn's two or three times. I was there on 16th January, 1880, and received a telegram telling me of the fire whilst I was at his house. I was in the act of seeing one of the lamps run when the telegram was put into my hand. It was a Carré carbon lamp. I can state very distinctly it was not a thread lamp. At my visits to Mr. Stearn's I never saw or was shown, prior to the fire, any thread lamp. In conjunction with Mr. Stearn I made experiments about driving out the occluded gases, in order to make the lamp more durable. I filed a specification on the 2nd January, 1880, for driving out the occluded gases. I did not know before I filed that that it had been described in the specification of Mr. Edison in 1879. That was the patent on which the Swan Company attempted to take proceedings in the Woodhouse and Rawson action.

Cross-examined by Sir HORACE DAVEY: I am a director of the Swan United Electric Lighting Company (Limited). They hold a large number of shares in the company who are at present the plaintiffs. I hold a number of shares in the plaintiff company indirectly. I do not think I hold any official position in the Edison and Swan United Electric Lighting Company (Limited). If I could render any service to the Edison and Swan Electric Lighting Company I would do so, but I hold no office in the company. The plaintiff company was the result of an amalgamation of the Edison Electric Light Company with the Swan Electric Light Company, made in October, 1883.

Was that amalgamation the result of an action brought by the Edison Company against your Company?—I believe it was.

Do you not know it was?—I know that other considerations entered into the question besides that.

I think the share capital of the amalgamated companies was divided between the two companies?—Yes.

Is it not the fact that the Edison Company got 45,000 shares fully paid up, or partially paid up, and the Swan Company 61,400?—I cannot speak to the fact. My impression was that the figures were 60,000 and 40,000.

The Swan Company 60,000, and the Edison Company 40,000?—Yes, I think so.

I think Edison's Company were suing the Swan Company for infringment of patent in November, 1879?—I think they were.

Do you know they were?—I cannot distinctly call to mind the position of the question of litigation at this moment.

You told us F I B I was a Carré carbon?—Yes.

Do you know how Carré carbons are made?—No, I do not know from absolute knowledge; but I have my idea on the subject.

Do you know that the Carré carbon received its present shape before carbonisation?—No, I do not know; I think it probable.

Witness was next asked if he remembered the telegram from Mr. Edison in October, 1878, sent to this country, and the learned counsel having read a quotation from Mr. Swan's lecture at Newcastle on the 4th February, 1879, asked, Was it the platinum lamp which was referred to in Mr. Edison's telegram which was going to revolutionise the world?—It was the platinum lamp.

It proved a complete failure?—I do not know that.

It has been superseded by the carbon lamp?—Yes.

Dealing next with the lectures of Mr. Swan the learned counsel asked, did you in addition to exhibiting a lamp at either of these lectures also exhibit some unmounted carbons?—I have not the slightest recollection of that.

Did you not exhibit some horseshoe-shaped cardboard or paper carbons?—I am able to say I did not.

Did you use horseshoe-shaped carbons during the year 1879 in incandescent lamps?—Probably towards the end of 1879 I did make some hairpin-shaped carbons.

Are you prepared to say you did not during the period from the beginning of July to the end of October, 1879, or some part of that period, make lamps with that hairpin-shaped carbon conductor?—I am not prepared to say I did not.

Did you during the period which I have named, and referred to by Mr. Heaviside, send lamps with that hairpin-shaped carbon in them to Mr. Heaviside to be tested?—I do not know.

Do you not think it probable that the lamps to which Mr. Heaviside refers with the horseshoe carbon had that hairpin Carré carbon in them?—I think it is just as probable he is mistaken altogether as to seeing the lamps at all. He is absolutely wrong as to seeing any lamps in the horseshoe-shaped carbons made with carbonised cardboard.

I am taking you away from that, if you will be kind enough to follow. Mr. Heaviside's impression is that they were carbonised cardboard, because you told him so?—I have no confidence in his recollection.

That is for his lordship to judge. You have already told me you are not prepared to say you did not make lamps with that hairpin-shaped cardboard in them during the period I have mentioned?—Yes.

Are you prepared to say you did not send lamps of that character with hairpin-shaped cardboard in them to Mr. Heaviside to be tested during that period?—I am not prepared to say that; I think it is extremely doubtful.

Take that hairpin-shaped carbon model in your hand, and I ask you, do you not think that a very fair filament?—I am not an authority on filaments.

Mr. Swan, is there any gentleman in the world who has delivered so many lectures about filaments as you have done? Tell me fairly, is not that a very fair filament? You know perfectly well that the word filament has come to have a technical and special meaning, and it is now used as simply equivalent to a conductor, without reference to science.—If you ask me if this is a good specimen of a filament in that sense, I say I cannot answer the question in that form.

What should you say was the diameter?—It is the twenty-fifth part of an inch.

Surely it is more than that?—No, it is not. I have had it very accurately measured.

In 1879 was not that a very fair filament?—The word filament was not used at that time. There was no fair or unfair filament at that time.

I think you were troubled with smoke in your lamp?—Yes; one of the difficulties we had to contend with was blackening of the bulbs.

You ordered these carbons from Carré?—I ordered them from Carré, through Breguet.

Did they turn out successful?—No, I cannot call to mind a single successful lamp made with these carbons.

Was that on account of the occluded gases?—No, chiefly on account of bad contact with the platinum wires.

Can you give me the date when you ordered the hairpin-shaped carbons from Breguet?—Approximately, I think it was in the spring of 1879.

And could you give me the date approximately when you received them?—I am sorry to say I cannot.

I suggest it might be a month or six weeks afterwards?—It might be.

And I suppose you did not order them before you wanted them?—No.

And did you not when you got them make use of them?—That is extremely doubtful, because I was engaged in other business that was very pressing, and Mr. Stearn was very often kept waiting a considerable time before I sent him the material to carry on the experiments. And it is by no means certain I immediately sent him the hairpins after I received them. The contrary is highly probable.

The smoke in the lamp engaged the attention of yourself and Mr. Proctor?—The only assistance I received from Mr. Proctor in reference to the blackening of the globes was his investigation on the nature of the deposit on the broken lamp shown at the Chemical Society.

On the 2nd January, 1880, you took out a patent for the purpose of getting rid of that difficulty by a process now known as running on the pumps?—Yes.

Did you claim that as a process of running on the pumps for the purpose of getting rid of the occluded gases?—Yes.

On the 18th January, 1880, do you remember writing a letter to a publication called *Nature*?—I remember writing such a letter.

Having quoted the letter, Sir HORACE DAVEY asked, Is it not a fact that during the six months before writing that letter you had been experimenting with cardboard?—No, the improvement I referred to in that letter which led me to believe I had removed the difficulty that stood in the way of producing an incandescent lamp was the running on the pumps, which I took a patent for directly afterwards.

Did you not intend by that letter to convey to the public that you had succeeded by means of your improvements in producing an incandescent lamp with a horseshoe cardboard conductor?—The letter is absolutely correct in every particular. I do not know that I can explain it better than any one else.

Then, after having conquered the difficulty, by running on the pumps, of getting rid of the occluded gases, you were in a position to say, "I have now completely conquered the difficulty which led to previous failure, and am now able to produce a perfectly durable incandescent lamp by means of carbon"?—That was my belief at the time.

And was not your belief well founded?—I did look upon the want of running on the pumps as the greatest barrier in the way of success of making a thoroughly efficient incandescent lamp, but I afterwards found there were several difficulties before that one to be conquered.

You now say that the letter was not perfectly accurate, or that it was too sanguine?—I still adhere to the statement, which is perfectly accurate. The other difficulties I refer to are the difficulties of getting a good contact, and also as to the material to be used for the carbon.

On the 20th January you took out a second patent?—Yes; No. 250 of 1880.

This is a patent for improvements in electric lamps. You did not mean to suggest at this date that there was any novelty in an incandescent lamp consisting of a glass bulb exhausted, of a vacuum, and with a carbon

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conductor between leading wires which were sealed into the globe?—No, I did not intend to suggest that there was any novelty in that combination.

Nor did you intend to suggest that any particular size of carbon would suggest a novelty?—I made no suggestion bearing in any way upon this point.

Was it not in 1879 exactly on the working of these details that the success of the incandescent lamp depended? I am now addressing you as the most experienced electrician in the world.—I have no objection to say that the success of the incandescent electric lamp will depend very much upon the working out its details.

And was not that, in November, 1879, all that remained to be done to make the incandescent electric lamp a success?—No, I think not.

What else was there?—Nothing but the careful working out of details

After luncheon witness was cross-examined by Sir HORACE DAVEY as to his patent of the 27th Nov., 1880, referring to parchmentised thread. After taking out the patents he delivered some lectures on incandescent lighting. He delivered one in October, 1880, in Newcastle. The learned counsel having quoted from the lecture the passage: "There were two great difficulties, one was the rapid wearing away and consequent breaking of incandescent carbon, and the other the obscuration of the lamp by black smoke," witness said these were the difficulties to be surmounted as far as he understood that subject at that time.

Having quoted further from the lecture, Sir HORACE DAVEY asked: Were you not representing to the people that the lamp which you produced at this lecture was the same lamp as the one of two years ago, with the improvements you mentioned of vacuum, contact, and material?—I say what I intended to convey was that it had the elements of simplicity; that it had glass, platinum wires, and a carbon conductor, and so far as the elementary character of the combination went that it was identical with Edison's; but that is as far as I go. I simply limit my expression of opinion as to the identity of the two things, and the simplicity of the combination of the conductor, the glass, and the platinum wires.

Sir HORACE DAVEY next quoted extracts from a Paper read by witness before the British Association at York, and reported in *The Electrician* on the 17th of September, 1881. Witness said he was perfectly certain he did not show any lamp containing carbonised paper carbon either to Sir Wm. Armstrong or Sir Wm. Thomson.

Was it not in the early part of 1879 that Mr. Stearn made you that bulb which you have described?—It is perfectly true.

But you do not think you showed it either to Sir William Thomson or anybody else?—I am quite sure I did not.

I ask you whether the lamp produced by Mr. Edison referred to is not the lamp made by him after his patent of November, 1879, and subsequent patents?—I should think it is.

I ask you whether it is not a fact that the lamp produced by Mr. Stearn was identical with that in all essential particulars?—I was referring to the combination of the carbon, platinum, and glass, and, in so far as the combination of these three elements is concerned, I look upon it as identical.

At that time you considered Edison's lamp identical with yours in all essential particulars?—Only in so far as it was of simple construction of glass, platinum and carbon.

I do not know what the practice of the Editor of *The Electrician* is, but was this Paper sent to you for correction before being published?—No; I do not think I saw it.

Perhaps you sent your MSS. to the Editor of *The Electrician*?—I do not know.

I refer you next to a lecture delivered at the Royal Institution, Albemarle-street, on the 10th of March, 1882, Sir Frederick Bramwell in the chair. You then produced your carbon filament from carbonised cotton thread, and pointed out the great beauty of it?—Yes.

You formed a company, called the Swan Electric Company (Limited), for making incandescent lamps and working the patent which you had taken out?—Yes.

And a company was formed for working the Edison patent called the Edison Electric Light Company (Limited)?—Yes.

In the year 1882 an action was brought by the Edison against the Swan Company?—Yes.

Will you accept it from me that that action was complaining of an infringement of the Edison patent in the year 1879 by the Swan Company?—I do not know.

Witness was then examined as to his affidavit in the case sworn on the 27th July, 1882, and filed on the 28th of the same month.

Shown the lamps, and asked, would either of these represent the Swan lamp at that date which was charged with the infringement?—I think these are long anterior to that date.

Are they substantially the same?—No; the lamp being made at that time was a good deal different from either of these.

The re-examination of the witness by the ATTORNEY-GENERAL had not concluded when the Court rose at 4 o'clock, to resume consideration of the case on Wednesday, the 30th inst., at 10:30.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended May 18th, 1888, are estimated at £5,326.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month to May 15th, 1888, are £2,802, as compared with £2,299 in 1887.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended May 18th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £4,405.

BOOKS, &c., RECEIVED.

"Principles of Dynamo-Electric Machines, with Practical Directions for Designing and Constructing Dynamos." By CARL HERING. (W. J. Johnston, Potter-buildings, New York.)

"Abstracts of Papers in Foreign Transactions and Periodicals. Excerpt Minutes of Proceedings of the Institution of Civil Engineers." Vol. XCII. (London: 25, Great George-street, S.W.)

"Bulletin de la Société Belge d'Electriciens." Tome V., No. 3. (Brussels: Imprimerie des Travaux Publics.)

"The *Journal* of the Franklin Institute." No. 749, Vol. CXXV. (Philadelphia: Franklin Institute.)

"Price Lists of the 'Manchester' and 'Edison-Hopkinson' Dynamos." (Messrs. Mather and Platt, Manchester. Second edition.)

"Illustrated Catalogue of Paterson and Cooper's Electrical Measuring Instruments."

MEETINGS OF SCIENTIFIC SOCIETIES.

(TO-NIGHT) FRIDAY, May 25th.

CITY AND GUILDS OF LONDON INSTITUTE (Technical College, Finsbury).

7 p.m. Students' Annual *Conversazione*. Lecture on "Polarisation of Light." By Prof. S. P. THOMPSON. And on "Magnifying Springs." By Prof. J. PERRY. Concert and Exhibition of Drawings, Apparatus, &c.

ROYAL INSTITUTION.

9 p.m. On "Personal Identification and Description." By Mr. FRANCIS GALTON, M.A., F.R.S.

THE DYNAMICABLES.

7:30 p.m. Dinner at the Holborn Restaurant.

SATURDAY, May 26th.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Later Works of Richard Wagner" (7). By Mr. C. ARMBRUSTER.

PHYSICAL SOCIETY (Normal School of Science, Exhibition-road, South Kensington).

3 p.m. Note on "The Governing of Electromotors." By Prof. W. E. AYRTON, F.R.S., and Prof. J. PERRY, F.R.S. On "The Formulæ of Bernouiltz and Haecker for the Lifting Power of Magnets." By Prof. S. P. THOMPSON, D.Sc. And "Experiments on Electrolysis. Part II. Irreciprocal Conduction." By Mr. W. W. HALDANE GEE and Mr. H. HOLDEN.

PHYSICAL SOCIETY OF GLASGOW UNIVERSITY.

Paper on "Recent Advances in Physical Chemistry." By Mr. G. G. HENDERSON, M.A., &c.

MONDAY, May 28th.

ROYAL INSTITUTION.

9 p.m. The Royal Society Croonian Lecture, "Uber die Entstehung der Vitalen Bewegung—On the Origin of Vital Movement." (In German.) By Prof. W. KUHNE.

TUESDAY, May 29th.

ROYAL INSTITUTION.

3 p.m. Lecture, "Conventions and Conventionality in Art" (2). By Mr. SIDNEY COLVIN, M.A.

ROYAL VICTORIA HALL (Waterloo Bridge-road, S.E.).

8 p.m. Lecture, "The Backbone of England." By Mr. J. E. MARKS.

ENGINEERING SOCIETY (King's College).

4:15 p.m. Paper on "Hydraulic Machinery." By Mr. C. SMITH.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Annual General Meeting of Corporate Members. Election of Council and Officers.

SOCIETY OF ARTS.

8 p.m. Applied Art Section.

WEDNESDAY, May 30th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting.

THURSDAY, May 31st.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

ROYAL INSTITUTION.

3 p.m. Lecture on "The Growth and Sculpture of the Alps" (2). By Prof. T. G. BONNEY, D.Sc., LL.D., &c.

SOCIETY OF TELEGRAPH-ENGINEERS.

8 p.m. Extraordinary General Meeting. "On the Influence Machine from 1788 to 1888." By Prof. S. P. THOMPSON, B.A., Member.

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The Electrician.

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Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

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THE PROPRIETORS *of* "THE ELECTRICIAN" *beg to inform Electricians and Electric Light Engineers that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

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THE PORTRAIT OF SIR JOHN PENDER.

To meet the desire of those who wish to frame the Steel Plate Portrait of SIR JOHN PENDER, given with our issue of the 27th April, a limited number of impressions have been taken on large paper, and can be obtained in a neat black and gold or carved brown frame, price Four Shillings each.

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VOLUME XX. OF "THE ELECTRICIAN"

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ELECTRIC FIRE-ALARMS.

The pressure of more immediately urgent, if not intrinsically more important, subjects for discussion has prevented us giving until now the attention it deserved to Mr. VON TREUENFELD'S Paper on Fire-Telegraphy, read at the Society of Telegraph-Engineers and Electricians before the Easter holidays. From the personalites and recriminations aroused by the issuing of the Society's "Rules" for the prevention of fires due to electricity, commented on in these pages last week, it is pleasant to turn back to Mr. VON TREUENFELD'S record of the services electricity has been rendering in reducing the destructive effects of fires, from whatever causes they may arise. The introduction of every new illuminant is always an additional element of danger, against which it is necessary to devise new precautions; but as regards the employment of electricity for lighting purposes it is satisfactory to know that not only is it safer than any illuminant it may supersede, but that the current which supplies it affords the most efficient safeguard against any serious consequences arising from its use. We have not, however, had to wait the development of electric lighting for this assurance. Electric fire-alarms in one form or another have been in practical use for upwards of thirty years, their introduction into the city of Berlin dating even as far back as 1849; and they have gradually, though slowly, extended their operations into almost every considerable town of the civilised world. Mr. VON TREUENFELD, who eleven years ago gave us the history of this valuable application of electricity down to that date, has now furnished complete statistics of its operations to the end of 1886. As a mere account of the rise and progress of an important electrical industry his Paper is extremely interesting; but as a contribution to the

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fire statistics of the world its economical importance can hardly be overestimated.

The chief value of these statistics lies in the fact that they have been compiled by an independent authority whose sole aim was to get at the actual figures, and to deduce whatever useful lessons might be learnt from the comparison of serious fires with the means available for preventing their occurrence. That Mr. VON TREUENFELD is an enthusiast for fire-telegraphy is obvious enough; but that he is not blinded to its shortcomings is equally evident from the candour with which he confesses its failure to lessen the death rate attending conflagrations—a subject on which we shall have something to say further on. From causes which are intelligible only to the insurance world its statistics of fires continue to be wholly untrustworthy; and in respect to the relation between fire telegraphs and the speedier extinction of fires the insurance offices afford us no information whatever, their attitude being one that on a less serious subject might be called cynical indifference. They are not at all anxious to prevent small fires, and they desire to avoid contributing anything for the prevention of large ones. It is their business to indemnify; it is not at all their business to lessen the risk. People would not insure their property if it were secured against fire; and as insurance offices subsist on insurance they are not in the least anxious to diminish the motive for that prudential transaction. As their representatives did not scruple to publicly avow these considerations in the discussion following Mr. VON TREUENFELD'S Paper, we are justified in reproducing them here, if only for the purpose of showing how little we can rely upon their figures, and how much we are indebted to the indefatigable industry of Mr. VON TREUENFELD. At the same time, it is only fair to add that some of the Fire Insurance Offices take higher views of their duty towards the public in this matter.

Now, the one broad fact which comes out after a careful study of the author's figures, making every allowance for the criticism to which the meeting subjected them, is that the number of serious fires has diminished in proportion as the electrical means of signalling them has been increased. The term "serious" in this relation is variously defined in different countries and even in different towns. Every fire is serious if it is not put out, but to insurance offices no fire is serious if it does not seriously tax their resources. A safer guide is to be found in comparing the amount of property destroyed at different periods; and perhaps the most trustworthy, certainly the most valuable, part of Mr. VON TREUENFELD'S statistics is that which shows how the aggregate destruction of property has been reduced in recent years, notwithstanding the large increase in the number of fires which break out. Taking New York as an illustration, the number of fires from 1872 to 1876 was 7,274, destroying 14,668,513 dollars' worth of property. Ten years later the fires had increased to 11,470, but the destruction had only amounted to $18,292,695. That is to say, the average loss by each fire had decreased from $2,017 to $1,595. In Brooklyn the results are still more striking. There, although the number of fires has doubled since 1876, the loss of property amounts now to only about half what it did then; and this result is attributable mainly, if not solely, to the increase of public fire-alarm points, which in 1886 numbered 321, whereas in 1876 they numbered only 22.

When it is considered that the most wasteful of all forms of destruction is the destruction of property by fire, the saving thus effected by the instrumentality of electric signalling is something to be proud of, and something which the public are not likely to ignore, whatever may be the sentiments of the insurance offices. One of their representatives calmly told the meeting that what they did not mind was plenty of fires in the suburbs to keep up the demand for insurance policies; but that they were quite alive to the importance of diminishing the ravages of fire in the City, where damage to property was often very serious indeed. Probably this speaker did not at the time reflect on the fact, which nevertheless is indisputable, that the fatalities attending fires are connected chiefly with suburban or residential fires, not with the business premises of the City. The painful confession had to be made by Mr. VON TREUENFELD that with the increase in the number of fires, notwithstanding the abatement in their destructiveness, loss of life has gone on proportionately increasing. And this circumstance calls for the remark that while the efforts to protect property have been rapidly augmented, those for the preservation of life in the residential suburbs have been comparatively neglected. Perhaps the most valuable result of Mr. VON TREUENFELD'S Paper was the speech made upon it by Captain SHAW, the chief of the London Fire Brigade. Every electrician interested in the construction of fire-alarms, either of the automatic or call-station type, ought to give the carefullest attention to Captain SHAW'S remarks, which are fully reported in the current number of the Society's *Journal*. The much-boasted automatic systems of America he showed to be utter delusions, and their adoption in England to be almost worse than useless. The automatic kind are largely used in America; but that, Captain SHAW assures us, is not because of their reliability, but because they are sold by the same people who are the insurance agents, and who work the two businesses together very profitably to themselves, though with small advantage to the public. The street fire-call points answer admirably, but are subject to the serious inconvenience of encouraging false alarms. Of 1,195 calls from these points in London last year 375 were false, and 170 of them were traced to malice or mischief. In the United States the proportion of false to genuine alarms appears to be still greater. Here, then, is an excellent opening for electrical ingenuity; and the plain way in which it has now been stated ought to render the problem not very difficult of solution. It might be easy to invent an automatic handcuff for the frivolous persons who ring fire-alarm bells without any provocation. It would be far more meritorious, though seemingly more difficult, to devise an automatic fire-alarm which will awake the inmates of a house when a fire really does break out, and so save their lives, whatever becomes of their property. In this way the electricians might do what no insurance office can, or, apparently, cares to do.

A NEW ALTERNATE-CURRENT DYNAMO.

The machine which is illustrated by the first of the accompanying figures is being brought out by the Anglo-American Brush Electric Light Corporation, principally for use in connection with distribution on the transformer system. It is one of a new type, the invention of Mr. W. M. Mordey, of the Brush Corporation, and gives an output of 35,000 to 40,000 watts, the terminal potential difference being 2,000 volts. The speed is 650 revolutions per minute. Fig. 2 shows the armature, which is stationary, and consists of a number of coils of narrow copper ribbon, wound on cores of non-conducting material. Each coil is bolted at the broad end between two brackets, the ends of the conductor being brought out through porcelain insulators.

The brackets are then bolted to a gunmetal supporting ring, the coils being thus rigidly and securely held in position by metal supports, which in no part come between the poles, and are, in fact, practically out of the magnetic-field. By this means

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eddy currents are almost entirely avoided, any loss from this cause being still further reduced by the use of German silver for the brackets and bolts, the high-resistance of this alloy preventing the generation of local currents of more than a very small amount. The gunmetal supporting ring, which is bolted to the bed-plate of the machine, is in two portions, being divided in a vertical diametrical line. These two parts, after having received the coils, are bolted together and to the bedplate, the field-magnet being first placed in position. This design provides ample facilities for repairs. It allows not only of single coils of the armature being quickly removed and replaced, but also renders it easy to take out one-half or the whole of the armature. It is of the first importance in all electric lighting work, especially for central stations, that the machinery should be planned not only with a view to the prevention of a breakdown, but also to permit of any necessary repairs being quickly carried out. It will be seen that in this armature both these ends have been very satisfactorily attained.

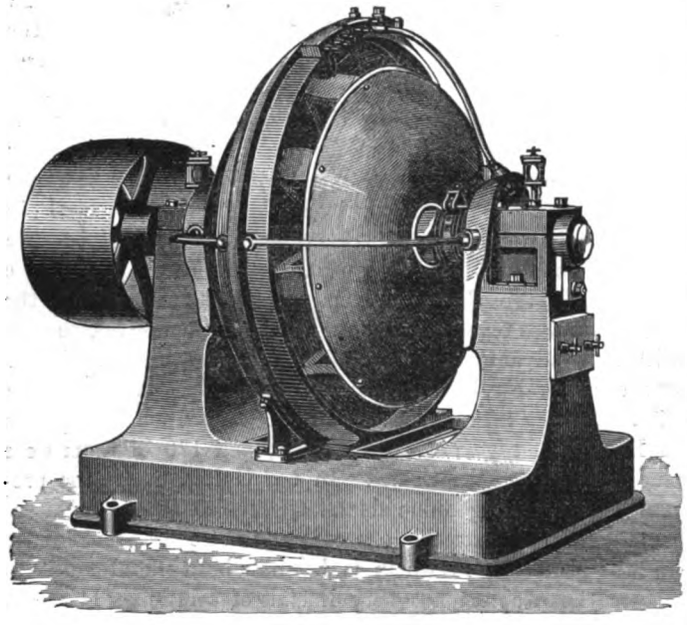

FIG. 1.—Mordey Alternator.

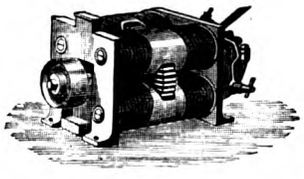

FIG. 1A.—Victoria Exciter.

The field-magnet (Fig. 3) cannot be said to bear any resemblance to any form of field with which electric engineers are familiar. It consists of a single electro-magnet, built up as follows:—A short cylinder of iron, through the axis of which the shaft passes, forms the core of the magnet, and round this core is wound the exciting coil. Against each end of this cylinder is placed a cast-iron piece, of a form which will be best understood from Fig. 3. Each casting has a number of horns or arms—nine in the machine illustrated—which radiate from the shaft and central part of the casting, and then bend over, forming nine pole-pieces on each side of the armature. These horns on one side, as will be seen, approach within a very short distance of those on the other side of the armature, and in this very narrow polar gap or slit the armature is held, the entire field-magnet revolving with the shaft on which it is mounted. The ends of the exciting coil are connected to "collector" rings on the shaft, which are shown to the right of the figure. These may be dispensed with, and the exciting coil as well as the armature may be stationary; but it is preferable, for mechanical reasons, to attach the winding to the rotating magnet.

It will be observed that this form of field-magnet is very simple. A single exciting coil suffices for a machine of any size, speed, or number of alternations. Besides its peculiarity of form it differs from the usual arrangements in that it has poles of one sign only on each side of the armature; thus the magnetic leakage between adjacent poles on each side is absolutely *nil*, a condition widely different from that of machines having the usual arrangement of alternate polarities, in which the leakage is very considerable.

By revolving the field-magnet, instead of the more delicate armature, safety and steadiness of running are secured, the heavy magnet acting as an excellent fly-wheel, and effectually neutralising any pulsation due to irregularity in the stroke of the engine. This is a point of some importance where slow-speed engines are used. Further, as the parts revolving at the highest velocity are simple solid iron masses of the strongest description, not subject to heating and having no copper wire to expand and fly out, the electrical and mechanical considerations which in ordinary dynamos usually render slow

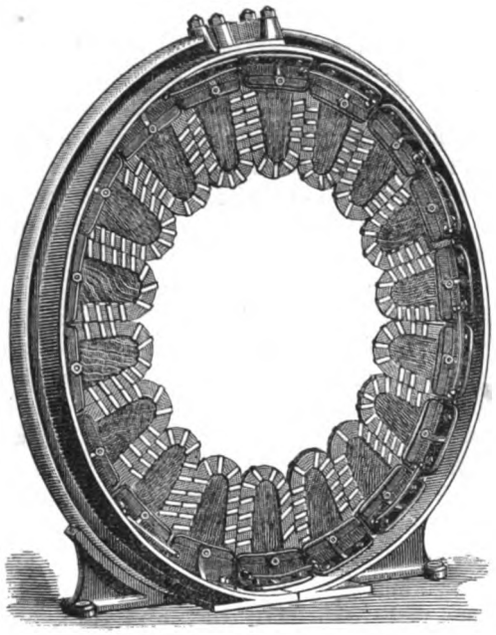

FIG. 2.—Armature of Alternator.

speed advisable do not here apply. The armature being stationary, the coils have to be supported only with a view to resisting the drag of the field. This renders insulation a matter of comparative simplicity, and is of great importance in high-tension work.

The Mordey Alternator is shown in its complete form in Fig. 1. The field-magnet is almost entirely hidden by sheet-metal covers, which have for their object the prevention of air-disturbance by the horns. The armature terminals, which are not seen in the figure, are at the upper part of the supporting ring. The thrust bearing is adjustable longitudinally for the purpose of enabling the field to be placed exactly symmetrical with regard to the armature. The alternator is very nearly self-regulating in itself, as is shown by Fig. 4, which is the characteristic of the machine throughout a range of 37,000 watts. From this curve it is clear that, practically, the whole of the load—or, say, 600 lamps—might safely be turned off without danger to any remaining lamps, and that a large proportion of the load—certainly 50 per cent.—could be turned off without attracting notice on the rest of the circuit. It is, therefore, not considered

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necessary or desirable, except under special circumstances, to provide other than a simple hand-regulation at the dynamo for the purpose of controlling the potential difference. Sudden and violent fluctuations of the lights are impossible with this machine, and an occasional touch of the resistance-regulator as the load comes on or off meets all practical requirements. It is only in the case of machines whose potential curve is a rapidly falling one that it is necessary to resort to automatic control. There is no doubt that by avoiding the use of additional apparatus of this sort the chances of temporary interruption are reduced. The small Victoria dynamo, used as exciter, is shown by Fig. 1A, which is to same scale as the alternator.

By the arrangement of the armature coils it is easy to obtain various combinations if desired. This circumstance is made use of for simplifying the measurement of the potential. Instead of taking the reading across the terminals, which would necessitate the use of an electrometer, or a very high resistance voltmeter, an ordinary voltmeter, indicating to 100 or 150 volts, is placed across one of the coils, the machine being fitted with a special pair of voltmeter terminals for this purpose. The indication thus obtained, multiplied by the total number of armature coils, gives the potential difference between the armature terminals. The voltmeter may, if desired, have its dial marked to directly indicate the total potential difference.

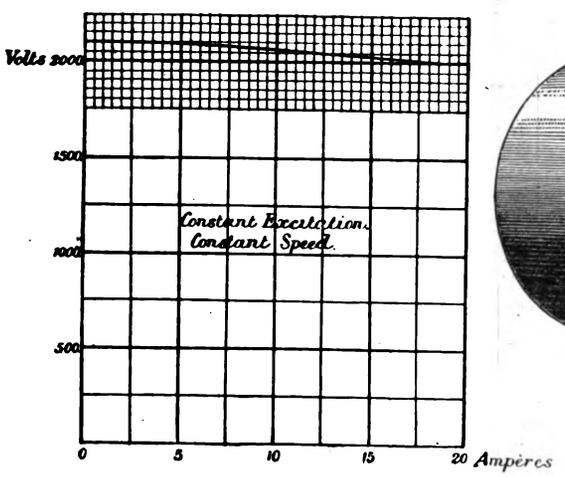

FIG. 4.—Characteristic of Mordey Alternator.

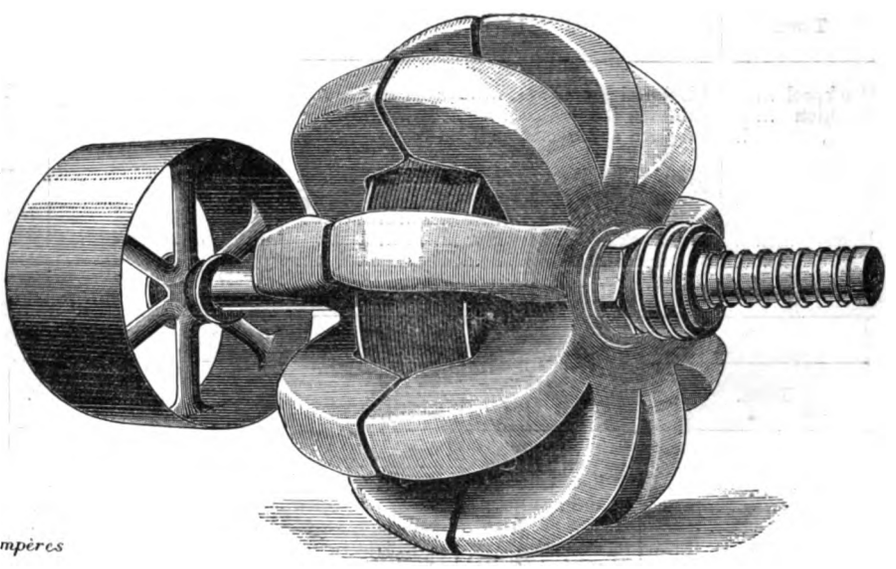

FIG. 3.—Field Magnet of Alternator.

We understand that this dynamo of 50 to 60 horse-power—the first of its type—was built directly from the first design, without recourse to any preliminary experiments.

ON THE MAGNETIC QUALITIES OF NICKEL.*

BY J. A. EWING, F.R.S., AND G. C. COWAN.

The experiments described in the Paper were made with the view of extending to nickel the same lines of inquiry as had been pursued by one of the authors in regard to iron (*Phil. Trans.*, 1885, p. 523). Cyclic processes of magnetisation were studied, in which a magnetising force of about 100 C.-G.-S. units was applied, removed, reversed, again removed, and re-applied, for the purpose of determining the form of the magnetisation curve, the magnetic susceptibility, the ratio of residual to induced magnetism, and the energy dissipated in consequence of hysteresis in the relation of magnetic induction to magnetising force. Curves are given to show the character of such cycles for nickel wire in three conditions: the original hard-drawn state, annealed, and hardened by stretching after being annealed. The effects of stress have also been examined (1) by loading and unloading magnetised nickel wire with weights which produced cyclic variations of longitudinal pull, and (2) by magnetising while the wire was subjected to a steady pull of greater or less amount. The results confirm and extend Sir William Thomson's observation that longitudinal pull diminishes magnetism in nickel. This diminution is surprisingly great; it occurs with respect to the induced magnetism under both large and small magnetic forces, and also with respect to residual magnetism. The effects of stress are much less complex than in iron, and cyclic variations of stress are attended by much less hysteresis. Curves are given to show the induced and residual magnetism produced by various magnetic forces when the metal was maintained in one or other of certain assigned states of stress; also the variations of induced and residual magnetism which were caused by loading and unloading without alteration of the magnetic field. Values of the initial magnetic susceptibility for very feeble magnetising forces are stated, and are compared with the values determined by Lord Rayleigh for iron, and the relation of the initial susceptibility to the stress present is investigated. The Paper consists mainly of diagrams, in which the results are graphically exhibited by means of curves.

*Abstract of Paper read before the Royal Society, May 17th, 1888.

JUVENILE LECTURES.

THE APPLICATION OF ELECTRICITY TO LIGHTING AND WORKING.*

BY W. H. PREECE, F.R.S.

Lecture II.

(Continued from page 43.)

The next purpose that electricity is used for to which I want to draw your attention, is that of the transmission or propulsion of coaches on railways. I have taken the trouble to find out the various railways and tramways in America, in Great Britain, and on the Continent, that are now worked by means of electric currents. A list of them is given in the Table on next page.

You will see how greatly and how rapidly this great power that electricity gives us is being utilised for useful purposes. One of the earliest lines upon which the power was used was the Portrush and Bushmills Railway, in Ireland (Fig. 10). Near Portrush there is that wonderful formation of rocks known as

* A course of two Lectures delivered before the Society of Arts on January 4th and 11th.

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ELECTRIC TRAMWAYS IN AMERICA.

THE "ELECTRICIAN" GIVES THE FOLLOWING LIST OF ELECTRICALLY-WORKED TRAM LINES NOW IN ACTUAL USE IN THE UNIEED STATES:—

Town.	Line.	Conductors.	Length of Line.	System.
Appleton, Wis.	Appleton Electric Street Railway	Overhead	4½ miles	Van Depoele, 5 motor cars.
Asbury Park, New Jersey	Lea Shore Electric Railway	,,	4 ,,	Daft.
Baltimore, Md.	Union Passenger Railway Company	,,	...	Daft.
Bellevue, Pennsylvania	...	...	½ ,,	—
Binghampton, New York	Washington Street and State Asylum Electric Railroad	Overhead	5½ ,,	Van Depoele.
Denver, Colorado	Denver Tramway Company	Conduit	4 ,,	Short-Nesmith, series.
Detroit, Michigan	Detroit Electric Railway Company	Overhead	2 ,,	Van Depoele, 4 motor cars.
,, ,,	Highland Park Railway Company	,,	3 ,,	,, ,, 2 ,, ,,
Gratiot ,,	Gratiot Electric Railway Company	,,	...	,, ,, 1 motor car.
Ithaca, New York	Ithaca Street Railway Company	,,	...	Daft.
Kansas City, Mobile	Kansas City Electric Railway Company	...	...	Henry.
Lima, Ohio	Lima Street Railway Motor and Power Company	Overhead	6½ ,,	Van Depoele, 7 motor cars.
Los Angeles, California	Los Angeles Electric Railway Company	,,	5 ,,	Daft, 4 motor cars.
Mansfield, Ohio	...	,,	...	Daft.
Montgomery, Alabama	Capital City Electric Street Railway Company	,,	11 ,,	Van Depoele, 20 motor cars.
Port Huron, Michigan	Port Huron Electric Railway Company	,,	2¾ ,,	,, ,, 3 ,, ,,
Richmond, Virginia	Richmond Union Passenger Railway	,,	...	Sprague motors.
St. Catherine's, Ontario	...	,,	6 ,,	Van Depoele.
Scranton, Pennsylvania	Scranton Suburban Railway Company	,,	2½ ,,	Van Depoele, 3 motor cars.
Wichita, Kansas	Wichita Riverside and Suburban Railway	,,	4 ,,	,, ,, 6 ,, ,,
Windsor, Can.	Windsor and Wakerville Electric Railway	,,	1½ ,,	,, ,, 1 motor car.
Woonsocket, Rhode Island	Woonsocket Street Railway Company	,,	...	—

ELECTRIC TRAMWAYS IN GREAT BRITAIN.

Town.	Line.	Conductor.	Length.	System.	Power.
Blackpool	Blackpool Tramway	Buried central rail.	2 miles.	Holroyd Smith.	Steam.
Brighton	Brighton Beach	Rails.	1 ,,	Volk.	Gas.
,,	Brighton and Shoreham Tramway	Nil.	4 ,,	Electric Traction Syndicate (Accumulators).	Steam.
Glynde	Glynde Clay Pits	Open.	1 ,,	Telpherage.	,,
London	North Metropolitan Tramways (Stratford and Manor Park)	Nil.	4 ,,	Elieson (Accumulators).	,,
Newry	Bessbrook and Newry	Raised central rail.	3¼ ,,	Hopkinson.	Water.
Portrush	Portrush and Bushmills	Raised side rail.	6 ,,	Siemens.	,,
Ryde, I.W.	Ryde Pier	Rails.	¾ ,,	Siemens.	Gas.

ELECTRIC TRAMWAYS ON THE CONTINENT.

Town.	Line.	Conductor.	Length.	System.	Power.
Amsterdam	Cortverloren Park	Overhead.	½ mile.	Siemens.	Steam.
Berlin	Lichterfelde (Berlin-Anhalt Railway)	Rails.	1·6 ,,	,,	,,
Brussels	Tramways	Nil.	..	Accumulators (Julien).	,,
Charlottenburg	Spandauer Rock	Overhead.	...	Siemens.	,,
Cologne	Tramways	Nil.	...	E.P.S. Accumulators (Hüber).	...
Frankfort-on-Maine	Frankfort to Offenbach Railway	Overhead.	4·1 miles	Siemens.	Steam.
Hamburg	Tramways	Nil.	..	E.P.S. Accumulators (Hüber).	...
Hohenzollern	Hohenzollern Colliery (Upper Silesia)	Overhead.	½ mile.	Siemens.	Steam.
Vienna	Moedling-Hinterbruel (Austrian Southern Railway	,,	2·8 ,,	,,	,,
Zankerode	Zankerode Mines, Saxony	,,	½ ,,	,,	,,

the Giant's Causeway, and in order to see this remarkable geological structure people travel a distance of some six miles.

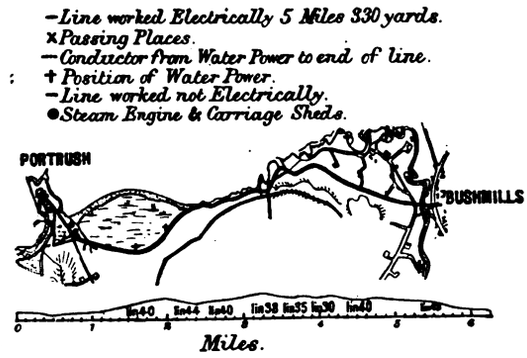

FIG. 10.

Not far from the line of route between Portrush and the Giant's Causeway is a place called Bushmills, through which a river runs, and this river has a very pretty and at the same time useful fall of water, which is utilised to work dynamos, which transmit currents of electricity through an insulated rail alongside the track of the railway to supply motive power to the cars. You now see a picture of the tramcar used (Fig. 11); that is a plan of it; the other is a perspective view; the

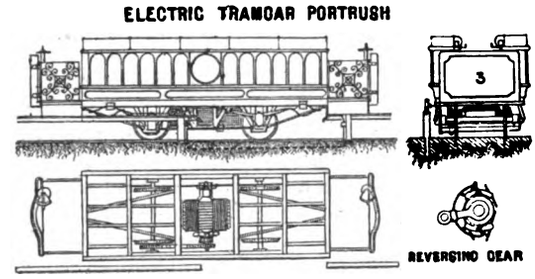

FIG. 11.

motor itself is shown in plan. You see the two electro-magnets, and the armature, or coil of wire, that rotates is in the centre. The rotation of that armature is transmitted to the wheels by

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means of the chain-gearing that is shown. This railway at Portrush has been the forerunner of a great many railways in different parts of the world, but the most complete and the most perfect railway of its kind has lately been carried out by Dr. Edward Hopkinson, Sir William Siemens's assistant in carrying out the Portrush Railway. I refer to the Bessbrook and Newry Electric Railway. Instead of showing you a drawing of this railway, Dr. Hopkinson has made and sent us a model; that model is fixed to the wall of this room by five brackets, on which the rails have been placed, and a coach. A small motor is attached to the coach. When I turn on the switch, you see, away goes the car along the railway, and on getting half-way it passes a brass pillar, catches a switch, which reverses the current, causing the car to return.

I read once a rather curious paragraph in a Belfast paper about the Portrush Railway. It was supposed that persons got shocks by stepping on one rail and touching the other. The paragraph ran as follows:—"A rather mysterious affair has happened in connection with the insulated electric rail on the Giant's Causeway and Portrush Tramway. It appears that country people are in the habit of touching the rail and receiving harmless shocks, but on Thursday evening a ploughman returning with his horses, stood on the rail to mount. [Well, he could not; there was no rail to enable him to mount; the rail is on the wrong side.] Immediately on applying his hands to the horse's back, the brute fell dead against the rail. The strange part of the affair is, that the man was uninjured, although the current passed through his body to the horse." That is a sample of reliable history.

Exhibitions have been very celebrated for electric railways; there was one at Paris, another at Munich, at Vienna, Antwerp, Philadelphia, the Inventions Exhibition at South Kensington, and at Edinburgh. The one at Paris carried a great many passengers for a distance of about a third of a mile to the Electrical Exhibition there. The peculiarity of it was that the conducting wires were overhead, and the rails were not made use of as at Newry and Bessbrook.

Another application of electrical power tried at the Paris Electrical Exhibition was carried out by M. Tissandier, who attempted to navigate a balloon by its means. The balloon worked satisfactorily inside the Exhibition building, but failed when tried in the open air, being simply carried away by the air currents, having nothing for the fans to work against. A good deal more is wanted to be known before we can possibly solve the difficulty of navigating balloons, and at present we are simply dependent upon currents of air to carry us from one place to another.

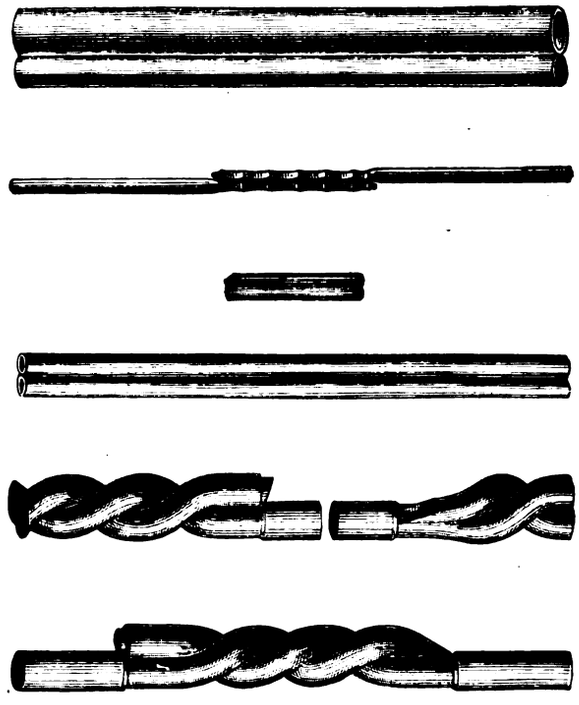
A very curious departure from the ordinary practice of conveying materials was started by Prof. Fleeming Jenkin, who is, unfortunately, now no more, and he, in conjunction with Profs. Ayrton and Perry, started a system called telpherage. Not far from Lewes, a mile or mile and a-quarter from the Glynde Railway Station, in the Downs there are certain clays which are valuable, and from the clay pits the clay is sent down to Newhaven for shipment abroad. This system of telpherage carries the clay from the pits to the station by means of electricity. Two heavy wires are fixed on cross-beams, or posts, which pass over the meadows, they do not interfere with the roads, or the grazing of cattle, they pass through bogs, marshes, rivers, and anywhere you like, and on these wire skeps—a kind of bucket—are carried on rollers, by which they pass along. Each skep carries about half a hundred weight of stuff. The arrangement is extremely ingenious, and daily and hourly trains pass by this means over the Downs to Glynde Railway Station carrying the clay. Such is the telpherage sytem.

But there is one system of carriage where electricity is destined to become more useful and more valuable than any other that I have brought before you, and that is in the working of a system of tramways in towns. There are few people who know that the number of horses required to work a tramway is 12 per car. My figures are taken from Manchester, where there is one of the best worked systems of tramways that we have in this country. There every car requires 12 horses to work it; the life of a car horse on those tramways is only four years. Working tramways in the north, wherever there are heavy gradients is really cruelty to animals. We know that a horse can only do a horse's work; there are some men who can do a good deal more than an ordinary man's work, but we rarely should expect any man to do more than five or six men's work. But these tramway horses are absolutely frequently called upon to do eight or ten times more than nature has constructed them to do, and it is no wonder that their life is so very short. This remarkable fact comes out in dealing with horses from a pure matter-of-fact point of view. If we work a tram car by electricity by means of batteries placed in the car, taking the price of horseflesh and the price of batteries per ton, the cost is exactly the same—it requires a ton and a-half of horseflesh, it requires a ton and a-half of batteries to work a car. The life, as I stated, of a car horse is four years, the life of a battery is four years. A horse will hardly do more than thirty miles a day; a battery will carry a car for sixty miles a day, and, in fact, when we remember that for the price of two horses, for the life of two horses, we can work tramcars by means of electricity, then when you think that it takes twelve horses, the mere question of £ s. d. will carry the day. There is not the slightest doubt that when the matter is properly and thoroughly worked out in a practical manner, batteries can and will work tramways, and the day is not far distant when all our tramways in and about London will be worked by means of batteries, and the poor horses relegated to duties for which they are better fitted.

(To be continued.)

MACINTYRE'S WIRE JOINTS.

The annexed illustrations represent the method of joining copper wires without the use of solder which has been introduced in America by Mr. Macintyre. It will be seen that the junction consists of a double tube of copper, the size of each tube being such as just to fit the gauge of the wire. After the two ends have been inserted the tube is forcibly rotated several times so as to force the wires into the most intimate contact. If the tube and wire be



afterwards cut across, as shown in one of the adjoining figures, the metal of the wire is often found to have flowed or welded itself into one mass with that of the tube. In the second of the above figures, which represents the joint as applied to very small wires, the sleeves are compressed by a special tool, and it is not necessary to twist them. Our illustrations, which are the exact size of the originals, are taken from some specimens brought to this country by Prof. Forbes. For joining branch wires at right angles a special T sleeve is supplied.

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THE ELECTRIC LIGHTING OF EMS.

The following is from the "Abstracts of Foreign Papers, &c.," published by the Institute of Civil Engineers:—"The plant used in this installation comprises a tubular boiler of six atmospheres, with Langen's step-grate and smoke consumer; two high-pressure engines, each of 70 h.-p. actual, and three shunt-wound dynamos, each giving 80 amperes and 230 volts at 600 revolutions per minute. The dynamos are connected in parallel, and the glow-lamps are arranged on seven different branch circuits. The loss of potential in the leading wires amounts to 15 per cent. Had the lamps been on a single circuit only, the potential at the one nearest the engine-house would have been 30 volts higher than at the most distant lamp, provided all the lights were in use at the same time. The insertion of lamps varying, according to their position in the circuit, from 230 to 200 volts, would not have answered so well as the seven-circuit system. A safety-fuze, switch, and current-indicator are inserted in the main wire from the positive pole of each dynamo, and between these wires and the external circuits is a series of automatic current-regulators. The return wires are led to a commutator, each being fitted with a safety-fuze, and then connected to a separate switch in circuit with the negative poles of the dynamos, so that any circuit can be cut out at pleasure. The current-regulator comprises a small relay, the armature of which is maintained between two contacts so long as the potential remains at the proper working limit; a series of resistances connected to terminal bars, and arranged beneath an endless screw, which is supported at each end by a bearing that serves also as a spring-contact. The screw carries a slider, the motion of which along the surface of the bars increases or diminishes the resistance of the circuit. On one end of the screw are two pulleys, between which is a disc of iron forming the armature of two separate electro-magnets, so arranged that the lower half of the disc is between one pole of each magnet. The branch circuit in which each regulator is placed is so disposed that an undue rise or fall of potential moves the armature of the relay against one or other of the two contacts, and thereby brings into action one of the electro-magnets; the disc is attracted either to the right or left, and one of the two pulleys, which are kept in motion in contrary directions by means of bands from the shaft, gears with the disc, and causes it to rotate as well as the endless screw. The number of glow lamps is 883, which are divided amongst forty renters; seven arc lamps, each of 500 candle-power, are likewise worked from the same machines."

ELECTRO-DYNAMIC ROTATION BY MEANS OF ALTERNATING CURRENTS.*

Prof. Galileo Ferraris, of Turin, who, as will be remembered, was one of the first to make a strictly scientific investigation of transformers, and who has since then continued to devote attention to alternating currents, has just published the results of some experiments made with a view to produce continuous rotation by their means. The experiments are interesting, because the apparatus used was based upon an entirely new principle, which may be capable of further development. The question how to produce continuous rotation by means of alternating currents is just now occupying the minds of many electricians, because the production of an alternating-current motor would greatly increase the earning capacity of central electric light stations supplying alternating currents. Whether the apparatus devised by Prof. Ferraris, and which we are about to describe, will lead to the discovery of an alternating-current motor, is a question on which we do not pretend to prophesy; but as the principle involved may also have other applications, notably in the construction of meters for measuring the supply of electricity, we think it of sufficient importance to lay a short abstract of the investigation before our readers. The principle on which the apparatus is based is exceedingly simple, and will be understood by reference to the accompanying sketches. Let in Fig. 1 the lines O A and O B represent in direction and magnitude the strength of two magnetic-fields. The combined action of these fields on a unit pole, placed in the point O, would then be represented by the resultant O R. Instead of having two distinct fields, we have one resultant field, represented in direction and magnitude by this line. If both fields undergo periodic variations of the same period, the resultant field O R will also undergo a periodic variation, and the point R will traverse a curve, the form of which depends upon the precise manner in which the lines O A and O B change with the time.

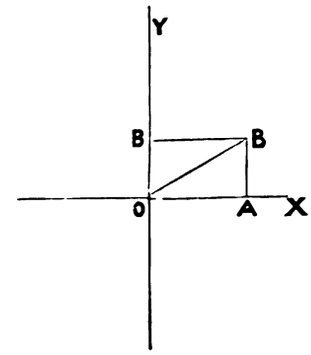

FIG. 1.

The fields O A and O B can be produced by two coils, having the lines O X and O Y respectively for their axes, and which coils are traversed by alternating currents of the same period. If the alternating currents may be expressed as sine functions of the time, and if there is an appreciable lag between the currents in the two coils, the point R describes an ellipse round O as centre. In this case the line O R representing the resultant field revolves round the centre O, the direction and magnitude of the resultant field changing at every instant. If, however, there is no lag between the two currents—that is to say, if they pass through zero simultaneously—the direction of the resultant field O R remains stationary, and the point R performs harmonic oscillation over the line R O and its prolongation with O as centre. This may

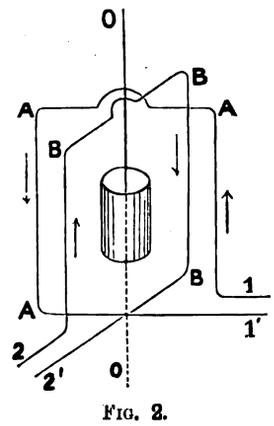

FIG. 2.

be considered as a special case of the ellipse where the latter has been flattened down to a mathematical line. Another special case occurs when the ellipse becomes a circle, and this must evidently take place when the lag between the two currents is 90°, when the coils are at right angles to each other, and when the component fields are equally strong. A metallic body suspended in the centre of the two fields, and free to revolve, must evidently have a tendency to participate in the rotation of the resultant field.

The application of this very simple principle will be clear from Fig. 2, in which the two coils are indicated by the rectangles A and B, the connections being made by the wires $1\,1^1$ and $2\,2^1$ respectively. When alternating currents are

* Abstracted from a pamphlet recently issued by Signor Ferraris. We have also availed ourselves of an excellent abstract which appeared in *Industries* of May 18th.

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sent through these coils a resultant field is produced, which revolves round the line O O. In the centre between the coils is suspended a small hollow cylinder of copper, and as the lines of the resultant field cut the metal Foucault currents are induced, and by the interaction of these induced currents and the revolving field the cylinder is set in rotation. The action is exactly the reverse of that occurring in the well-known experiment in which a copper disc is rapidly revolved below a compass needle, with the result that the compass needle is deflected on account of the induced currents in the copper disc, and ultimately caused to rotate with the copper disc.

Up to the present we have spoken of two distinct currents being required in the coils A and B, one lagging behind the other by a quarter period; and to perform the experiment we might employ an alternating-current dynamo with two circuits in the armature, so arranged with regard to each other as to produce the desired lag. It is, however, possible to perform the experiment by using an ordinary alternating-current machine with only one circuit on the armature, and to produce the second current by means of a transformer. The current from the machine is sent through the primary of the transformer and then through the coil A, whilst the secondary current obtained from the transformer is sent through the coil B. It is then possible, by the interposition of a suitable inert resistance into the secondary circuit, to obtain very nearly the desired lag of 90° between the currents in the two coils. As the strength of the secondary current will, by the insertion of the resistance, be considerably reduced, it is necessary in order to obtain approximately equal fields from the two coils to employ a larger number of turns in the coil B than in A. Another method of producing the desired result consists in using a transformer with one primary and two secondary coils, and to insert into the circuit of one of the secondary coils a large self-induction, and into that of the other a large inert resistance, by which means the desired lag between the two secondary currents can also be obtained. It will be seen that in either of these ways it is possible, by means of a simple alternating current and a transformer, the coils of which are abreast, to obtain a revolving magnetic-field of approximately uniform intensity, by which phenomena can be produced in every respect similar to those obtainable from a revolving permanent steel magnet.

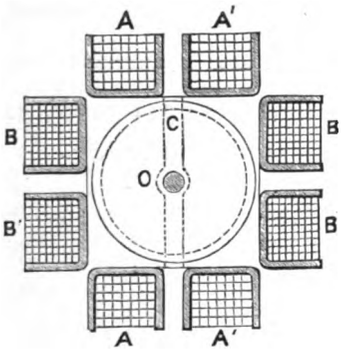

FIG. 3.

In the first experiment made by Prof. Ferraris, a Gaulard and Gibbs transformer, with an equal number of turns in the primary and secondary coils, was used. In the primary circuit was included the coil A, consisting of a few turns of stout wire, whilst in the secondary circuit were included an adjustable and non-inductive resistance and the coil B, the latter consisting of many turns of fine wire. A small hollow copper cylinder was suspended on a thread in the centre of the two coils, as shown in Fig 2. If the current was sent through only one of the coils, the cylinder remained at rest; but if currents were sent through both coils, the cylinder immediately started to revolve, twisting the thread on which it was suspended. A reversing switch was inserted in the secondary circuit, and if the current through this circuit was inverted, the cylinder was immediately brought to rest, and started in the opposite direction. Prof. Ferraris next substituted a small iron cylinder for the copper one, and found equal results; but when using an iron cylinder sufficiently large to nearly fill the place within the coils, the experiment did not succeed so well. He attributes this to the greater self-induction which the presence of iron in a large mass necessarily introduces into both circuits. Another experiment was made with a small iron cylinder, composed of a number of thin discs insulated from each other, and this experiment also succeeded. Foucault currents could not in this case be the cause of rotation, and Prof. Ferraris thinks that the rotation is due to hysteresis. A larger apparatus was then constructed, which is indicated in our sketch (Fig. 3). In this case the copper cylinder, which was mounted upon a horizontal axis in bearings, had a diameter of 3½in., and was 7in. long, its weight being 11lb. This cylinder was closely surrounded by the primary and secondary coils wound upon wooden bobbins. To make room for the shaft each coil was in halves, the primary consisting of ninety-six turns of seventy-seven mils. wire, both coupled in series, so as to produce the effect of a coil of 192 turns; the secondary consisting of 504 turns of thirty-eight mils. wire, both being coupled in parallel, so as to produce the effect of 504 turns. The resistance of the primary coils was 7·12 and 6·63 ohms respectively, and that of the two secondary coils coupled in parallel was 3·43 ohms. In the secondary circuit was also inserted a rheostat without self-induction, and the best results were obtained when the rheostat was set to between 15 and 18 ohms. A Gaulard and Gibbs transformer was used, giving eighty reversals per second. The copper cylinder began to revolve when the primary current was 5 amperes, and with higher currents the velocity could be increased to 900 revolutions per minute, and might have been still further increased but for the somewhat imperfect mechanical arrangements, which occasioned considerable vibrations. To the shaft was applied a small friction dynamometer, and the following table gives the work obtained on the brake by a primary current of nine amperes at different speeds:—

Revolutions per minute.....	262	410	516	653	722	770	900
Watts obtained on brake ...	1·32	2·12	2·65	2·77	2·55	2·40	0

The maximum energy was obtained at 650 revolutions. Beyond that speed the energy decreased, which is attributed by Prof. Ferraris to the imperfect mechanical arrangement of the apparatus, causing a considerable waste of power in vibrations. If it were not for this, the maximum energy would have been obtained at about 1,200 revolutions, whilst at 2,400 revolutions, which is the speed of the revolving resultant field, no energy at all could be obtained. Prof. Ferraris suggests that this apparatus may be used for lecture purposes, and as a motor when the power required is small, and it may also be used as an electricity meter. The torque exerted by the revolving field upon the copper cylinder is proportional to the square of the current, and in order that the total number of revolutions performed in a given time may be an indication of the number of coulombs supplied, it is necessary to introduce some opposing force which varies with the square of the velocity. If this can be done, and if the friction of the journals can be sufficiently reduced, an ordinary counter attached to the axis would indicate the quantity of electricity supplied.

ELECTRICAL COMMUNICATION ON OUR COASTS.

Mr. Robt. Bayley, of Plymouth, writes on this subject to *The Times*, as follows:—

"The Earl of Onslow has introduced a Bill into the House of Lords to give Lloyd's power to purchase land for signal stations, and thus to improve the electrical communication on our coasts. It is much to be desired that such powers may not be granted without a full inquiry by a committee into the whole question of electrical communication around our coasts, which has never been hitherto made. Last year a Board of Trade committee sat, but their inquiries were strictly confined to electrical communication with lightships and with rock lighthouses. Beginning at the most difficult and costly end of the question, and without inquiry as to the necessary for electrical communication with coastguard stations, lifeboat stations, shore lighthouses, and the salient points on our coasts, they recommend an adjournment for eighteen months,

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during further experiments, which are being conducted at the Sunk Lightship only.

"We are becoming alive to the fact that our defences are not what they should be, and that our navy should be strengthened, yet this Bill, if it is allowed to pass, will leave the question of a national system of electrical communication around our coasts untouched.

"Except at a few points it is impossible to signal on our coasts at all, these points being chiefly in the hands of Lloyd's.

"Although our coasts are patrolled by coastguards, all men of the Royal Navy, Her Majesty's Navy has no means of conveying or receiving any intelligence from them—in the event of war, a matter of the first importance as regards our coast defence, which would have to be provided in haste.

"We have only to go to Denmark to find that electrical communication of the best kind has been provided by the Government on the west coast of Jutland, and, in the Kattegat, telephone lines are laid to the lifeboat and rocket stations, which connect them with the inland telegraph stations. The telephone stations are served by the man or woman who may be on the station, and they are allowed to charge about 3½d. for each message or telegram sent off. For those received no charge is made.

"The lines are laid chiefly in the interests of the fishermen, and, as they serve both lifeboat and telephone stations, they use them very freely among themselves for market purposes, as well as in case of shipwreck and for private information.

"In the year 1887 the following messages were received and sent from the telephone stations:—Received from Denmark 2,560 messages; received from abroad, 619 messages; sent off to Denmark 3,162 messages; sent off to abroad, 1,314 messages; 1,807 communications were also held between the various stations.

"At the Skaw, Hirtshalls, and the Hirtsholm lighthouses the keepers act as telegraph clerks. They advise the Copenhagen exchange of all ships that signal as they pass, and report information about weather, wind, shipwrecks, &c., to those who desire to know.

"If it is possible to have such information in Jutland, how much more should it be afforded along the coasts of this country, particularly in the English Channel, where the traffic is so great and shipwrecks frequently occur, besides the advantage of being able to signal the state of wind and weather, the passing of ships, the movements of great shoals of fish, and of the enemy. The system should be national, as in Denmark, and in the hands of the Post Office authorities. The beginning should be made at the most salient and practicable points on our coasts, including shore lighthouses, Coastguard stations, and lifeboat stations.

"It will be a matter for regret should Parliament pass the Bill now in the House of Lords in the interests of Lloyd's, without the fullest inquiry by a committee being made into the subject."

MAGNETIC LAG.*

BY MR. T. BLAKESLEY.

As mentioned in our last issue, a Paper was read by Mr. T. Blakesley, at the last meeting of the Physical Society, on "Magnetic Lag, and the Loss of Power accompanying the Reversal of Polarity in an Iron Core subject to the Influence of Harmonic Currents." On other occasions Mr. Blakesley has given formulæ for determining the lag in transformers, and for calculating the loss of work incidental to it; but in this Paper the methods of calculation were for the first time given. A dynamometer is placed in each circuit, and a third has one of its coils in each circuit. These furnish without difficulty the current, and therefore the magnetising stress produced thereby in each coil, and the angle of phase difference between them. The resultant magnetising stress is therefore known, and the phase relatively to each component. If this resultant is in quadrature with the current in the secondary, there can be no magnetic lag, for the magnetism must be in quadrature with that current. But experiment shows that the magnetic stress is in advance of the magnetism from 5° to 6°. If this angle of advance be represented by ϕ, then—

$$\tan\phi = \frac{\frac{m}{n}\,C a_3 - B a_2}{\frac{m}{n}\sqrt{A B a_1 a_2 - C^2 a_3^2}}$$

where m = the number of turns of wire on the primary coil; n = the number of turns of wire on the secondary coil; A B C are the dynamometer constants; and a_1 a_2 a_3 are the dynamometer readings.

The dynamometer constant is that number which, multiplied by the reading, will give half the square of the maximum value of the current. Thus the existence of a magnetic lag may be detected by the use of the second and third dynamometers alone, and measured by means of the three together. Further, as the current induced in the secondary coil is known, the E.M.F. of this induction can be easily calculated if the resistance r_2 in that coil is also known. This E.M.F. per turn is $\frac{I_2 r_2}{n}$, I_2 being the secondary current. But this must also apply to the coils of the primary. Therefore, $\frac{m}{n} I_2 r_2$ is the whole induced E.M.F. in the primary, and $\frac{m}{n}\frac{I_2 r_2}{r_1}$ must be the induced component of the current in the primary coil; and, consequently, $\frac{m^2}{n}\frac{I_2 r_2}{r_1}$ is the magnetic stress arising from it, and forms one of the components of the whole magnetic stress due to the current in the primary coil. Their difference of phase being known, the remaining component due to the E.M.F. (E) of the machine itself, viz., $\frac{E}{r_1} m$ becomes known.

All these vectorial quantities can be plotted geometrically in a way with which Mr. Blakesley has endeavoured in other Papers to make electricians familiar, so that the work done and other matters become functions of a simple triangulation, the sides of which merely involve dynamometer readings and constants, the resistance in the circuits, and the number of turns of wire in the two coils. The whole work done by the machine takes the simple form—

$$r_1 A a_1 + r_2 \frac{m}{n} C a_3.$$

The first term is obviously the power heating the primary coil. The second term is the sum of the power heating the secondary coil $r_2 B a_2$, and the power involved in the magnetic reversals; it follows that the latter is equal to

$$r_2\left(\frac{m}{n} C a_3 - B a_2\right),$$

which contains as a factor the numerator of the expression for the tangent of the lag, and showing that one is the result of the other.

In speculating upon the cause of the lag Mr. Blakesley believes that the increasing magnetisation calls into being an opposing magnetic stress, as motion in a medium calls into being an opposing friction. This induced magnetic stress must be compounded with those impressed by the currents to obtain the effective magnetic stress which is in phase with the magnetism. This involves the conception of magnetic self-induction and a corresponding coefficient symbolised by N, to which Mr. Blakesley is careful not to attribute constancy, though he points out that its constancy is a necessary condition to the maintenance of the harmonic character of the changes. These views were illustrated by experimental results.

* Abstract of Paper read before the Physical Society on May 12.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

At the meeting on Thursday, 17th inst., Dr J. Hopkinson, F.R.S., in the chair, it was announced that the Council had decided that, in the discussion of Papers read before the Society, speakers should be limited to ten minutes each. At the end of eight minutes a bell would be rung, and if the speaker did not conclude his remarks within the two minutes succeeding, the chairman should put it to the house whether he be allowed to proceed. The consideration of Mr. Crompton's Paper was then resumed.

Central Station Lighting.—Transformers v. Accumulators.

The CHAIRMAN called upon Mr. Crompton to reply to the discussion on his Paper, a report of which has already appeared in former issues of *The Electrician*.*

Mr. CROMPTON, in reply, said: The long discussion which has taken place on my Paper, and partly in my absence, is not a very easy one to answer without extending my remarks to a troublesome length; but I will do my best, by grouping them into various heads and by giving one answer for all such remarks as may be thus grouped. I must at once make an explanation regarding Mr. Hammond. Mr. Hammond seems to labour under the idea that when I spoke of some installations of his I spoke of them as installations carried out partly for advertising purposes. Nothing was further from my thoughts. I spoke of them as pioneer installations—as installations more for the purpose of popularising the electric light than being specimens of what installations of a more permanent nature ought to be; and I characterised all overhead installations thus. I must apologise to him at once for the mistake I made about Eastbourne. A further misunderstanding has taken place between Prof. Forbes and myself.

* See *Electrician*, Vol. XX., pp. 634, 655, 694, 749.

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He appears to think that I was discussing the question of transformers *v.* accumulators for all purposes and for all kinds of installations. That was not the object of my Paper. My Paper was to discuss transformers *v.* accumulators under the light of a certain installation which I described as suitable for London; and I commenced by saying that I put overhead wiring out of court. Wherever overhead wiring can be used I have no doubt that distribution by means of alternating currents and transformers is a very good system to use, and probably is considerably cheaper than that by batteries. But I wish to confine the discussion to the limits I put upon it—that is, the lighting of London. I will now go on to the remarks that were made by Mr. Kapp. Mr. Kapp commenced with a discussion of my load diagram. Mr. Kapp stated that though no doubt my load diagram was correct, it was hardly a representative one for London. He stated that if I had taken a district in which there was much office lighting, my valleys would have been filled up, and that instead of the 2,100 units calculated from the area of that diagram, I should get the 3,600 units which he spoke of in his article published in *Industries* on December 2nd. Now, I do not admit this for one moment. London is not like New York. In London our residential districts contain very few offices. Our offices are grouped together in the City—a few are at the West End, but the majority are in the City. No doubt a diagram prepared from the City of London would be widely different from the diagram I have shown on the wall; but I think you, all of you, will admit that the matter that is of supreme interest at the present moment is the lighting of our private houses in London—the houses in which we live. It is there that we shall feel the full benefit of the electric light, and anything that any of us can do or say which will forward the cause of the distribution of the electric light into our private houses is of the utmost value to all Londoners at the present moment. I will go on further to say, while on the subject of these diagrams, that I admit the full force of what Sir David Salomons and several other speakers have said on the subject of the sale of motive power. There is no doubt that the sale of motive power is much to be desired, as by such sale we shall get a filling-up of that valley which will be of the greatest advantage to the supplying company. For, mark you, as the capital expenditure of the company is somewhere in proportion to the height of the peak of the diagram, and the income of the company is in proportion to the area of the diagram, it follows that the more we fill up the valleys the better the company will pay (hear, hear). Now, this filling-up by the use of motive power of course is a thing to be devoutly desired, and I hope it will come. But I hardly think it was a fair argument for me to use in favour of the accumulator—the B.T. system as against the A.T. system, which cannot use motive power, and I think you will appreciate my motives in keeping it on one side. But if I did wrong, I did it simply from the motive of absolute fairness (hear, hear). Every argument that I have been using in favour of the B.T. system will be considerably strengthened when I have the additional income that I shall get in the day time from motive power by using the direct system and the batteries. Mr. Kapp, I am sorry to say, appears to have misunderstood my figures in Table I., because otherwise it is difficult for me to follow the calculations that he made. He says that, instead of using the cable that I used, costing about £116 per hundred yards—that is to say, for the double cable—he proposed to use cables insulated in the same manner, but covered with lead, bringing the price up to £130. He hopes by that extra expenditure on the cable itself to save a great deal of money in the cost of laying. Well, in this he will find himself mistaken. He seems to think that the sum of 3*s.* per yard is an ample sum to cover all the expenses of laying a pair of cables under a London footway. Is he aware that the figure that I have put at £25 per hundred yards for trenching and replacing is absolutely the figure levied by the Vestry? That is to say, for every yard of York paving we take up we have to pay 4s. a yard, for every yard of asphalte 11s.; for wood pavement about the same as asphalte. If we suppose there is only about 10 per cent. of asphalte footway in our lighting we must fetch up the 4s. to 5s., and I have taken it at 5*s.* throughout, which gives the £25. Further than this, Mr. Kapp seems to have made the most astonishing omission. He seems to think that contractors will be found who will lay cables without taking any profit, and this notwithstanding the risks attendant on the work. I put a sum down for that, and I think that you will all admit that it is a very small sum when you consider that it has to cover the expense of drawings and the expense of the clerk of the works and the engineer's fees who devises and manages the installation. If you thus correct Mr. Kapp's estimate it comes to a figure sensibly higher than mine—viz., £187. 10s. per hundred yards. That is a specimen of Mr. Kapp's criticisms of my figures. It is highly important that I should dwell upon this point, because I should tell you that, on this cost of laying the mains, so much depends. It is the one item that has been very little understood, for the simple reason that none of us have had any experience of it until the last two years, and I really thought that I was bringing before you something that would be of very great use to the members. Referring to my second table, General Webber, although he criticised it tolerably severely, yet the edge of his criticism is taken off by the fact that he misunderstood it. He talked of the conductor being suspended from the roof of the culvert. If that were the case, no doubt water collecting on the roof would run down the suspending loops, whatever they are made of, and would deposit a film of water, which would stand on the insulators and very much reduce the insulation. But, as a matter of fact, it is not so. The insulators stand upon short pillars from the bottom of the trench, and I see no reason to believe that the insulation would suffer in any way if we had had a couple of inches or even more water, either running or lying in the bottom of the trench throughout its length. How it is possible for the state of things proposed by General Webber to occur I cannot conceive. He says we shall gradually get the trench blocked up by the *détris* left by water, that vermin of every kind will congregate in the trench, and we should have legions of rats running along them, and in a short time we should lose the insulation entirely. Well, we have had one year's experience of this class of culvert, and none of these things occurred. Not only have they not occurred, but there is no sign of them occurring. We have had a very trying winter. As is natural under the circumstances of commencing a new installation, the trenches have been opened many times oftener than they will be in the future. They have been exposed to all kinds of weather. There have been far more opportunities of wet getting into them than there ever will be again, and yet, in spite of that, the insulation of these cables is as high, length for length, as that of the best cables made in the world, which, I believe, are made in London or near London (hear, hear). Well, on this point I want to bring to your notice an interesting fact, which I think may be also of some use to you. It is very easy to get high insulation in a cable that is not cut into by the distribution branches being jointed on to it. As long as the insulating covering of a cable remains intact from end to end it is very easy to measure its insulation by megohms, but when there have been a few hundred cuts made through the insulation, and the branch wires have been jointed on, it matters not how carefully the insulation is replaced and the joint remade, every one of those joints becomes a source of leakage. The megohm resistance goes down very soon to a few thousand ohms, and, what is a most curious thing, the whole of the exterior surface of the cable becomes a means of communicating the leaks that start in the minute cracks at the joints to the ground—that is to say, there is an enormous ground surface wherever hemp or jute covering comes in contact with the pipes or troughs containing the cables. I am speaking now from practice. I find it extremely difficult to make these joints tight, and it is *the one* point where underground cables carrying these high potentials proposed by the advocates of the A.T. system will find their greatest difficulty. There has been a writer in one of the electrical papers, I forget which, who calls attention to this fact, and I am sure that whoever plans a district and carries out a district with this large number of attachments to the high-tension mains will find his difficulties at these points are extremely great, infinitely more than any difficulties we are likely to encounter with the B T system. I am perfectly aware, that there are many places in which one cannot use the culvert system, as has been stated by Mr. Fleetwood. But Mr. Fleetwood has made a mistake. He believes that it is necessary to have a culvert 18in. square. We have actually used culverts only 5in. deep, and, I believe, 4in. deep in some cases. We want a considerable width, because it is my system to put a mid feather between the brickwork and every one of my conductors, so as to make it impossible for any swinging or side movement of the conductor to make a short-circuit. But 18 inches is found ample for the three-wire system, and I have no doubt that, if I want to get a four-wire system, 24in. would be ample. There is no difficulty in getting width under the footway, the difficulty is in getting depth. Hitherto we have been able to get a sufficient space in depth. We have, in several cases, had the depth cut down to 2in., and then no system will do but putting in lead pipes and drawing separate cables into them. I mean the ordinary plumber's lead pipe of an inch and a-half to two inches diameter, and drawing the cable into that.

I must turn now to the cost of the generating plant. Most of the actual makers of alternate-current dynamo machines appear to think that I have under-estimated their cost in my Paper. Prof. Forbes is alone in thinking the contrary; but this is no doubt due to the wonderful organisation of Mr. Westinghouse's factory, who, as he says, makes only three patterns of machines, and has, consequently been able to turn them out by special machinery. There is no reason why we should not be able to imitate this in this country, if we have a demand equal to that of Messrs. Westinghouse. But, if my arguments are correct, I do not think there will be ever the same demand for alternating sets in this country that there will be in America. As to the cost of transformers Mr. Kapp says I over-estimated them, not because he considers that my price is too high, but because I use too many of them. I have estimated the cost of fixing a transformer common to two houses at, I think, £15, which price includes the chamber which contains it, and all the labour incidental to fixing; but he thinks that the number of transformers could be reduced, and he at once goes to the extreme of collecting his transformers into ten distributing stations. Now, I wish to point out that, if we take Mr. Kapp's figures as correct, to distribute over these ten stations he will use just as much copper as I use also for distributing from 4 stations. He told me my calculations were all wrong for 4 stations, and that the copper I had allowed was only sufficient to give the correct fall of potential if I distributed from the ten stations. Therefore, he will have to adopt my figures, and he will have to adopt 20,000 yards of cable at the cost in my table for the B.T. system. By that means he will at once put £6,000 on the top of his distributing mains, and, on the top of that, he will have to add the cost of such sub-feed mains as he employs to carry the current from the end of his large charging mains to these sub-stations. I have not worked that figure out because I do not know how he is going to place his station, but it will probably add another £3,000 or £4,000; so we have to add £10,000 on to the cost of his system at once by this new method of distribution. What is he going to gain by it? He is going to gain a few thousand pounds on the cost of transformers. Possibly he may. I have given the total cost of the transformers there as £7,500. He may gain one-half of that; so that to gain £3,500 he is deliberately going to sacrifice £10,000. That is a specimen of the proposal made by Mr. Kapp to reduce the cost of the A.T. system. I have, however, from conversations I have had with other gentlemen, learned that Mr. Kapp's proposals are not generally acceptable. From what I understand from Prof. Forbes's remarks, and from other gentlemen's remarks, it is pretty certain that they would wish to put transformers to one or two houses as I have put them down; and, under those circumstances, I do not see how the cost can be reduced. It is not

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the cost of the transformers themselves, but the cost of starting a fresh job each time that you put down a transformer, and these will not be all put down simultaneously. A couple of men will have to be sent out, and we all know, at least all we contractors know, how much more expensive is a small job of that kind than the continuous work that you can give out on contract. I think those of you who have had experience of working in the streets will admit that the figure of £15 for every two houses, including the cost of the transformer itself, including the profits and risks of it, is exceedingly small, so that I do not see how by hook or by crook that cost can be materially reduced.

I now come to the very vexed question of the efficiency of these transformers. My statement that their efficiency is very low at low rates of output has been traversed by several speakers. Mr. Mordey wrote to me on the subject, as he was unable to speak during the discussion. I am quite prepared to say at once that I will adopt the figures given by the advocates of the alternating-transformer system, I will suppose that the efficiency is as high as they make it to be; but what I did say in the body of my Paper, and what I now say is, that 40 per cent. of the total output of the station is taken at extremely low rates. You will see what 40 per cent. consists of on that diagram, you will see that it hardly goes up to the lower horizontal line, and that really means that there are two or three lamps running in each house during about nine hours of the day. Two houses having one transformer common to both would require this to be of 4,800 watts capacity to supply their maximum demand, whereas during these nine hours it would be worked at about 108 watts capacity—that is, rather less than four per cent. of its total output, and it is during this time that its efficiency is so very low, and, what is more, it is during the corresponding time that the efficiency of the accumulators is at its highest.

I have got to the point at which I must cordially endorse all that Mr. Preece has said when describing the pluck and perseverance shown by Messrs. Gaulard and Gibbs. Nobody admires the results of their labours in pushing the system to its present success more than I have done. Nothing in my Paper was intended to detract from the credit and honour they have won, in the teeth of just such uncompromising opposition as I am now receiving from their friends (laughter). Mr. Swinburne made a remark about transformers which does not appear to have been noticed by the friends of the A.T. system. He points out that the transformers do not regulate—that is to say, to use our electrical slang expression, they compound down; the E.M.F. falls as the load is increased, and no one has succeeded in winding them so as to overcome this difficulty. If this is so, and no one has denied it, it is another serious difficulty in the face of the distribution by the A.T. system.

Now, I turn to the accumulators. First, I must point out generally that my Paper speaks solely of the use of accumulators as transformers. Mr. Drake appears to be the only gentleman who has brought this strongly before your notice. There is a very wide difference between accumulators worked in the manner that I have described, so that during the hours of large demand most of the current comes direct from the dynamos—the accumulators only supplying a portion of the current during the peak of the diagram, and again supplying the current during the very long periods of small output—and the other plan of using accumulators, which is to fill them in the daytime and discharge them at night. Mr. Frank King, Mr. Parker, and other gentlemen asked me why I did not refer to the Colchester installation. Now, I admit that the Colchester installation was worthy to be referred to; but it is so totally different from the system that I have been talking about, and it is so utterly impossible to compare its cost with the alternate transformer cost, that it is out of court. These gentlemen do not appear to see that you require six times the amount of batteries—so that my figure for batteries must be multiplied by six if you are to use them in the way they were used at Colchester—and the mere fact of the cost of those batteries makes the capital charge so high as to rule them out of court. You see, after all, I am a very timid user of batteries. I do not deny at all that we are only just beginning to understand them; and no doubt, as our experience extends, I should use them much more largely than I now propose.

The next point I wish to come to is that I have been asked why I stick to the figure of 400 or 450 volts as my figure for distribution. The reason I do so is that, although I would very much like to use 600 or 800 volts, I do not know whether difficulties will then occur which we have not hitherto met with. I have successfully distributed an installation of 13,000 lights at Vienna—that is the size of the Vienna installation. It is larger than this installation we are talking of now. The mains are nearly 1,500 yards long; consequently, it is very much on all fours with the installation described, and it is not too much to say that everything that I have put down both for working cost and capital cost in my tables is nothing more nor less than the figures from Vienna as near as I dare state them. At Vienna the 440 volts we are using has never given any trouble.

The Le Mans station, about which I have said very little, is an extremely perfect little station, which has worked from the commencement up to date without any hitch of any kind. At the gasworks there is a generating plant, working at 250 volts. A pair of cables is carried to an accumulator station close to the market place, and from thence the three-wire system is taken all over the town—at least a modified system, for with batteries you do not require quite the same complication as when you are using dynamos working a three-wire system. You, gentlemen, hardly appear to appreciate the fact that when you are using batteries—even on the direct system—you may reduce the cost of your charging or feeding mains very largely if you put your batteries at the distant point. You make a corresponding gain when you use the three-wire system and put the batteries again at a distant point, and you make still a corresponding gain again with the five wires, or four batteries in series, with the batteries at a distant point. I have shown that the gain is then so great that when you are using the 440 effective volts which the extra cost of the copper involved, as against the 2,000 of the other system, is more than compensated for by the extra cost of the insulation of the wire of the mains of the A.T. system. Thus you see, if you compare one main with the other, the figures are very nearly alike. In the case of the A.T. system, the cost is £6,160 for 2,000yds., and in the other case it costs £6,137. I do not deny for a moment that when the length of the charging mains gets beyond 2,000yds. there will be a considerable balance in favour of the A.T. system.

As to Mr. Kapp's criticisms on the cost of accumulators, you will notice that his questions have been answered by all the practical makers of accumulators. Mr. Parker, Mr. Sellon and Mr. Drake have agreed that my figures are correct. Now as to the efficiency of accumulators, about which so much has been said. Mr. Preece, Prof. Forbes and a great many other gentlemen seem to be surprised that I claim an 80 per cent. efficiency between the lamps and the terminals of the dynamo. I may call attention to this fact strongly later on. But in reply to this I may state that I have obtained this efficiency for many months at Vienna, using E.P.S. accumulators. I have obtained a far higher efficiency at Kensington and in a private installation of my own. I am speaking now of the watt efficiency. I say that when the dynamos and batteries are worked in parallel, and the current has neither been taken out nor put into the accumulators, there is little or no loss, due to the fact that the batteries are connected parallel to the circuit, which otherwise is a direct circuit. Of course if there were any short-circuits in the cells, or any leakage inside them from plate to plate, then there would be loss. But it is perfectly easy to guard against such a thing happening, and with proper precautions it need not happen. It has not happened in Vienna, and it has not happened in Kensington. Now I have shown that at the time when there is about 60 per cent. of the total output the efficiency of the accumulators does not come into the question. It is, then, a mere question of direct supply. I have shown you when speaking of the transformers that for nine hours the batteries are discharging at a very low rate. From actual experiment I know that you can get an 82 per cent. efficiency during this time, but I do not claim it. I have really only calculated 70 per cent. Now, if you add 60 per cent. of the output at no loss, and 40 per cent. at the loss I speak of, you get a total efficiency of 87 per cent, whereas I have not claimed anything of the kind. I have claimed something very considerably less; therefore the severe criticisms Prof. Forbes has cast on that portion of the Paper entirely fall to the ground because he has not appreciated these points.

I turn now to the question of the depreciation of batteries. Mr. Gordon has made public certain figures which show without any further comment from me what is my personal opinion, and the opinion of my partners and those working with me, as to what we can afford in the way of maintaining accumulators. I think we have made ourselves safe on that contract that he read out to you. It was not my intention that he should read it out, but as he has done it, it is there for you to judge of. All the experience I have had with the form of accumulators that I have been using points out that we are well within the mark when we say that we can maintain the 12½ per cent. I think I am at liberty to say this much, that during my recent visit to Vienna, which is since the Paper was read, I took very great pains to inspect the large battery of accumulators. I ascertained that the company were not willing to allow anybody to contract and maintain the accumulators at 10 per cent They thought they could do it for considerably less (applause). I believe at Kensington Court the cost of the battery, of the alterations and little repairs that have been made to the battery during the fifteen months' working, amounts to about 2 per cent. of its cost. Mr. Kapp bases certain elaborate calculations on Mr. Shoolbred's mains at Bradford. Mr. Shoolbred, on the contrary, tells me there were no calculations made for Bradford.

Mr. KAPP: I made a calculation quite privately when I saw the matter at Bradford, and that was the result.

Mr. SHOOLBRED: I beg Mr. Crompton's pardon. I never made any such statement. I cannot understand what he means.

Mr. CROMPTON: I understood decidedly that you did not know how many lamps were going to be used in Bradford, and that the cables were to be laid down as they were required.

Mr. SHOOLBRED: It is not an installation for lamps; but you said there were no calculations made whatever, which is a very wide statement, as if it was a haphazard laying down altogether.

Mr. CROMPTON: I now come to the remarks of Mr. Hammond. When Mr. Hammond tells me that he thinks there is no necessity for providing accumulators, because, of course, everybody knows when the steam engine is going to stop, all I can say is that Mr. Hammond's experience has been exceptionally favourable. But what about the belt coming off? Has nobody had a belt off? And what happens then? What happens if you have got four or five machines parallel and the belt comes off one of them and the other machines have to drive?

Mr. MORDEY: The cut-out acts then (laughter).

Mr. CROMPTON: A gentlemen says a cut-out acts. I know what happens in addition—a report comes in from the customers next day that the light has been exceedingly bad on the previous evening (laughter). On the other hand, with accumulators you can stop the engines for half an hour, as was the case when we had not boiler power enough at Kensington. We were able to stop the engines and get up steam and start them again without the customers knowing anything about it (applause).

Prof. Forbes has certainly made a mistake with regard to the efficiency of the Westinghouse plant He does not seriously believe you can get 600 kilowatts out of 1,000 horse-power. He will, no doubt, have to admit that he wants about 1,200 horse-power to get the 600 kilowatts, and he will have to admit that the 250 horse-power I have allowed for reserve power is not an extravagant figure, but is the very smallest that is necessary. When he has admitted that he has got to admit the extra allowance for increased cost of site and building, and when he has admitted those two items he has admitted pretty nearly all

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that there is in my Paper, excepting that of the cost of the mains; and I decline to discuss the mains with him, because he bases everything on overhead wiring, and mine is underground wiring. I think I have answered most of the speakers who have discussed my Paper. The opinions of those who are practically connected with the working of central stations are practically fairly balanced; but figures are worth more than opinion. There are, no doubt, several persons in this room who know that I speak accurately when I state that the experience of the Grosvenor Gallery installation is such that the estimate for the future coal consumption is based on the supposition that each electrical horse-power in the lamps will take about 18lb. of coal. It is needless to say that I should not have the hardihood to stand before you if I thought the B.T. system would take so much as that, or that it would take a quarter as much. I hope to have an opportunity at no distant date of proving this question beyond dispute. I do not know whether the Grosvenor Gallery people will give you an equal chance as I intend to do, for as soon as our enlarged plant is in at Kensington I shall have great pleasure in allowing gentlemen to make such experiments as they choose to show that what I have stated about the consumption of fuel on the B.T. system is correct.

I have shown that in the A.T. system the dynamos are slightly more expensive; they are certainly more difficult to put parallel. In the A.T. system a part at least of the machinery must always be in motion; whereas with the B.T. system you have got smaller plant, you have got cheaper plant, you have got machinery which need not be always moving, and consequently the labour in the B.T. system costs much less than the labour in the A.T. system. I have shown that the saving in conductors in the A.T. system is excessively small, whereas the likelihood of the breakdown of underground conductors when they are used in the A.T. system is much larger than in the other case. I have shown you that there is no motive power possible with the A.T. system. I have shown you that the A.T. system is extravagant in fuel, and that the B.T. system is not so (oh, oh). I think that when I have put all this together that I have prepared a very formidable array of charges against the A.T. system.

On the motion of the CHAIRMAN, a cordial vote of thanks was then awarded by acclamation to Mr. Crompton for his Paper, and for his reply to the discussion.

"On the Risks of Fire Incidental to Electric Lighting."

On resuming the discussion on Mr. Preece's Paper,

Mr. HEAPHY said that he had obtained permission to make a statement that evening as to the reasons of the committee on the Phœnix Rules being interrupted. But in the account given by Mr. Preece, he unintentionally conveyed an erroneous impression. Had it not been for that remark he (the speaker) should not have spoken at all, for obvious reasons. In May last the committee of the Council was formed to revise their rules of 1883. Communications were opened with the Phœnix on the matter, the result being that a tentative agreement was arrived at that in order to settle once for all any additions as to the rules for the future the Telegraph Engineers' Rules and the Phœnix Rules should come out under the same cover, the cover to contain no mention of the Phœnix. The first portion of the pamphlet was to contain the general rules and principles for installations drawn up by the committee. The second portion of the pamphlet contained "The Phœnix Detailed Rules for Installations," that being the acknowledgement that these detailed rules were the Phœnix Rules. In order to make certain that there was nothing in the Phœnix Rules objectionable the committee were to form a sub-committee to go over them clause by clause and word for word, and in the event of their not agreeing the arrangement was to come to an end. These gentlemen were to be men practically acquainted with the difficulties of electric light installations, viz., Mr. Preece, Mr. Siemens, Mr. Crompton, and General Webber. There were many sittings at the offices of the Telegraph-Engineers, and there was not the slightest hitch or difficulty of any kind, and the Phœnix Rules were unanimously approved of. After certain verbal alterations had been made, and a few other slight variations (all of which were agreed to), an acknowledgment clause was then framed and agreed to. The sub-committee then revised their general rules. With those he had nothing to do. The rules came out in the cover of the Telegraph-Engineers, and that was done to prevent the susceptibility of any other fire office which did not like the word "Phœnix" to be alluded to. They were to see the "Society of Telegraph-Engineers and Electricians' Rules and Regulations recommended for the fire risks from electric lighting." Then came the names of the members of the committee, with Mr. Preece as chairman. Then there was a little acknowledgment clause, as follows:—"The following detailed rules having been laid before the Society for approval are recommended for general use." He thought that the matter was at an end so far as he was concerned, when he received a letter to attend their committee to explain certain rules. He thought that this was strange, as the matter had been so thoroughly thrashed out by the sub-committee, and that they were so thoroughly conversant on every point. However, he accordingly went, when, to his surprise, the first thing he heard spoken at the table was that the acknowledgment clause was called into question, with a kind of half intimation that instead of the detailed rules being acknowledged as the Phœnix Rules they should be called rules based on the Phœnix. He also found that the whole of the Phœnix Rules were to be gone over again—not the original Phœnix Rules, but the slightly altered Phœnix Rules. That was the point. They were under the cover of the Telegraph-Engineers (laughter). What, then, was the position of the Phœnix Fire Office? These rules might have been slightly altered again verbally, and the acknowledgment clause altered objectionably, and all copyright lost; perhaps the very name of the Phœnix might have been expunged in the next edition, and what remedy would the Phœnix have had? None whatever. If it had been objected to the answer might have been the detailed rules had been drawn up with the consent of their own representative sitting as one of the committee; they could not now refuse to recognise nor object to the acknowledgment clause, whatever it might be. The Phœnix Fire Office, after a time, might have been deprived of its rules. Well, what was the only course open to the Phœnix? What would any of them under the circumstances have done, except to retire from all negotiation? He had to acknowledge in high terms of praise the conduct of Mr. Preece, Mr. Crompton, General Webber, and Mr. Siemens; and he could not tell them the amount of time and trouble those gentlemen had taken, and this difficulty would not have arisen had it not been that these people were outvoted by the others.

Mr. PREECE: I object to that.

Mr. HEAPHY: Well, they were outvoted. He thought he had the sympathy of practical men. He wrote a letter to the committee, and at their next meeting they declined to give him any information as to the acknowledgment clause, whether it was to be altered or what was to be done; and until the sittings on the Phœnix Rules in the pamphlet—not the real Phœnix Rules - had been completed he had nothing to do but retire. Several gentlemen of the committee asked him to stop, saying that he could reckon on their support; but when he said they might be outvoted by others of a different opinion the reply of the others was, "Yes; that might be so" (laughter). He did not wish for a moment to imply that that committee would have done anything that it did not consider right and honourable. He did not wish to cast the slightest imputation upon anyone; but they must remember that there were often two ways of regarding the same thing, and what would seem perfectly fair and right in one view would be felt as a bitter wrong and injustice from another point of view. For instance, the speaker last Thursday actually stated in effect that, because some of the clauses in the Phœnix Rules which were brought out in February, 1882, were then similar to certain rules in America, therefore there was no right to copyright in the present Phœnix Rules, and that, too, notwithstanding all the original thought and labour bestowed on them to make them perfect, and that they were tried upon systems of lighting undreamt of six years ago. The Phœnix Fire Office was anxious to do everything that was just and right. He would just tell them what had taken place connected with the use of their rules by one of the leading offices of the day. The Phœnix gave up everything; the only thing was to have that acknowledgment clause to save their copyright. "The following rules"—that was the only acknowledgment, the only page in which the Phœnix name was mentioned. "The following rules having been drawn up by the Phœnix Fire Office for electric lighting installations and electric power installations, have been adopted by the leading fire offices throughout the kingdom, and are recommended for general use." He could assure them that demand for these rules from a number of offices was getting so large that it was becoming difficult to supply them in time. He believed almost every office in the kingdom would have used them with certain exceptions; but one office came and said, "You must not say the 'fire office rules'—you have no right to say 'fire office rules'"—or words to that effect. And something to this effect, "You say they have been adopted by the leading fire offices throughout the kingdom, but we are not aware that all the leading offices *have* agreed." And so they agreed to withdraw that part of it. Now he left the meeting to judge of the feeling in that matter. It did not seem to matter what trouble the trade had been put to as long as the "Phœnix" was put away. The meeting knew what injustice was, for they had had to feel the tyranny of Chamberlain's Act; but that Act was mercy itself compared to the one which was now sought to be imposed upon the Phœnix. They had had 21 years allowed them before their worst time would come (laughter), but he was not to have 21 weeks. He never believed that the meeting would be a party to such an injustice (cheers).

Mr. HUMAN (of the Guardian Office) said he had risen to refer to the last occasion, when Mr. Preece rather condemned a clause which applied in his (the speaker's) opinion to another purpose, and which had another application altogether. Mr. Preece read out the clause of those rules which specified the minimum electrical resistance of the insulated covering to the conductor; and he compared that with the Society's rule which dealt with the total of leakage of an installation. Now the two things were not altogether the same, and they did not deal, as a matter of fact, with the total leakage. First of all, in the previous rule, they specified what materials should be used to form the coating of a conductor, and then with reference to that they felt that it was necessary to specify what should be its minimum electrical resistance, and they adopted simply what was the common practice of the trade. He believed it was a practical rule of the makers of conductors—they specified so many megohms resistance; and they believed that it was a term that was well understood by those dealing with insulated conductors. It was of very simple form, and he did not quite understand why Mr. Preece condemned it.

The EARL of CRAWFORD and BALCARRES said: Before this discussion closed he wished to say a word as to the question of the rules that were put up for the guidance of electric contractors in wiring houses. A short time ago he had the honour of being admitted to the committee appointed by this Society to consider the rules, and he then spoke to them, urging them not to go into this question of the multiplication of the rules. He took the liberty of then expressing his views to them and the committee that where rules were multiplied they were multiplying their weaknesses. There were certain points which were strong common to both. Every set of rules had weak points; and the more rules they had, therefore the more weak points. The result really came to this, that if they were to begin to set up an installation they had it wired, and practically any contractor who was not of high moral tone would take advantage of those things and take all the weak points together, and be strictly within the letter of the law, but still have an installation really in a non-satisfactory state. Now, what Mr. Heaphy said with regard to the Phœnix Office was very true, Some considerable time ago, he believed

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in May, in 1882, the rules known as the Phœnix Rules were first published in *The Times* newspaper. Since that time the Phœnix Office had devoted its attention very largely to the subject of electric lighting, one which was vital to them. All other offices at that time were almost unanimous in saying electricity was an unknown factor; one with which they might burn their fingers, and one with which they would have nothing to do. To the Phœnix Office they owed a debt of gratitude (cheers) for having set up these rules; and not content merely with having set up rules for every advance in the science that they all had at heart, but for every new discovery the Phœnix had fairly gone into the question, and investigated it, and seen how it could be dealt with in the fire risk, and modified their rules so as to bring these new inventions into fair play. Well, they had found out that at the Grosvenor Gallery the installations which had been set up in accordance with the Phœnix Rules, and which had been passed by an inspector of the Phœnix Office, were the most satisfactory of any that could be done or that they had come across. They had certainly as large an experience as anybody in this kingdom. They had at the present time a considerable number of lights running; they had an output of over 20,000 lights daily. They were putting on installations at the rate of something like ten houses a day. They found in certain cases (he would not give any particulars, but allow them to guess what he meant to allude to) that the work was not done to the satisfaction of the fire office. The result of that was that under certain rules work might be passed by inspectors to their satisfaction; but it was absolutely and entirely prejudicial to their interests as producers of electricity and as distributors of current, because the work in their opinion was absolutely unsafe, and he might inform them now that having this in view they had come to the determination at the Grosvenor Gallery that in future any installation that came to them which had not been wired under the Phœnix Rules, which had not been inspected for the Phœnix Office, would have to be inspected again under the Phœnix Rules before they turned a current into the house (applause). In making this statement he was aware that it was a strong statement to make, but they had a very great stake in this business. He did not say necessarily that defective work was the fault of the contractor, but he did say in his own case that it was the fault of the person who employed him to put that work in. A man could not make a racehorse out of a donkey, and a man also could not get the best article unless he was willing to pay a proper price for it, and that was the fair English of it (applause). He thought the sooner the bogus installations were stamped out in this trade the sooner they should have the electric light taking its place as a recognised commercial business in London (applause). There was only one other thing that he might be allowed to mention; he thought Mr. Crompton might have made a little mistake when he spoke of their using at the Grosvenor Gallery 18lbs. of coal per horse-power, and he stated he could prove it. He was afraid he had misplaced a decimal point—if he said 1·8 he would have been right (laughter).

Mr. WHARTON (of the firm of Laing, Wharton and Down) said the question of these rules was of very great importance to two classes of persons, one the electric light contractors and the other the insurance offices. The question was, did they require any alteration in the standard up to the present? He was taking the Phœnix Rules as the standard. The contractors, he took it—those who did honest work—did not require any alteration. Fires had not occurred under the rules, and although Mr. Heaphy was very strict, he was not too strict. Did the fire insurance companies require any alterations? (cries of "Yes" and "No"). He thought not. Up to the present moment he thought a fire had never occurred where the Phœnix Rules had been faithfully carried out.

Mr. HEAPHY: Not one.

Mr. WHARTON: Those were the classes of persons most interested in a change in the Fire Insurance rules. It appeared to him that neither of them required a change; but if any alteration was to be made, what kind of alteration was that to be? It must be for the worse, it seemed to him. As a matter of sentiment and with respect to the parentage of the rules, Mr. Heaphy had put it to them very happily that night, and they must all acknowledge that he had done very good work, and was entitled to the honour (applause). For himself, as a contractor, he did not want any alteration.

Mr. SHOOLBRED said he thought a good deal of feeling had been imported into the discussion by the non-attention to one particular paragraph, the second one at the commencement of the Society's Rules, which said that it is to be understood that those general rules were not intended to supersede any detailed rules which fire offices might issue for their own protection. He understood it was meant by the committee generally—and he had attended many of the meetings—that there was no intention whatever to create, as it were, antagonism between those rules and those of the Phœnix or any other fire offices. The re-appointment of the committee was, he understood, at the request of several of the fire offices, in order to lay down certain scientific principles——

Mr. HEAPHY: Certainly.

Mr. SHOOLBRED: Scientific principles upon which fire offices might themselves, quite independently of these rules, formulate others for their own guidance, taking these rules or not into consideration. These rules were to a certain extent based upon abstract principles. The fire office rules had to deal with various risks, and other matters of application, which these rules did not pretend to do.

Mr. PRYOR, Chairman of the Fire Office Committee, said he should prefer not to speak in any way on the part of the offices generally, as he might perhaps, but only on behalf of his own office (the Sun) to say that he could not admit Mr. Heaphy's position, or understand why he should feel surprised that the other offices did not accept the statement that the rules were accepted by the leading fire offices, because they were not so accepted, and the statement was absolutely false (hear, hear). They were accepted by some offices certainly—not in any sense by the leading offices, although by some important offices. Therefore there was some little feeling aroused by so direct a misstatement. With regard to the rules, and the reasons so many offices did not accept them, the reason was this: The fire offices were not in a position to protect the contractors for the supply of electric lighting. They quite admitted that on the whole good installations were safe installations, and therefore satisfactory to them, but they had no concern with any possible waste at the expense of the contractors, and they did not intend, he was sure, to protect the contractors in any way. They wished to protect themselves against undue fire risks, and by so doing they would prevent increasing the cost to the public where electric lighting installations were established. They were therefore very anxious, of course, to lay down rules; but he was sure that most of them were not anxious to make it necessary that inspectors should be employed in all cases. It appeared to them to be no more their business to inspect installations than to inspect gas lighting installations. They had nothing to do with anything but to estimate the risk produced by any given cause, and there they intended to draw the line. In the present tentative state of the question inspection was necessary, and they made it, but they could not look upon it as a permanent state of things. They therefore could not accept rules which were drawn so as to involve the necessity of satisfying certain inspectors. They were not, from their point of view, working rules. They wished to use rules laid down which would cover principles and be fairly easily applied, and, where tests were necessary, that those tests should be easily made. Beyond that they did not wish to go. It was perfectly clear that if electric lighting took the place which he trusted and hoped it would take, inspection of every installation in every house would be perfectly and absolutely impossible; it would be a great annoyance to the householder and no benefit whatever to the insurance offices. Therefore the Phœnix Rules were, from his point of view, inadmissible wholly, when electric lighting became as prevalent, as he supposed it would, as gas lighting.

Mr. HEAPHY: May I ask whether Mr. Pryor is speaking for his own office (the Sun) or for other offices?

The CHAIRMAN ruled that Mr. Heaphy was out of order.

Mr. RAWLINS said: Mr. President and Gentlemen, as a member of the Society and surveyor of the Kent Insurance Company I have to claim your indulgence for a few moments. I regret that I was not present on the last occasion in order that I might have heard the complimentary remarks made by Mr. Preece upon the rules as to electric lighting issued by the Guardian, the Kent, and other insurance companies. I think those remarks are to be regretted; but probably Mr. Preece meant them to be interpreted in a "Pickwickian" sense. I daresay it has struck you, gentlemen, as being singular that two members of the Council who spoke on the last occasion should after their arduous labours, extending over nearly twelve months, have been anxious to throw over the new rules of this Society, which they had assisted in framing, for those of the Phœnix, which are not, I should consider, favourable to electricians generally, as they seem to point to the necessity of the surveyor of the fire office superintending the installation on behalf of the insurer, and then on behalf of the fire office passing judgment on himself. One illustration I should like to give of the Phœnix Rules. "All conductors to have sufficient sectional area, so as to allow at least 100 per cent. more electricity being safely sent through them than will ever possibly be required for the lights they supply. Under certain circumstances the inspector may give permission for a larger quantity of current to be sent through a given section of conductor than the proportion above named, and under certain circumstances he may require a lower quantity to be used. Problem.—It is required to find the necessary area of the conductor." The advantages that are claimed for our rules are that they are not copyright; that no charge is made for them; that any insurance company may adopt them, or any part of them; and they do not require the services either of a honorary or a paid interpreter. These rules were drafted in the latter part of last year, the reason being that it seemed doubtful whether the new rules of the Society would ever see the light; and the rules of the Society of 1882 and 1883, under which we had previously worked, were in abeyance. We do not claim in any way to usurp the functions of electricians in regard to electric light installations; but hope that our requirements being, as we consider, so clearly set forth, contractors will be able to carry out their work without the slightest friction between us.

Mr. HAMMOND thought it would be well to suggest to Mr. Preece that in his reply he might take advantage of all the leading companies being represented there that evening to impress upon them the great desirability of not only admitting the electric lighted premises at the same rate as the gas lighted premises, but at a considerable reduction (applause).

Mr. PREECE, in reply, said the discussion on this Paper had taken a very different course to that which he contemplated, viz., to bring the matter before the Society on the question of fire insurance risks incidental to electric lighting. His hope was that by bringing before them several examples of serious cases of accident that they might have elicited from members of the Society other cases and accidents that, to the majority of them, were novel and interesting. Unfortunately, owing to the necessity of his having to refer to the action of the committee and to the rules that were brought out, matters quite foreign to the risks incidental to electric lighting had been imported into this discussion. He did not propose to refer in any shape or form to the burning question to some of them—he simply wished to refer to one or two points that were more of a scientific interest than a personal one. There was only one thing he should like first of all to point out: some speakers seemed to think that the risks connected with electric lighting and the rules drawn up to reduce those risks to a minimum were questions that simply affected insurance offices and contractors. He protested against that with all his power (hear, hear), and he said that the

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people here most interested were the users of the electric light (applause). He himself said that the chief object of the rules, and the chief reason why the Society of Telegraph-Engineers took up the subject at all, was to protect the users of the electric light from what he called the rapacity of certain contractors. Again the discussion had, to his mind, proved the truth of a very old proverb, and the discussion which was ended by Mr. Crompton was also a proof of the same proverb, which was this, "That a man convinced against his will is of the same opinion still" (laughter). He did not know that really either the result of the great contest that they had had on the question of alternating current and battery distribution as well as the discussion on fire risks had changed the opinion of a single man present (laughter). It had afforded them a great deal of amusement, and they had passed three or four evenings that session he thought far more pleasantly than they would have passed than if they had visited either a theatre or a music hall (laughter.) He was not quite sure that they had added very much to their information or to those scientific facts that this Society was originally constituted to distribute to its members. There was just one point—he did not like to say one word after what he had said—he scarcely liked to refer to his friend Mr. Heaphy, but he did think it was only right to say that this green cover [referring to a pamphlet criticised by Mr. Heaphy] that had been flourished before them was not printed by the Society of Telegraph-Engineers; it was printed and produced in that form by the Phœnix Fire Office.

Mr. HEAPHY: At the desire of the Telegraph-Engineers.

Mr. PREECE: He merely mentioned that because he did not want to say one word of complaint, but he could repeat every word that he had said the other night in praise of what Mr. Heaphy had done towards the improvement of the electric lighting industry (hear, hear). He did not want to raise any further discussion, but he did want to say this, that if he, as chairman of the committee, or as one who took a great personal interest in the question of the distribution of electric light, could in any shape or form further the interests of their science by bringing together the fire offices and the telegraph engineers, or by doing any mortal thing, he was always ready to do it (hear, hear). He wished further to mention one point of a little scientific interest:—Mr. Human, referring to that rule by which one could distinguish or measure the leakage on a system by taking one-5,000th part, wanted to know how they could detect the one-5,000th part of 15 amperes. Well, he did not suppose there was a single telegraphist in this country—he did not think there was a budding electrician in that room who could not, with the simplest galvanometer in his possession, measure at once three milliamperes, and three milliamperes was the one-5,000th part of 15 amperes; so that really the system of measuring a leakage by taking the figures they had named was a matter of very great simplicity. Mr. Shoolbred asked another interesting question, and that was with reference to the question of heating wires. This relation between heat and currents was one that had occupied him more than any other question for the last five or six years. Scarcely a year had passed that he had not brought in some shape or other a Paper before the Royal Society, or before their Society, or before the British Association, developing the relation between the heating effect of currents on currents; and the last Paper which he read was not very long ago, where he gave the constants that would enable them to determine with great accuracy the current that would fuse a wire of any size or any material, and he had been endeavouring within the last few weeks to apply this same formula and these same constants to the case of wires heated to a given temperature above the normal temperature of the atmosphere. Prof. George Forbes, some four or five years ago, gave them a table in which the currents required to raise wires to 9 degrees and to 26 degrees above the normal temperature were calculated; and Mr. Robert Sabine not very long before his death did something of the same kind. But both of these gentlemen based their calculations upon the constant of missivity determined by Mr. Macfarlane in Sir William Thomson's laboratory in Glasgow—that was, the rate of loss of heat per unit area on the surface of a copper sphere when polished and blackened. Now, there was every reason to believe that this constant of Macfarlane's was not applicable to cylinders. Mr. Box wrote a book in the year 1868 where several tables were produced showing the influence of heat in contact with air, and he showed that the law determining the emissivity of spheres and cylinders was different. He (the speaker) was convinced from experiments he had made that they were a little bit in the dark on this question, and he hoped before this session was over that he should be able to put the results of those experiments in such a form that anybody might calculate with exactitude what temperature the wire would acquire with any given current (applause) They could get at it roughly and approximately now, but he was afraid that they were 30 or 40 per cent. out. He did not know that there were any other questions that he had to answer. He could only, in concluding, express a certain amount of regret on his part that his original notion had not been carried out; but it had this advantage, that while there was no question that was of more interest or of more consequence to them than the risks attending electric lighting that question remained to be solved, and therefore there would be reasons why on some future occasion somebody more competent than himself would be able to bring the question before the Society, and let it have a full and free discussion (loud applause).

On the motion of the CHAIRMAN, a vote of thanks was proposed to Mr. Preece for his Paper, and carried by acclamation.

Mr. CROMPTON said he should like to add that it would only be justice to Prof. Forbes, after what he had said that evening, to say that there was a point in which they were completely in accord. Prof. Forbes had reminded him of what was perfectly true, that he (Prof. Forbes) had started the very important subject mentioned in the Paper, namely, the great advantage from underground mains at the same time as he (the speaker) did. If he had himself got the credit of the introduction, it was as much due to Prof. Forbes as himself.

The proceedings then closed.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *May 12th*, 1888.

We are once more launched on a sea of telephonic controversy. The papers for the re-hearing of the Bell Telephone case have been filed this week in the Supreme Court by the counsel for the People's Telephone Company, which claims, as you are aware, that Daniel Drawbaugh, the village blacksmith of Eberly's Mills, is the real inventor of the telephone. It will be remembered that a distinguished minority of the Supreme Court entered an opinion in Drawbaugh's favour, and encouraged by this, as well as the recent changes in the *personnel* of the Court, this appeal is made: first, on the ground that the Court, in rendering in favour of Bell, erred inadvertently in respect of certain points of facts and of law that were material; and, second, that in consequence of these errors the decision of the Court was against the weight of the evidence. It is not known just what will be done with this appeal. Bell Telephone stock has fallen off a little, standing now about 225. There is some wonder expressed as to where all the money comes from to enable the Drawbaugh people to carry on this fight, especially when it looks so hopeless, and I am informed that a circular has been put out by the president of the People's Company stating that to raise the necessary funds the directors have decided to offer to stockholders 2,000 shares of stock of $100 par value at $6 per share.

It is hard to tell in these days, in America, just where the popular interest in electricity ends. I have recently had occasion to make mention in this letter of several articles in various well-known periodicals, by prominent writers, on electrical topics. But this is only one side of the desire to meet the general curiosity with regard to everything pertaining to electrical applications. Many of the newspapers from week to week devote no small portion of their space to electrical topics. One of the leading papers in St. Louis, for example, serves up to its readers every week an electrical miscellany; while the Omaha *Bee* every Sunday morning lays before the public of that western city three or four columns of the latest electrical items, not merely news, but discussion of scientific questions and topics. All this has its educational side, and must be regarded as full of encouragement. A peculiar evidence of this widespread interest in things electrical was given this week by the *New York World*, which commissioned its celebrated funny man, Bill Nye, to write a comic article on electricity. As you are probably aware the funny man is one of the brightest ornaments of American journalism, and no first-class paper is considered complete unless it has one such humorist on its staff. Bill Nye's reputation is national, and when, therefore, with the aid of illustrations, he expounds his views as to the development of our science for the benefit of a daily paper with a circulation of 250,000 copies, the occasion is one to be noted. I need not ask your readers to follow me into Mr. Nye's description of the manner in which B. Franklin "tapped the low-browed and bellowing nimbus with his buoyant kite," nor into his description of the manner in which the teleseme system keeps its "eye peeled for policemen, and informs the central station where the patrolman is all the time; also as to his temperature, pulse, perspiration, and breath," as you will probably see the article reprinted in England. All will agree with Mr. Nye in the opinion that "electricity and spiritualism have arrived at that stage of perfection where a coil of copper wire and a can of credulity will accomplish a great deal."

The subject of employing wind power for the generation of electric current continues to occupy attention. Not long since I called attention to the figures that had been compiled by Mr. Wolff as to the average rate and duration of breezes in this country, his conclusions being that a good deal of wind power was actually available. The idea is now being given a test by Mr. C. F. Brush at Cleveland, and it is also to have another trial in a large building just being put up at Minneapolis. On the top of this building in a tower will be placed

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a windmill capable of developing 10 horse-power in a breeze blowing at the rate of 15 miles an hour. This windmill will be geared up to a dynamo, and the dynamo will charge accumulators into which current will pass of course, as soon as the necessary rate of speed isattained. The plant will be arranged with the requisite gauges and meters, and there seems no reason why it should fail. If it succeeds, there will be a good many other plants of the same kind started.

On every hand one continues to hear and see evidences of the great development that is now being experienced in the electric power business. Motors are being put in everywhere, and every one of the motor companies is increasing its capacity for production. Some notion of the extent which the business is assuming may be formed from the fact that the Daft Company have just secured a factory building near this city which has a frontage of 256 feet, 3 stories high, in iron and glass, is supplemented by a brick wing of the same height, 142 by 80 feet, and has a total available floor space of about 85,000 square feet. There are about 2 acres of yard room in which cars can be run. To keep such an establishment as this in full blast requires a plenitude of orders; yet the management of the company have no doubt on this score, but are pushing ahead with the utmost activity, and are the more anxious to be ready because the contracts already on hand are far beyond their present power of execution.

By degrees the necessity of regulating more closely interior installation and street line construction is being recognised, and efforts in various quarters are being made to meet the wants of the case. The Board of Aldermen of this city have just adopted an ordinance requiring that all men handling wires shall carry a numbered badge, so that some check may be put upon indiscriminate handling of the wires, and also on carelessness in putting them up or leaving them loose. At a meeting also of the executive committee of the National Electric Light Association in this city this week steps were taken to look into the subject of licensing the men who are entrusted with wiring and with plants. This work has already been begun by the Boston Electric Exchange, and there is said to be no good reason why the National Electric Association should not take it up, and secure common action throughout the country in this respect. Action is expected when the Association meets here next August.

A testing apparatus for telephone transmitters and induction coils has recently been brought out by Mr. Hammond B. Hayes, of Cambridge, Mass., which may interest some of your telephonic readers. Recognising the difficulty of obtaining the relative value of transmitters and induction coils by the measurement of their effects in absolute units, Mr. Hayes has fallen back on a comparative method, and forthis purpose has devised an arrangement of the induction balance. Thus, he places in connection with a fixed coil the transmitter and induction coil to be tested, and by means of a telephone connected with another movable coil he determines the distance at which the effects in the two are *nil* with different forms of transmitters and coils. It is evident that the relative efficiencies of the different apparatus are in the ratio of the square of the distance between the two coils. In order to obtain a true comparison of the value of the transmitters alone it is, of course, necessary to use the same induction coil, and a constant battery for all experiments; and, *vice versâ*, if it be desired to ascertain the respective merits of a number of induction coils, it would be necessary to employ the same transmitter in all experiments. Another method to which the instrument is applied by Mr. Hayes is the ascertaining of the fall in current along the line. Thus, he first determines the distance between the coils at which silence is obtained when the apparatus is connected in circuit only a few feet from the transmitter. He then observes how much nearer together the coils have to be placed at successively increased distances from the transmitter end of the line. In this manner there can be mapped out with considerable accuracy the conditions of a telephone line, as well as the carrying power of any given transmitter.

A short time ago your Institution of Civil Engineers had a Paper read before it by Dr. Hopkinson "On the Bessbrook and Newry Electric Railroad," and in the discussion which took place on that Paper Mr. W. Lineff cited some figures to show that electrical accumulators laboured under a great disadvantage when compared with the direct system of distribution. These proceedings were published in the electrical papers on this side of the water, and have drawn out a reply from Mr. R. M. Hunter, who is identified with a well-known company here engaged in the exploiting of storage battery street cars, but who also equip on the direct system. Mr. Hunter cites Mr. Lineff, and points out that the latter confessedly left out of the calculation all expenses relating to permanent way, generating plant, &c., and consequently the showing made by the storage battery was far smaller than it would have been if these items had been taken into account in the calculation. Mr. Hunter takes Mr. Lineff's own figures, but includes these items, and arrives at these results: That for a few cars on a long line the electrical accumulator system is the most economical as to cost of equipment, but where a large number of cars are used the central station supply or direct system is the cheapest; the latter can only be put in in large cities by means of expensive conduits, which make it nearer equal to the cost of the accumulator system, and on large roads in densely populated districts where many cars are running. Thus, his tables show that if we ignore the difference in depreciation, to operate 10 cars on four miles of track is cheaper with the accumulator than with line conductors; but owing to the greater depreciation in the accumulator system (accumulators as now made) the line conductor becomes cheapest when we get above eight cars on a four-mile track. Mr. Hunter also avers that there are other points besides cheapness of construction which should be considered in this case, and that the storage battery is well able to compete with direct distribution in many cases.

Lieut. H. Hutchins, of the U. S. Navy, has just published in the *Colliery Engineer* some important experiments on the behaviour of incandescent lamps in explosive gases, and has pointed to the fact that precautions must be taken in the use of these lamps when surrounded by such gases. His experiments—which were made with different lamps—as a rule, consisted in placing the lamp in a box with a glass window, and having an opening inside to admit a steel rod for piercing the bulb. His first experiment with a Swan sixteen candle-power lamp consisted in raising the lamp to a white incandescence, the case being filled with hydrogen and oxygen. When the bulb was pierced the gas exploded immediately, completely shattering the lamp bulb. The carbon filament remained intact, probably due to the fact that the glass bulb was shattered into innumerable fine fragments. The conclusion he reached from these experiments was that the inrush of gas does not break the Swan filament before the gas can become ignited. Consequently in a highly explosive gas the breaking of an incandescent lamp would be dangerous, at least with a filament not less delicate than that of the Swan lamp. In another experiment with marsh gas the gas did explode, but the filament was found to be broken, due to the flying pieces of glass. Next, the Maxim lamp, ruptured in pure coal gas, merely resulted in the deposition of the carbon of the gas upon the filament, or, in other words, in the "flashing" usual in the manufacture of lamps. With coal gas and air mixed another Maxim lamp did not have its filament broken by the inrush of gas, nor by the flying pieces of glass. The lamp continued to burn for a few seconds, then the required temperature being apparently reached the gas exploded, the containing case was lifted 5ft. or 6ft. in the air, and the filament broken by the force of the explosion. From these experiments Lieutenant Hutchins concludes that the incandescent filament, providing it is as tough as either the Swan or Maxim filaments, coming in contact with either a high explosive gas, such as the mixture of hydrogen and oxygen, or a comparatively weak one, such as coal gas and air in explosive proportions, will explode them. And he concludes, finally, that when explosive gases are allowed to collect on board ship from bad ventilation or other causes, incandescent lights, such as are used in these experiments, are dangerous for ship lighting. The moral or lesson as to the necessary precautions is obvious.

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CORRESPONDENCE.

"THE RISE AND PROGRESS OF TELEPHONY IN THE UNITED KINGDOM."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your issue of last week on the above subject gives what at the present time must be to many very interesting information in regard to telephone matters, and outsiders will welcome what is given with reference to the Telephone Exchanges in London, as hitherto so little has been brought out with reference to them.

There are some points in the statistics which seem to require explanation, however. I notice in the weekly average of the number of calls the United Company is shown as 221,764, and the National Company as 420,000—which is nearly double for the National; while in the statistics for June, 1887, it is shown that the calls per day are greater for the United than for the National Company—the former having 74,462, while the latter has only 70,000. Can this be right?

I would likewise point out that there is a difficulty in seeing how the United Company, with 4,622 exchange subscribers and 1,003 private, can use as many as 13,477 instruments. Each exchange subscriber requires only one instrument (except in the case of extension lines), while each private line requires, of course, two instruments. The same is to be remarked with reference to all the companies with the exception of the South of England Company, and it seems strange how they can work 1,203 exchange lines and 370 private wires with only 1,667 instruments.

The plan showing the wires connecting the exchanges in London is interesting in so far as it shows how the work is done; but few, I fear, outside of London can approve of this way of doing what is a very important part of telephone exchange work, and in scarcely any of the provincial centres is it done in this manner, the approved way being to establish what is known as a trunk exchange for giving connections between all the different exchanges, a system which is proved to have many decided advantages. This means that a central point is established, and all trunk or junction wires run to that point, the operators at which are provided with what is known as a call wire to as many outside exchanges as they can reply to and operate for. With this call-wire system the operators in the branch exchanges are practically as much in communication with the Central Trunk operators as if sitting by their sides, as no ringing or calling of attention in any way is necessary.

The advantages are obvious, inasmuch that more work can be had out of the wires, and in consequence a fewer number will suffice when run to one point, where they are all under the control of one or more operators, than if divided into a certain number run to several exchanges.—Yours, &c.,

TELEPHONIST.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is perfectly true, as stated by "Telephonist," that very little authentic information has hitherto been available with regard to the work of the metropolitan telephone exchanges. We understand that this has been due in the main to the exigencies of the commercial development of the telephonic work of the country, carried out as it has been by a series of companies working with common interests, but in friendly rivalry. An immense amount of work is continually in progress in connection with the telephone exchange system in London which does not come directly under the public notice, but bears fruit in the ever-increasing efficiency and extension of the telephone service.

The writer is informed, however, that the parent company considers that the time is now ripe for taking the public more fully into their confidence, and that they intend from time to time to make public any particulars which would appear to be of general interest.

The writer has to express his obligations to "Telephonist" for having detected two errors in the figures given. These errors occurred in the figures supplied by the companies, and were not noticed in time to prevent their insertion. The manner in which they occurred is fairly obvious. It may be pointed out, in the first place, that every telephone call involves two messages, the call and the reply, so that the total number of messages is obtained by doubling the number of calls. The number 420,000 given as the total number of "calls" per week in 1887 is really the number of messages, the number of calls being only 210,000. The numbers for the other companies all refer to the calls only, so that the number 210,000 must be subtracted from the final total. With regard to the number of instruments employed, two instruments are required for each exchange wire, namely, a transmitter and a receiver, and more in the case of extension wires, some large firms having as many as 60 or 70 instruments on their premises. In the case of private wires four instruments are required, two at each end; but a small deduction usually has to be made from the total owing to some subscribers possessing both an exchange connection and a private wire, and using the same set of instruments for both; but, on the other hand, the instruments in use in the switch rooms have to be added. In the case of the South of England Company the number 1,667 is clearly too small, and evidently refers to sets of instruments instead of to single instruments.

"Telephonist's" criticism of the London system is entirely beside the mark. A more careful inspection of the diagram and reference to the text would have shown him that the central exchange at Oxford-court is a central trunk exchange, the trunk lines leading to it being shown by the dotted lines in the diagram, as explained in the text. There are, indeed, no subscribers connected directly with the Central Exchange, which is exclusively for trunk lines.

In addition to this, all the exchanges between which there is frequent communication are directly connected by one or more local trunk lines, which greatly facilitates the work; and, besides, it would be the height of imprudence to risk having all the trunk wires in one building, and consequently all subject to derangement by fire or other accident.

The ideally perfect system would be to have every subscriber connected directly to a single central exchange; but this, even if the necessary way-leaves could be obtained, would necessitate the use of wires nine or ten miles in length to connect single subscribers to the exchange.

Failing this, the best system ideally would be to have every exchange directly connected with every other; but this, again, would be physically impossible in London, and the system adopted is a combination of this with the central trunk exchange system which "Telephonist" advocates, while he has failed to perceive that it is actually in use, and is clearly set forth in the diagram which he refers to.

At the present time there are upwards of 300 of these trunk wires working from Oxford-court, and almost as many more local trunks working between the exchanges.—Yours, &c.

THE WRITER OF THE ARTICLES
ON "THE RISE AND PROGRESS OF TELEPHONY
IN THE UNITED KINGDOM."

SYNCHRONOUS MULTIPLEX TELEGRAPHY.

(Translated from the Danish.)

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the issue of your esteemed journal dated the 27th of April last, Mr. Patrick B. Delany has contributed a Paper as a reply to some articles which appeared in the *Electrical Review* during the autumn of 1887, and in which I proved that the synchronism which Mr. Delany applies to his synchronous multiplex telegraphy is essentially mine.

Synchronous multiplex telegraphy comprises three things:—

1. To provide an isochronous motor; *i.e.*, a motor of as even a motion as possible.

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2. To make two or more isochronous motors at different places to move absolutely synchronously.

3. To connect telegraphic instruments to the motor in such a manner that two and two successively are joined to each other by means of the synchronous motors.

It is well known that synchronous multiplex telegraphy on these principles is not new, that all the methods which formerly were used utilised a less successful isochronous motor —for example, a conical pendulum. Nevertheless, synchronous multiplex telegraphy was largely used, and there were many solutions regarding it; whereas the basis, the isochronous motor, as a rule, was little modified, although greater exactness and simplicity were vastly needed.

My first work in this field was therefore to provide a new foundation, which I did by means of my invention "the phonic wheel." The instrument is based upon a new principle, quite independent of the isochronous motors formerly employed; nay, it even represents a new physical principle, *dynamic stable equilibrium*. It has been described in detail so often that it is quite unnecessary for me to say more about it here; suffice it that it is an invention, which in its relation to a vibrating body—for instance, the tuning fork—is the same as that of a clock to a pendulum.

This invention no one has hitherto disputed as mine. Now, however, Mr. Delany comforts himself that Lord Rayleigh says that he nearly simultaneously with me had the same idea, that he carried out and made it public. I do not consider this circumstance has anything to do with Delany's; it is not the first time that two physicists simultaneously, and yet independently of each other, have had one and the same idea, nor does this detract from the honour of either. On the contrary, it is not to Mr. Delany's credit when he says that Lord Rayleigh's instrument was "exhibited with a detailed statement of the theory of its operation at a meeting of the Physical Society on the 30th of March, 1878, and published in *Nature*, May 23rd, 1878," while he suppresses—what cannot have escaped his observation in my reply to Lord Rayleigh—that "on the 22nd of February, 1878, Prof. Holten laid my invention before the Royal Danish Academy of Sciences, and on the 8th of March, 1878, my pamphlet, 'Tonehjulet' ('La Roue Phonique') was published in Copenhagen." The reason that Lord Rayleigh has not raised any remonstrance against Delany's synchronism is probably simply this, that Lord Rayleigh never intended nor tried to use his instrument in this direction, but only mentions that "an application to the determination of absolute pitch is given as an appendix to one of my Papers upon the ohm (*Phil. Trans.*, 1883, page 295). It has sometimes appeared to me that the principle might be applied to regulation of equatorial telescopes;" while my pamphlet of the 8th of March, 1878, points out a variety of applications, and especially the enormous importance of the phonic wheel for synchronism. It is, therefore, and because I have introduced the principle of the synchronism which Mr. Delany uses, that I have strong reasons for objection, and I say, as before—and history will doubtless confirm my view—that the phonic wheel is the very base and foundation of the new synchronous multiplex telegraphy. The scientific principle of this instrument will maintain its ground long after Mr. Delany's special application of it is forgotten, and it will be no slight to me, but an honour, when, then, Lord Rayleigh's name will be named together with mine.

When, on the other hand, a powerful company as the "Standard Electric Manufacturing Company," of New York, with Mr. Fred. P. Jones as President and Mr. Patrick B. Delany as electrician, thinks it becoming to wage an economic war against a poor scientist instead of coming to terms with him, then this proceeding is not either unknown in the history of science and its applications. In the United States I have been paid what I asked; but in Europe, where I could not afford to renew my original patents for the phonic wheel, and where the matter could be completely secured by patents for the synchronism, even when I sold my American patent, they have been simply appropriated. With the money I received I was enabled to patent the improved synchronism in Europe, shortly after having sent Mr. Jones a description of it, while Mr. Delany just a year after patented the same synchronism with some modification in the description. After this the synchronism belonged to me in Europe, not only morally but legally. Now Mr. Delany says that he has about 20 patents. Everybody who knows anything at all about waging war with patents knows also that it requires a long purse, especially, as in this case, when it is Mr. Delany who is to be attacked, for instance in England, while his patents belong to a company in America. As far as pecuniary support is concerned I am not a match for Delany.

It will be observed that there is here a question of two different synchronisms. *The first* rests upon the law that when a tuning fork is acted upon by attraction or repulsion, corresponding approximately with its own pitch, it will oscillate perfectly in accordance with these and not with its own pitch. This was thus utilised: Impulses from station 1 kept a tuning fork at station 2 in absolute synchronous movement. *The second* synchronism aims at sending a correction current from station 1 for each revolution by which an independent oscillating tuning fork at station 2 is kept in automatic synchronism with that at station 1.

The Americans have now proceeded as follows: First and foremost they have endeavoured to preserve for me the honour of the first synchronism, in the hope that attention should thereby be drawn from the fact that the second likewise is mine; they further sought to maintain that the first is an impossibility. I have already spent too much time in proving that the first synchronism was good. I have another and later one, patented in 1881, which is better. It is misleading to continue to negotiate about the first; Mr. Delany, however, still treats of the first one. He insinuates continually that there never was real synchronism, but only something that was kept going by means of a "turntable," and to prove it Mr. Delany speaks of the small amount of work that was done on the line. He overlooks what I have so often said, viz., that I do not pretend ever to have invented a telegraphic system; and after having solved the first part of the problem, viz., the isochronous motor, I went to work on the second part, the synchronism. It was this I accomplished and tried in 1880 between Frederica and Nyborg. It is impossible to make Mr. Delany understand that synchronism is one thing and telegraphy another. If I try the synchronism with galvanometers, I do not pretend to have made a galvanometric invention, nor a telegraphic one because I employ telegraph instruments.

Mr. Delany, however, gives a means of settling the dispute. He says (*Electrician*, April 27, page 715): "If Mr. la Cour will pardon the suggestion, I would advise him to repeat his Frederica and Nyborg demonstration, unless synchronism on that plan has become a lost art. Its reproduction would throw much light on this question. If he succeed without the turntable, then I will publicly recant all my doubtings."

Well, I take him at his word on two conditions. First, that by "all my doubtings" is understood not only the possibility of this synchronism but also my improved synchronism, patented in 1882, which he, by-the-bye, does not appear to doubt so much; and, secondly, when he not only will recant publicly "all his doubtings," but also, without it being necessary for me to go to law with him about his European patents, will pay me for the encroachment, which he by these has made upon my rights, the sum of £10,000 sterling. As a matter of course I cannot spend time and money on a demonstration without gaining something by it; and to all impartial men I am in possession of a sufficiently distinct declaration by the Danish officials (see *Electrical Review*, September 30th, 1887) without going to further trouble. If Delany is so sure that neither the first nor the second synchronism is workable, he can safely accept my offer. I require naturally a guarantee that Mr. Delany will fulfil his part of the arrangement, and it would be better if Mr. Delany himself, or some competent person, be present, and certify that the synchronism really keeps in order from morning until night *automatically*, and *without the use of a turntable*.

After this offer on my part it is not necessary to consider further the "improved synchronism," which by-the-bye is the

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main point, as it is this Mr. Delany has appropriated. The reason why I have not been fortunate enough to make use of the system practically is easily understood from the fact that I never took the final step in synchronous multiplex telegraphy, *i.e.*, to construct telegraph instruments; and Governments and telegraph companies are not disposed to introduce anything but complete telegraphic systems. *The perfection and simplicity of my synchronism have in all cases* been acknowledged and demonstrated (see *Electrical Review*, October 7th, 1887), and it is further absolutely unfounded on the part of Mr. Delany to write that the synchronism which M. Cassagnes uses, and which is attested by the French Government, is not mine, but his. It is true that they are difficult to distinguish, but M. Cassagnes has not employed anything whatever except what is indicated in my patent, which is a year older than Delany's. The only thing to be seen on Mr. Cassagnes' drawing that is somewhat different from mine is that he varies the strength of the current in the receiving fork by the insertion of larger or smaller *resistances*, whereas my drawings show the application of a higher or lower *electromotive force*. This is no greater difference in the electrical world than a nail or a screw amongst joiners, and I have been careful enough to remove all misunderstanding, for I claim "*by varying the strength of the current that operates the tuning fork.*"

As Mr. Delany's arrangement of the improved synchronism is so similar to mine that he has not been able to distinguish them in Cassagnes' installation, there is only one excuse for his interference—namely, that he has added that very part which changed my synchronism from impossibility into possibility; and if Mr. Delany accepts my above named offer, I shall further prove to him that an arrangement in all its details corresponding to and identical with the particular parts of my patent—I cannot afford to multiply them into twenty patents—also works with absolute precision from morning till night. I may add that I shall publicly withdraw any claim on Delany's synchronism if both demonstrations do not succeed perfectly.

It is quite superfluous to reply to Mr. Delany's remark that I "make no provision for static discharge." This is a special telegraphic arrangement which I have not been occupied with.

From the certainty with which Mr. Delany, in *The Electrician* of the 27th of April last, speaks of the impossibility of my synchronism, and from the offer I have here made, it will now be seen whether the Americans have acted in good faith when they appropriated rights which in their opinion were worthless, or if the whole is only a manœuvre, similar to those practised on several other occasions, the object of which is to make a large profit without coming to terms with the rightful inventor.—Yours, &c., PAUL LA COUR.

Copenhagen, May 18, 1888.

TAVENER'S COULOMB METER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the current issue of a contemporary journal appears a notice of an electric meter said to be of Prof. Elihu Thomson's design, and a note also appeared in your journal on the 11th inst. describing the same meter and attributing its design to the same gentleman. Now, as these notes are calculated to mislead, I think it is only right to state that the principle upon which this meter works has already been adopted by Tavener in his meter, a notice of which appeared in your journal on December 16th, 1887. The principle involved is that of utilising the heating property of the current for producing an oscillating motion of the containing tube, and consequent registration of the quantity of electricity, whether by continuous or alternating currents, passing through the circuit.

As Prof. Thomson has designed his meter on exactly similar lines as Tavener, and as his, moreover, bears upon it evidence of a knowledge of the prior existence of Tavener's meter, it appears to me that to the last-named is due the credit for the ingenuity manifested in the production of a meter working on a principle differing so completely from those upon which current meters have hitherto been designed and worked.

Honour to whom honour is due; to originate a meter working on the principle I have delineated, which shall register accurately the amount of current passing through it at any time, is one thing, while to copy such a meter and calmly to appropriate its invention is quite another.—Yours &c.,

WILLIAM PHILLIPS MENDHAM.

Western Electrical Works, Bristol, May 22, 1888.

JARMAN'S ELECTRIC TRAM CAR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I observe your notice upon Messrs. F. Walker and Hyde's report *re* the electric tramcar that bears my name. Perhaps this report was not so full as might be desired; this, however, will before long be forthcoming. The trials recently made with this car prove, as near as proof can be got outside everyday working, that tramcar propulsion by stored electric energy will, ere long, take its place in competition with horses. If the life of the accumulators proves what is expected then there will be no fear of a real commercial success.

Respecting the double armature motor, which has been the subject of some remark, I can only state that I more than ever rigidly adhere to this plan for every trial yet made with this car proves its advantage. No matter the number of stoppages, this plan enables the time to be kept on the outward or homeward journeys, a point so necessary in tramway traffic.

There is every prospect before long of having a couple or more of these cars running upon one of the suburban lines, which will enable the electrical, engineering and commercial values to be fully proved.—Yours, &c., A. J. JARMAN.

Brixton, S.W.. May 23rd, 1888.

PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

5,522. A. H. G. SEGNITZ (of the firm of Rösing Brothers and Co.), London. Improvements in telephonic apparatus (E. Brand, Brazil). April 13, 1888.

5,528. E. HERMITE, E. J. PATERSON, and C. F. COOPER. London. An improvement in plates for voltaic batteries. April 13, 1888.

5,529. P. G. MERRY. London. Improved construction of reflector for use with incandescent electric lamps to facilitate its removal or re-adjustment.

5,531. J. G. STATTER. London. A new or improved system of electric lighting and apparatus therefor. April 13, 1888.

5,586. H. H. LAKE. London. Improvements relating to holders or supports for electric incandescent lamps and to contact devices for use therein, and for other purposes (C. Grivolas, France). April 14, 1888.

5,640. H. EDMUNDS. London. Improved means to be used in supplying, distributing, controlling, and indicating electricity for lighting and other purposes. April 16, 1888.

5,681. C. S. SNELL. Saltash. Improvements in switches used for electrical purposes. April 17, 1888.

5,704. J. S. RAWORTH. London. Improvements in switch-boards or apparatus for the distribution of electricity. April 17, 1888.

5,708. J. LEA and C. JULIAN. London. Improvements in dynamo-electric machines and motors. April 17, 1888.

5,713. J. K. HALLOCK and J. C. BLICKENSDERFER. London. Improvements in electric elevators. April 17, 1888.

5,723. W. WEBSTER. London. The production of chalybeate waters by electrolytic action and apparatus therefor. April 17, 1888.

5,731. H. H. LAKE. London. Improvements in and relating to apparatus for measuring electric currents, which apparatus will also serve as a motor (E. Thomson, United States). April 17, 1888.

5,732. H. H. LAKE. London. Improvements in and relating to apparatus for measuring electric currents, which apparatus will also serve as a motor (E. Thomson, United States). April 17, 1888.

5,745. S. H. GILLAM. Bridgwater. An instrument for use in making electrical contacts. April 18, 1888.

5,753. G. HUCK. Burnley. "The Daisy" long-distance telephone and transmitter. April 18, 1888.

5,782. W. C. MOUNTAIN. London. A new or improved electric arc lamp. April 18, 1888.

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5,783. W. C. Mountain. London. Improvements in electric transformers. April 18, 1888.

5,786. G. Cashel. Liverpool. Improvements in clips or holders applicable for use in connection with telephones and other instruments whereby writing paper for recording messages received, or books and the like, can be firmly held in place while messages are received or transmitted. April 18, 1888.

5,790. H. Steinach. London. Improvements in and relating to the preparation of non-metallic porous bodies for electro-metallurgic deposits. April 18, 1888.

5,811. R. E. B. Crompton and J. Swinburne. Chelmsford. Improvements in and connected with the generation and distribution of electrical power, chiefly by alternating currents. April 19, 1888.

5,831. T. Schönherr-Schöner. Leeds. Improvements in means or apparatus for lifting, lowering, and regulating the height of the elements in electric batteries. April 19, 1888.

5,848. H. Edmunds. London. An apparatus for performing operations at intervals applicable to the making of electric contacts, or for analogous uses. April 19, 1888.

5,870. R. Rauschke (of the firm of Mayer Meltzer and Co.). Halifax. Improvements in electric batteries. April 20, 1888.

5,899. W. Chadburn. Liverpool. Improvements connected with ship's engine-room telegraphs. April 20, 1888.

5,900. W. Chadburn. Liverpool. Improvements connected with mechanical telegraphs for use in navigable vessels. April 20, 1888.

5,911. M. H. Smith. London. Improvements in railway rolling stock and in the arrangement of switches and of motors for electrically propelling same. April 20, 1888.

5,913. A. W. Heaviside. Newcastle-on-Tyne. Improvements in electric telegraph, telephone, and electric light insulators. April 20, 1888.

5,922. G. Stuart. London. Improvements in connections especially suitable for joining electric conductors. April 20, 1888.

5,937. A. Collingridge. London. Improved galvanic salts. April 21, 1888.

6,046. R. von Fischer-Treuenfeld. London. Improved jointer or coupling for electrical conductors. April 23, 1888.

6,075. E. E. Ries. London. New and improved method of heating by means of electricity. April 24, 1888.

6,076. A. Gross. London. Electrical appliances for a mariner's compass to give alarm upon deviation from the ship's course. April 24, 1888.

6,083. F. Jacob. London. "Improvements in "Morse inker" apparatus for telegraphic purposes. April 24, 1888.

6,100. J. T. Todman. London. An improved form of locking electrical indicator. April 24, 1888.

6,133. F. R. Boardman and F. Teague. London. Improvements relating to electric arc lamps. April 25, 1888.

6,157. R. E. Keen. London. Improvements in lanterns for electric arc lamps, and in posts or columns for supporting the same. April 25, 1888.

6,184. M. Ruddle (of the firm of Sanderson, Ruddle and Co.). Manchester. Improvements in telephones. April 26, 1888.

6,191. C. A. J. H. Schroeder. London. Mode of preparing carbons for electric lighting. April 26, 1888.

6,214. C. W. Farquhar. London. Improvements in laying underground electric conductors. April 26, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

Note.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

April 21, 1888.

6,204. W. J. Muller. London. Improvements in induction coils and transformers. April 28, 1887.

7,553. F. George. Dursley. A method of regulating the electromotive force of dynamo-electric machines. May 25, 1887.

8,181. H. A. Taylor (of the firm of Clarke, Forde and Taylor). London. Improvements in means or instruments for testing submarine electric telegraph cables or for analogous purposes. June 7, 1887.

8,708. J. Oppenheimer. Manchester. Improvements in apparatus for fixing telegraph posts. June 16, 1887.

8,710. T. Nordenfelt. London. Improvements in electrical apparatus to be used with ordnance to fire the charge. June 16, 1887.

8,855. E. Julien. Liverpool. Improvements in and appertaining to electric piles and plates therefor. June 20, 1887.

10,963. J. A. Fleming and C. H. Gimingham. London. Improvements in instruments for the measurement of electromotive force and power. August 10, 1887.

13,970. M. Nightingale. London. Improvements in the mode of and means employed for automatically administering medical electricity to the human frame; also applicable for other purposes. October 14, 1887.

2,515. J. Feaveryear. London. Improvements relating to dynamo-electric generators and motors. February 20, 1888.

3,835. H. P. Copeland. Manchester. Improvements in telegraphic apparatus. March 13, 1888.

3,995. H. H. Lake. London. Improvements in and relating to galvanic batteries (H. Walter, United States). March 15, 1888.

4,274. W. P. Thompson. Liverpool. Improvements in or relating to storage batteries (C. D. P. Gibson, United States). March 20, 1888.

4,275. W. P. Thompson. Liverpool. Improvements in or relating to storage batteries (C. D. P. Gibson, United States). March 20, 1888.

April 28, 1888.

1,333. W. Webster, Jun. London. Improved means of oxidizing and decomposing by electrical action organic matter and inorganic salts in sewage, water and other liquids. January 27, 1888.

6,682. J. Swinburne. Chelmsford. Improvements in and connected with electrical distribution by means of direct or alternating currents, chiefly for lighting purposes, and in electric measuring instruments which may be used therewith. May 6, 1887.

6,993. H. H. Slater and A. S. Newman. London. An improved apparatus for signalling by electricity. May 13, 1887.

7,426. A. C. Henderson. London. An improved process for the preparation of aluminium, aluminium bronze, alloys of aluminium by electrolysis (P. L. T. Héroult, France). May 21, 1887.

7,618. W. M. Mordey and C. E. Webber. London. Improvements in electric transformers, induction coils, or inductional resistance coils. May 25, 1887.

7,857. H. Tudor. Liverpool. Improvements in registering meters for electric currents. May 31, 1887.

8,433. F. W. Neale. London. A telephone apparatus without a diaphragm. June 11, 1887.

9,011. E. Jones. London. Improvements in the construction of dynamo-electric generators and motors. June 24, 1887.

14,544. W. D. Sandwell. London. Improvements relating to electric motors for driving tramway vehicles and for other purposes. October 25, 1887.

14,622. E. E. Vaughton. Birmingham. An improved electric accumulator. October 27, 1887.

3,678. W. G. Olpherts. London. Improvements in and relating to electrical signalling on railways and in apparatus therefor. March 9, 1888.

4,561. C. A. Brown. London. An improved battery jar. March 24, 1888.

PATENTS SEALED.

April 20, 1888.

14,974. M. Settle. Bolton. Improvements in electric safety lamps for use in mines and other places. November 18, 1886.

3,225. R. Dick and R. Kennedy. Glasgow. Improvements in and relating to the generation and distribution of electric energy and machines or appliances therefor. March 2, 1887.

4,032. M. Immisch. London. Improved holder for brushes of electromotors and dynamo machines. March 17, 1887.

4,322. J. Hopkinson (London) and E. Hopkinson (Manchester). Improvements in dynamo-electric machines. March 22, 1887.

4,472. S. P. Thompson. London. Improvements in electro-deposition of cobalt. March 25, 1887.

4,978. F. T. Schmidt. Bradford. An inproved holder and switch for electric lamps. April 4, 1887.

4,980. F. T. Schmidt. Bradford. Improvements in apparatus for making and breaking electrical circuits in connection with call or alarm boxes. April 4, 1887.

5,009. J. T. Armstrong. London. New and improved methods of charging and recharging, cleansing, changing, and varying the chemicals and liquids used in secondary batteries or accumulators. April 4, 1887.

5,092. B. Egger. Vienna (Austria). Improvements relating to switches for electrical purposes. April 5, 1887.

5,228. W. H. Bayley. Walsall. Improvements in holders for incandescent electric lamps. April 9, 1887.

5,972. A. Johnston. Dundee. A new or improved method of attaching telegraphic, telephonic, or other insulators to bolts, spikes, and the like. April 25, 1887.

6,972. J. C. Mewburn. London. Apparatus for obtaining derived currents of variable intensity from a main electric current (La Société Anonyme pour la Transmission de la Force par l'Electricité). May 12, 1887.

April 27, 1888.

2,598. T. P. Hewitt. Prescott. Improvements in electric gas lighters. February 19, 1887.

5,096. G. Kapp. London. Improvements in dynamo-electric machines. April 5, 1887.

5,365. W. T. Barnard. United States. Improvements in acoustic or tone telegraphy. April 13, 1887.

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5,383. H. LIEPMANN. London. Improvements in galvanic batteries. April 16, 1887.
100. H. H. LAKE. London. Improvements in and relating to apparatus for generating electricity (W. Humans, United States). January 3, 1888.
623. R. J. GULCHER and J. PINTSCH. Berlin, Germany. Improvements in thermo-electric elements and piles. January 14, 1888.

SPECIFICATIONS PUBLISHED.

4,220, 1887. J. W. KING. Measuring electric currents. (Price 8d.)
4,447, 1887. P. B. ELWELL. Measuring, &c., currents of electricity. (Price 8d.)
4,832, 1887. H. LIEPMANN. Carbon plates for primary batteries, &c. (Price 8d.)
6,104, 1887. A. LE N. FOSTER and F. V. ANDERSON. Electrical measuring instruments. (Price 8d.)
6,219, 1887. J. SWINBURNE. Induction apparatus. (Price 6d.)
7,184, 1887. W. MACKIE. Electric arc lamps. (Price 8d.)
7,950, 1887. D. J. SMITH and H. F. JACKSON. Telephones. (Price 8d.)
8,159, 1887. W. SMITH. Electric telegraphic communication. (Price 8d.)
2,179, 1888. M. WHEELER. Incandescent electric lamps. (Price 6d.)
2,246, 1888. H. H. LAKE (Eickemeyer). Dynamo-electric machines. (Price 1s. 1d.)
2,250, 1888. J. H. LINVILLE. Printing telegraphs. (Price 3s.)
2,308, 1888. C. COERPER. Dynamo-electric machines. (Price 4d.)
3,079, 1888. B. M. DRAKE and J. M. GORHAM. Secondary voltaic batteries. (Price 6d.)

COMPANIES' MEETINGS.

The Bournemouth Electric Light and Power Company (Limited).

The first general meeting of the shareholders of this Company was held on the 15th inst. at the Fine Art Gallery, Palmerston Lodge, Old Christchurch-road, Bournemouth. Dr. Nunn was voted to the chair, and called upon the secretary to read the Directors' report and the financial statement, which were adopted without a dissentient.

The election of officers for the ensuing year was next proceeded with. The names of those gentlemen who had qualified for the post of Director, or who had the intention of doing so, were—Major-General Hutchinson, Mr. D. M. Fox, Mr. A. H. Sanderson, Mr. W. A. Smith, Mr. J. Donkin, Mr. G. J. Piercy, Capt. Williams, R.N., Dr. Dewes, and Mr. J. S. Helyer. Dr. Dewes declined to stand, and Mr. Helyer, the originator and promoter of the Company, also withdrew, whereupon the names of the first seven gentlemen were put to the vote, and they were afterwards declared elected. Mr. H. T. Trevanion was appointed solicitor to the Company; Messrs. Wheatley and Cridland were appointed auditors in the room of Mr. Atkinson; and Mr. W. E. Shakell was re-elected secretary. Mr. Shepherd was appointed manager of the works.

A vote of thanks to the Chairman concluded the proceedings.

We understand that the work of laying down the plant is nearly completed, and it is expected that lights will be running within a month from the present date.

Schmidt Douglas Electric Company (Limited).

The first annual meeting of the shareholders of this Company was held at the Alexandra Hotel, Bradford, on Thursday, the 17th inst. The chair was occupied by Dr. Bowman, the Chairman of the Company.

The annual report and balance-sheet were adopted. The accounts showed a profit of 7½ per cent. on the year's working, carrying forward £400 to the reserve fund.

The CHAIRMAN stated that in consequence of alterations in the premises the Company had only virtually been working for six months, and had large contracts uncompleted.

It was decided by the shareholders for the present to carry the dividend to a suspense account, so as not to interfere with the working capital of the Company.

The CHAIRMAN of the Company spoke hopefully of the future prospects of electric lighting, and said that if a larger number of shareholders could be obtained there was no doubt but that the business of the Company could be made highly remunerative.

At the conclusion, a vote of thanks to the Chairman and the Directors was moved by Alderman FREDERICK PRIESTMAN and seconded by Mr. STEPHENSON.

NEW COMPANIES REGISTERED.

THE WATERWORKS, GAS AND GENERAL LIGHTING CORPORATION (LIMITED).—Registered by R. B. Johnson 50, Parliament-street, Westminster. Capital £1,000,000, divided into 100,000 shares of £10 each. Object, to promote and assist in promoting waterworks, gasworks, hydraulic works, electric and other lighting works, and the business of supply connected with them, or any of them, in the United Kingdom or India or in any foreign country or in any colony or dependency of the United Kingdom or India. The first subscribers are:—

	Shares.
J. J. Gibson, 22, Noyna-road, Tooting, S.W.	1
H. J. Hogarth, 24, Hanover-gardens, Kennington, S.E.	1
H. J. Newell, estate agent, 7, Railway-terrace, Wemby, N.W.	1
R. Thorp, mantle manufacturer, 44, Farringdon-street	1
A. Bell, accountant, 17, Springdale-road, Stoke Newington, N.	1
A. Martin, accountant, 23, Billifield-road, Brixton, S.W.	1
M. Ross, 3, Queen Anne's-gardens, Bedford-park	1
E. Thomson, clerk, 73, Linnell-road, Camberwell, S.E.	1
W. Whittington, 53, Fleming-road, S.E.	1

The number of directors shall not be more than 11 nor less than three. The first directors shall be appointed by the subscribers to the Memorandum of Association. The qualification of every director shall be the holding of not less than £2,000 in stock or shares of the company. The directors shall be paid the sum of £100 per annum each for their services to the company.

BRITISH ASSOCIATION OF MEDICAL ELECTRICIANS.—This association was registered on the 5th inst., as an unlimited company without specified capital, to promote and encourage the study and practice of medical electricity. The subscribers are:—

C. B. Harness, Potter's Bar, consulting medical electrician.
J. F. Leesen, L.R.C.P., 57, Church-road, Brighton.
H. C. R. Sharman, 1, Maley-terrace, Lower Norwood.
C. B. Hollier, Oakbrew, Streatham, consulting electrician.
J. H. Hodges, 16, Great Ormond-street, medical electrician.
Prof. Carter Moffatt, Northumberland Park, N.
A. Smith, 1, Rathbone-place, W.

The management will be vested in a council.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, May 23, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending May 23, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American	37½ 38½	3 11 5	Jan., Apr., July, Oct.	38½	...
2,614,820	Stock	20/0	Do. Preferred	63½ 64½	4 4 0	,, ,,	64	...
2,614,820	Stock	nil.	Do. Deferred	12½ 13	...	February	...	...
130,000	£10	3/0	Brazilian Submarine	12⅝ 12⅞	5 12 0	Mar., June, Oct., Dec.	12 9/16	12⅝
16,000	10	8/0	Cuba Submarine	13 13⅛	6 1 0	February and August	...	...
6,000	10	10/0	Do. Preference	18½ 19½	4 2 1	,, ,,	...	..
12,931	5	2½%	Direct Spanish (£4 paid)	3½ 4½	3 10 0	March & September	...	...
6,000	5	5/0	Do. Preference	8½ 9½	4 4 3	April and October	...	...
60,710	20	2/0	Direct United States	8⅜ 8⅝	4 10 0	Jan., Apr., July, Oct.	...	...
380,000	10	2/6	Eastern	11⅝ 12	4 12 9	,, ,,	12	11¾
70,000	10	3/0	Do. 6 per Cent. Preference	14¾ 15¼	3 19 0	,, ,,	...	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	110	...
250,000	10	2/6	Eastern Extension	12⅞ 13⅛	5 0 9	Jan., Apr., July, Oct	13 1/16	12⅞
22,050	10	5/9	German Union Telegraph and Trust	9 9⅜	7 7 4	January and March	9	...
179,177	10	1/6	Globe Telegraph and Trust	5⅞ 6⅛	5 1 0	Jan., Apr., July, Oct.	5 1/16	5⅞
178,992	10	3/0	Do. 6 per Cent. Preference	13⅞ 14⅛	4 5 0	,, ,,	14	13¾
150,000	10	5%	Great Northern	14⅛ 15	5 0 0	Jan., July, and April	14⅜	14⅛
17,000	25	5/0	Indo-European xd	36 38	6 11 7	April and October	37	...
38,348	10	3%	London Platino Brazilian	5⅞ 6¼	...	May and November	6	...
9,000	8	4/0	Reuter's	7⅛ 8	5 0 0	April and October	...	...
338,225	Stock	12%	Submarine	140 150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America	5⅞ 6¼	8 0 0	January and July	6 1/16	5⅞
150,000	100	8%	Do. Debentures	112 117	6 16 2	June and December	...	...
88,321	10	nil.	West India and Panama	7/8 1⅛	...	...	1	...
34,563	10	9/0	Do. 1st Preference	10⅝ 11¼	8 8 9	April and October	11¼	11
45,181	15	3/9	Western Brazilian xd	10 10¼	6 4 6	March & September	10¼	10 1/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 10	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	6/8 7/8	5 0 0	Yearly	...	...
220,000	£1	...	Oriental (11s. paid)	1/16 1/8	...	...	...	...
80,000	5	5/0	United	14⅜ 15	4 6 8	June and December	15⅛	14⅞
50,000	5	2/6	United River Plate	4⅞ 5⅛	...	April and October	...	...
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb. '86	Anglo-American Brush (£4 paid)	2⅜ 3½	...	...	2½	...
23,692	5	nil.	Do. (fully paid)	3½ 4	...	February & August	3⅝	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2 2¼	...	...	2	...
312,000	½	0/1¼ '86	Maxim-Weston	1/16 1/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	39½ 40½	6 1 0	March and July	40½	40
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 3	February & August	17⅝	17¼

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

BOARD OF DIRECTORS.

The Right Hon. Sir H. J. SELWIN-IBBETSON, P.C., Bart., M.P., *Chairman.*
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THE ELECTRICIAN:

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NOTES.

The enthusiasm which greeted the appearance of Sir William Thomson at the Society of Telegraph-Engineers and Electricians is a significant mark of the profound esteem in which his name is universally held as that of the greatest physicist of the age. But the series of brief speeches which followed Sir William's address, and took the place of the customary discussion, coming, as they did, from men in the front rank of the profession, formed a tribute of respect and admiration such as perhaps no other living scientist could command, and to which it would be superfluous to add any words of our own. We shall publish our report of Sir William's address in a subsequent issue, when we hope to fully illustrate it.

We insert in our columns this week an article on electrical traction, written by a German engineer who may be assumed to have had some considerable experince in that subject. We think it desirable, however, to note that the general theory therein stated is not entirely in agreement with the views usually held amongst English electricians. In the first place, there seems to be a certain amount of confusion between the torque of a motor and its brake horse-power. Herr Coerper tells us that a motor should develop its maximum power at starting, and that an electrical motor, as ordinarily constructed, gives out its minimum power when doing so. The problem appears to be misunderstood. What is required at starting is maximum torque and not maximum work, and this is precisely what a motor does give. (For the sake of students we may recall the fact that torque is measured in pound-feet and is independent of time, while the work done is the product of the torque and the time taken to make any number of revolutions of the armature or rolling wheels according to the units chosen.) Considered from this point of view, we are afraid that the ingenious device designed by Herr Coerper to give maximum power at starting is really only a complicated friction clutch. At the same time a device of this character may sometimes prove very useful where stoppages and slow speeds are frequent, as it tends to obviate undue heating of the motor.

In our last issue we printed a letter from Mr. Jarman, whose "system" of electric traction is receiving a trial upon one of the South London tramway lines. It will be remembered that the special feature of Mr. Jarman's scheme consists in the employment of two motors, one to drive the car in each direction. To this plan, says Mr. Jarman, "I more than ever rigidly adhere." Since, then, our criticism is challenged, we feel bound to say that we also adhere with equal rigidity to our first opinion (expressed some two years ago), namely, that the use of two motors where one will serve the purpose is a wasteful and unnecessary complication. Mr. Jarman takes it for granted that the heating of the motor is the chief difficulty to be overcome in electric traction; but no electrical engineer (*pace* Mr. Jarman) requires to be convinced that the remedy first to be tried simply consists in making the motor large enough for the work it has to do. At the same time we recognise the possibility, to which we have alluded above, of even a well-designed motor getting into trouble from this cause where the load is heavy and stoppages or slow speeds are frequent. But even this does not seem to necessitate two motors; it points rather to the use of some such gearing as that adopted by the Helios Company. A somewhat similar solution, proposed some time ago, we believe, by Mr. Radcliffe Ward, is perhaps still better because more positive; it consists in the use of two sets of driving gear of different ratios, the large ratio being used for the start and the smaller ratio when going at full speed. However, if Mr. Jarman will use one motor of proper dimensions and suitable design, we have little doubt that he will find it much cheaper and more satisfactory than the employment of two small motors each of which gets uncomfortably hot.

In this issue we give the concluding part of the short series of Papers on the history of continuous-current transformation which Mr. Percy Sellon has contributed to our columns. That the last word has yet to be spoken on this subject everyone admits; what we now want is to see some experiments in this method of distribution upon a practical scale. We are sorry that nothing of the kind is being done this year, so far as we are aware, at any of the Exhibitions. The Glasgow Exhibition would have formed a favourable field for a trial of the system on a suitable scale. The question of regulation probably offers a rather serious difficulty. Mr. Sellon mentions a patent of Mr. Swinburne's (with the details of which we are unacquainted), in which a method of regulation by some kind of compound winding is spoken of. It is, however, rather difficult to see how this can be done, since both armature windings are moving through the same field and both must be equally affected by whatever affects that field. But it would be rash to pronounce

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judgment on Mr. SWINBURNE'S device before we know something more about it. For our own part we are still inclined to think the revolving commutator arrangement designed by Mr. F. JEHL, and described in *The Electrician* of October 28th, 1887, page 514, and December 2nd, page 75, as promising a device as any yet described.

A. FOEPPL (in Wiedemann's *Annalen*, Vol. XXXIII., page 492, 1888) describes some experiments he has been making on the conductivity of a vacuum. The results obtained are negative, but the method employed is extremely pretty. Herr FOEPPL uses a coiled glass tube as the secondary of a transformer, the ends being continued to some distance and then joined to the terminals of a galvanometer coil, also made of glass tube. Arrangements are made for exhausting the tube. He thus obtains a circuit consisting *wholly* of rarefied air, and avoids transition resistances. The results, however, as we have already said, are negative, as on making or breaking the primary circuit no deflection was obtainable on the galvanometer. From this Herr FOEPPL shows the resistance of the air cannot be less than 3×10^6 that of copper.

FROM the latest returns we gather that the visible supply of copper is at the present time larger than it has been for many years past. Not only has production been stimulated by the present high price, but the consumption has been seriously diminished by the substitution of mild steel and iron wherever these materials are admissible. In several industries, where copper was formerly used, it will henceforth probably be dispensed with altogether. Large quantities of old copper and brass have also been thrown on the market within the last few weeks, especially by the railway companies. In view of these facts it is anticipated in some quarters that a fall will take place before many months are over. But it would probably be unwise to reckon too confidently upon this.

LORD ONSLOW'S proposed Bill to enable Lloyds to acquire sites and construct telegraph lines for coast-signalling purposes will apparently not be allowed to pass unchallenged. To the merits of the proposal, taken by itself, no objection can reasonably be urged; but, considered as part of our national defences, it is altogether illusory, and is only calculated to postpone indefinitely the scheme for providing the whole of the coast with a continuous line of telegraphs, which is now so much needed for outlook purposes in time of war. The present is an opportune moment for having the whole question gone into by a Parliamentary Committee, as suggested in Mr. BAYLEY'S letter to *The Times*, reprinted by us last week. We have no doubt that Lloyds would be quite willing to abandon their project if the country would take up the larger scheme as a national affair. That it would probably pay for itself in time of peace by its service to the mercantile marine, and in the succour it would lend to ships in distress, is pretty evident from the fact of a private corporation offering to undertake the business.

At the Chicago Electric Club some discussion recently took place on a point which will most likely come under consideration before long in this country. It is agreed that within a certain limited area a simple parallel distribution is the cheapest. Supposing, then, it be decided to light a district by alternating transformers, the question is whether a commencement should be made in the area immediately around the station with direct currents. We have heard several people express an opinion in favour of this plan, and it also appears that it has commended itself to many electricians in America. But from the discussion above alluded to, we gather that practical experience does not recommend it. Mr. CUTTER, of the Thomson Houston Company, spoke very strongly in favour of a single unmixed system for central station work. A mixed system is nearly always more expensive to work, it necessitates additional reserve plant, and is likely to lead to mistakes on the part of the *employés*. We are, moreover, inclined to think that in this country it is especially undesirable to go through the early—and to some extent experimental—stage twice over. The slight additional first cost of transformers in the nearest houses will probably pay for itself by the additional experience gained, to say nothing further of the extra cost of the mixed system to which allusion has already been made.

OUR recent observations upon the state of affairs at Leamington have called forth a reply from Messrs. CHAMBERLAIN AND HOOKHAM which will be found in our correspondence columns. We are quite unable to admit that we have acted either with unseemly haste or without due and full consideration in this matter. Our remarks were based upon the published reports of the proceedings of the Leamington Town Council, abstracts of which appeared in our columns on January 20th, March 9th, April 6th and May 25th. We now learn for the first time that the proceedings of the Town Council were "not to be taken seriously as criticisms on electric lighting, but only as illustrations of personal pique or of trade rivalry." We shall be the first to rejoice if it can be shown that nothing more serious than this is the matter; but, if so, we think it a very great pity that Messrs. CHAMBERLAIN AND HOOKHAM have not long ago taken the trouble to let the facts be known. For months past the gas journals have been rejoicing over the alleged failure of the electric light at Leamington, and it is within our positive knowledge that the reports have done no little mischief to the prospects of electric lighting in other localities. It was an instance of this kind, coupled with the result of the motion brought before the Town Council a fortnight ago, that led us to think that the time had come when it was due to the profession generally that the matter should be cleared up. It is especially noteworthy that, with the single exception of the Mayor, all those speakers who opposed Mr. CROWTHER DAVIES' motion to terminate the agreement did so solely on the ground that they thought the Company should be allowed a further trial. Dr. THURSFIELD, for instance, "thinks the electric light a dismal failure, but still he would not support the motion, as he should like the Company to have a further chance." Mr. SALMON "could not vote for the motion that day, but if the light continued as at present, at some not very distant period such a notice would have to be given." (See *Electrician*, May 25th, p. 73.) Several other speakers followed to the same effect. Messrs. CHAMBERLAIN AND HOOKHAM should evidently pray

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rather to be saved from their friends than from their trade rivals. We intend shortly to avail ourselves of this invitation to visit Leamington, which we hope may not be countermanded, as was a similar invitation accepted by us some months ago.

WE have so often complained of the daily press in its treatment of electrical subjects that we hasten to pay a high compliment to the *Morning Post*, which on Saturday last published an article on Lord THURLOW'S Electric Lighting Bill quite exceptional both in tone and intelligence. Among other sensible things which are said in that article we note with pleasure a confirmation of our own oft-repeated contention that if Parliament had enforced upon railway projects, canals, docks, gasworks, and waterworks the conditions it now endeavours to apply to electric lighting, we should have had to do without those things altogether, unless Parliament itself had undertaken to provide them.

So long as the State, or the local authorities, are not prepared to take up a new enterprise for fear of the losses, so long must they be content to let private speculation take its chance of the gains. On this point the *Morning Post* expresses itself with more hesitancy than there is any occasion for. We fear it is not likely that new discoveries may lead to the production and delivery of electric light at "a fraction of its present cost;" but even admitting the possibility of such an eventuality, what then? The recognition of future contingencies could operate only in one of two ways—either we must assume that they will be realised, which would meanwhile be extremely unfair, or we must wait until they are realised, which would be extremely foolish. "Gigantic profits," under conditions accepted by Lord THURLOW'S Bill, would be next to impossible. But if the State itself declines to make these profits we see no valid reason why private ventures should not pocket them. From among the innumerable trades and professions in which gigantic profits are made unmolested, it is hard to see why corporations which supply the public with the luxuries of life should be excluded with such venomous hostility.

It will be seen from our report of the proceedings in the incandescent lamp litigation that at the suggestion of Mr. Justice KAY it has been arranged to carry out some experiments upon the manufacture of lamps in accordance with EDISON'S specification. Experts representing both sides of the case are to watch the process, and a report is to be presented to the judge by an independent witness.

The Barbadoes Cable.—The cable between St. Vincent and Barbadoes, which was recently interrupted, is now repaired.

Notice of Removal.—The Midland Electric Wire Company have removed their factory to Braunston Gate, and their address for the future will be "Faraday Works," Braunston Gate, Leicester.

Electric Railways in Japan.—It is stated that the Mikado has commissioned an engineer to visit the United States to gain information with the view of introducing electric railways into Japan.

Wolverhampton.—We are pleased to hear that Messrs. Elwell-Parker have been compelled, owing to the rapid increase in their business, to build two additional shops, and to put down a large extra engine to meet the increased demand for both dynamos and accumulators.

Reported Amalgamation of the Edison and Swan Companies in France.—The amalgamation of the Edison Continental Company with the Swan Company, so far as the French patents are concerned, has been announced. This union will, of course, put an end the litigation between the two companies in that country.

The Gibson Storage Battery.—We have received a pamphlet from the Gibson Electric Company of New York, from which we learn that the Gibson storage battery possesses an efficiency of 90 per cent. (!); that it requires no skilled attendance; that no possible rate of discharge can injure it; and that as to durability "it is practically indestructible." Hem!

Electrical Heating.—The Union Electric Railway Company, of Richmond, U.S., are now heating their offices by means of the Burton electric heater. With a current of 1·75 ampere and an E.M.F. of 300 volts a room of 15 feet square is efficiently warmed. It is the intention of the railway company to heat all its cars by this means during the ensuing winter.

The Paris-Marseilles Telephone.—On the 14th May, the first words were spoken over the new telephone line between Paris and Marseilles, which is shortly to be opened to the public. Excellent results were obtained, and conversation was easily carried on. The wires are of copper, and in diameter 4·5 mm., and the total length of the line is 900 kilometres (562½ miles).

Mouldings.—Mr. Samuel Elliott of the "Albert" Moulding Mills, Newbury, sends us a book of designs of wooden cleats, and mouldings, &c., in great variety. This firm is well known for the excellence of its designs in all classes of woodwork of this description, and electrical contractors will find it worth while to examine the price list and designs for cleats and mouldings.

Blair Lodge School Installation.—Blair Lodge School, near Falkirk, will soon possess a complete electric light installation of 700 lamps. Messrs. M'Whirter, Ferguson and Co., of the Faraday Works, Govan, are the contractors. In addition to the electric light there is telephonic communication throughout the school buildings. We believe this is the only school so provided in the country.

Freemasonry.—At a meeting of the Electric Lodge on the 26th ult., held at the "Mitre Hotel," Hampton Court, Mr. Thomas Barlow, Assistant Controller of the Central Telegraph Office, was installed Worshipful Master for the ensuing year, and Mr. James Hookey, the outgoing Master, was presented with a very handsome Past-Master's jewel on his retirement from the Chair.

New Cable to Ireland.—A new cable is being laid between Scotland and Ireland. Her Majesty's ship "Monarch" is in Belfast Lough with the cable on board, but the weather has been very unfavourable. The cable will be laid from Whitehead, on the county Antrim side of Belfast Lough, to Portpatrick. After the "Monarch" has completed her task, she will proceed to the Shetland Isles.

Electric Lighting Tenders Invited.—The Ilfracombe Local Board invite tenders for the lighting by electricity of the Victoria Promenade. Particulars may be obtained from the surveyor. Hotels and other establishments in the neighbourhood contemplate taking the light jointly with the above.—The Poole Town Council invite tenders for lighting the borough by gas, electricity, or other means, for one or three years from 1st September next. Particulars may be obtained from the town clerk.

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Messrs. Whittaker's Forthcoming Publications.—The third edition of Sir D. Salomon's book on the "Management of Accumulators" having sold within a few months, Messrs. WHITTAKER will publish next week a new thoroughly revised and enlarged edition. They will also publish a second edition of "Leland's Practical Education," and a second edition of "Bottone's Electrical Instrument-Making for Amateurs," enlarged by a chapter on the telephone. They hope to have Mr. Preece's large work on "The Telephone" ready during next month.

Yokohama.—The electric light has been introduced into Yokohama by Messrs. Cocking and Co., of 55, Main-street, who have laid down a Gülcher plant. There is already in existence an Electric Lighting Company in Tokyo, chiefly, we believe, in the hands of natives, and they have recently applied for permission to establish a central station at Yokohama The local Gas Company are also anxious to go into the business on their own account. Mr. Cocking has, however, forestalled his competitors, and as an Englishman—and also we believe a thoroughly competent electrician—we trust that his enterprise will be successful.

City and Guilds of London Finsbury College.—The annual *conversazione* of the above college was held on Friday last, and may be pronounced as the most successful yet given. The lecture by Prof. S. P. Thompson on the Polarisation of Light, and that by Prof. Perry on Magnifying Springs, were extremely interesting. Two concerts were given in the Chemical Lecture Theatre; there was an extensive display of electrical, mechanical and chemical apparatus, including several novelties, and, finally, the second Annual Exhibition of the College Photographic Society. The attendance numbered 450. We intend to give some further particulars next week.

Hamburg Central Electric Lighting Station.—The firm of Mr. S. Schuckert, of Nuremberg, has been entrusted by the State of Hamburg with the installation of the Hamburg Central Electric Lighting Station, for which about twenty-four prominent firms have tendered. The central station is intended to supply about 20,000 incandescent lamps and an enlargement is in contemplation. During the course of this year a first installation of 10,000 lamps will have to be completed. According to the calculations issued by the Finance Committee it is expected that the undertaking will prove a financial success, 6 per cent. on the capital invested being the estimated net profits.

Paterson and Cooper's Instrument Catalogue.—Messrs. Paterson and Cooper have issued a new illustrated catalogue of their well-known electrical measuring instruments. Most of our readers will be already aware that this firm manufacture ammeters and voltmeters under the patents of Capt. Cardew and Profs. Ayrton and Perry, as well as a serviceable "engine-room" instrument of their own design. The improvements which have from time to time been introduced by Messrs. Paterson and Cooper in these various instruments have been fully described in our columns (see *Electrician*, Vol. XIX., p. 270; Vol. XX., p. 220). The present catalogue is well printed and illustrated, and gives ample information on all the subjects referred to. In addition to the various types of ammeters and voltmeters, it also includes the Thompson and Starling "Universal" photometer, and Mudford's improved Thomson galvanometer.

The Schuckert Projector.—The Schmidt Douglas Electric Company have lately been astonishing the inhabitants of Bradford by a fine display of electric light from the top of their premises at Hustlergate. The plant furnishing this powerful light has been manufactured by M. Schuckert, of Nuremberg. It consists of a projector with a horizontal arc, taking 150 amperes and 50 volts, and regulated both automatically and by hand; the lamp is furnished with a parabolic silvered-glass reflector, 3ft. in diameter, constructed to be movable in all directions; the whole apparatus with iron case, glass protector and stand weighs 7 cwt. The carbons used are made by M. C. Schmelzer, of Nuremberg, the positives being 1¾in. and the negatives 1¼in. in diameter. This apparatus has been adopted by the German Government for use in the Imperial Navy, and a portable field plant has been specially constructed for the Italians at Massowah.

Trial of a Police Signal System.—We are glad to learn that the police of London are about to be afforded an opportunity of experimenting with a system of electric communication between the police stations and certain fixed points on the beats of the men. The system adopted is that of the "Public Safety Signal Association." Sir Charles Warren has authorised the trial on condition that it involve no expense to the Metropolitan Police Fund, and has selected Islington, with headquarters at the Upper-street Police-station, for the scene of operations. The Vestry has conveyed its formal consent to the erection of the required apparatus in the district, and the Postal Telegraph Department has undertaken to run the necessary wires. As soon as these can be laid, the system will be put in operation and continued for three months at the expense of the association, during which time its value will be thoroughly tested. The experiment will involve a total outlay of some £1,200.

Breakdown in Paris.—On the evening of Sunday, 20th May, about eleven o'clock, the electric light suddenly failed at the Opéra Comique, and also in the Châtelet Theatre. Anything that came to hand was immediately lighted, candles, oil-lamps, and gas jets. Fortunately, owing to the recent introduction of the electric light, communication with the gas-mains had not yet been cut off. The cause of this failure was simple enough. Four machines, two large and two small, running in the basement of the Châtelet Theatre supply the current for the two buildings; of these, three are used every day and the fourth is in reserve. On Sunday evening the bearings of one of the dynamos began to heat, and it became necessary to stop running and start the reserve machine, and during this stoppage (owing to the inadequacy of the accumulators) the light went out. *L'Electricité* pertinently asks if it is not possible to guard against such a breakdown as this. The contracting company assert that if they had been allowed to run a double pair of mains they would have been able to have immediately restarted the light.

Fatal Accidents to Electric Light Linemen in Halifax, N.S.—Captain H. E. Rawson, R.E., writes from Halifax, N.S, as follows:—"I have forwarded by this post some local papers, reporting a coroner's inquest on the death of an electric light patrolman, who was killed on a pole which he had mounted in order to see to the light. The facts excited considerable interest, as it was the second death on the same pole within forty-eight hours. In the first case very little evidence was taken at the inquest; but it appeared that the man had crossed his leg over the cross arm, and was not touching the lamp, when 'blue fire' was seen under his thigh. He fell back, and was found badly burned between the legs and on one hand. The second case was taken up by the authorities, who applied to the general officer commanding to allow me to make a careful test of the lamp and its attachments. The Ball lamp is manufactured in Toronto. I have corrected the errors in the newspaper reports, which I think will interest you." We fear that the chief part of the papers sent by our correspondent have

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been lost in the post. One paper has reached us, but it contains only an unimportant portion of the evidence.

Masters' Anti-Magnetic Watch.—We have had one of these watches in our possession for several weeks, and have subjected it to a series of very severe tests, with results of an exceedingly favourable character. The watch is provided with a gold balance and a hair-spring of palladium; the escapement contains no steel with the exception of the pallets. After being placed in the strongest part of the field of a powerful dynamo, which must have magnetised the whole of the steel parts to saturation, we found that the rate of the watch remained unaffected; and this, notwithstanding that for the succeeding three weeks it was continuously subjected to the influence of magnetic fields of varying intensity. It should, however, be noted that this watch, in common with all others, is brought to rest in a sufficiently powerful field, the reason being that the spring cannot do work against the Foucault currents which are generated in the balance-wheel. We do not know that the reason for this effect has been pointed out before; but it will be seen that so long as the rapidly-moving parts are made of metal it will be impossible to overcome it. This defect is, however, of small importance, as it causes no error in the rate of going of the watch.

Exeter.—At the last meeting of the Exeter Town Council the Special Committee on Electric Lighting recommended that tenders be invited by advertisement for lighting a specified area by means of the electric light, subject to the terms of the specification prepared by the surveyor and to the stipulation of the Board of Trade.—Mr. Townsend moved the adoption of the report, and said that when the tenders were received the committee hoped to lay before the Council a report as to whether it was desirable to proceed further, or whether they should continue the present system of gas lighting.—Mr. Jones seconded the motion.—Mr. Dunn said that to ask for tenders before the Council decided whether they would adopt electricity was not treating the persons who went to the trouble and expense of tendering with proper consideration.—Mr. Daw (interposing) said he should save Mr. Dunn the trouble of speaking any longer by leaving the Chamber, when there would no longer be a quorum.—The Mayor: There is another councillor coming.—Mr. Hall, who had gone outside, was returning to his seat as Mr. Daw was leaving his. On learning, however, that the subject under discussion was a proposal to advertise for tenders for the electric light, he at once took up his hat and left again, amid much laughter. The Council then broke up for want of a quorum.

The Conductivity of a Vacuum.—M. Foeppl, in *Wiedemann's Annalen*, gives the results of some experiments *apropos* of this vexed question. M. Edlund, in maintaining his theory, claims to have recognised phenomena of a luminous character, even when the vacuum has become so perfect as to prevent a visible discharge between the electrodes. M. Foeppl has studied the currents of a secondary closed circuit, actuated by an induction coil. This first was formed on a glass tube 7 millimetres outer and 4·2 millimetres interior diameter, and was composed of two layers of 18 turns, having an outer diameter of 67 millimetres. The electrodes of this glass coil were connected to the two ends of a second coil, also on glass, so arranged as to form a galvanometer, within which was placed a circular mirror magnet, suspended by a fibre of cocoon silk. The primary coil was 24 centimetres in length, 7·1 centimetres inner and 15·3 centimetres outer diameter, and was composed of 12 layers of 72 turns of copper wire 22 centimetres diameter, without the insulation. With this apparatus, and a current of 22·5 amperes, M. Foeppl could not discern the least movement of the needle, either on closing or opening the circuit. Neither could he discover the least phosphorescent light in the glass coil, with large range of rarefaction. The specific resistance of a vacuum, as shown by mathematical calculation, is at the least 48,000 times that of mercury, or about 3,000,000 times that of pure copper.

The British Association.—At the fifty-eighth annual meeting of this association, which will begin at Bath, on Wednesday, September 5th, the president will be Sir Frederick J. Bramwall, D.C.L., F.R.S., M. Inst. C.E. The local secretaries for the meeting will be Mr. W. Pumphrey, Mr. J. L. Stothert, M. Inst. C.E.; Mr. B. H. Watts; and the officers of Section G (mechanical science) are:—President, W. H. Preece, F.R.S., M. Inst. C.E.; vice-presidents, W. Anderson, M. Inst. C.E., W. Shelford, M. Inst. C.E.; secretaries, C. W. Cooke, W. Bayley Marshall, E. Rigg, M.A., recorder. The first general meeting will be held on Wednesday, September 5th, at eight p.m. precisely, when Sir H. E. Roscoe, F.R.S., will resign the chair, and Sir F. J. Bramwell, D.C.L., F.R.S., M. Inst. C.E., president-elect, will assume the presidency, and deliver an address. On Thursday evening, September 6th, at eight p.m., a *soirée*; on Friday evening, September 7th, at 8:30 p.m., a discourse on the "Electrical Transmission of Power," by Prof. W. E. Ayrton, F.R.S.; on Monday evening, September 10th, at 8:30 p.m., a discourse on "The Foundation Stones of the Earth's Crust," by Prof. T. G. Bonney, D.Sc., LL.D., F.R.S. F.S.A., F.G.S.; on Tuesday evening, September 11th, at eight p.m., a *soirée*; on Wednesday, September 12th, the concluding general meeting will be held at 2:30 p.m. Excursions to places of interest in the neighbourhood of Bath will be made on the afternoon of Saturday, September 8th, and on Thursday, September 18th.

Atmospheric Electricity.—Prof. L. Weber describes in the *Elektrotechnische Zeitschrift* a very interesting series of experiments on atmospheric electricity. He erected two *insulated* conductors on the top of the Reisengebirge, but he says that, curiously enough, since these have been put up they have never been struck by lightning, although before their erection lightning flashes were continually occurring. He also made some kite and balloon experiments, in connection with which he goes at considerable length into the question of the effect of the conducting string in altering the electrical condition of the circumjacent air-layers, and also considers the effects due to a long conductor completely insulated from earth, and without discharging points; a similar conductor, with slight power of discharge along its whole length; an insulated conductor, with strong discharging power (*e.g.*, a flame) at the upper end; and other similar and more complicated cases. His kite-string was really a steel wire; the discharging points on the kite consisted of 400 needle-points. In other cases he had the tails of the kite made of silver-paper for the same purpose. The potential was measured by the length of the sparks, and the current with a galvanometer; the latter varied in general from ·07 to 2·5 microamperes. The potential varied generally from 3,000 to 10,000 volts. When thick clouds were overhead there were no appreciable sparks, the strongest sparks being obtained when the zenith was either quite clear or when cumulo-stratas clouds appeared. With potentials of 11,000 and 20,000 volts, currents of 4 and 8 microamperes were obtained. The original paper will well repay perusal by those interested in the subject.

"The Dynamicables."—The dinner of the Dynamicables on Thursday passed off very pleasantly under the presidency of Sir William Thomson, who, when a suitable stage of the proceedings had been reached, made a brief, but well-directed speech, which we have pleasure in reporting in full. It was

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as follows :—"Gentlemen—You may smoke." The members were afterwards invited by the chairman to "recount their experiences," and this they did in a very entertaining manner. Prof. Forbes related a few of his experiences in the United States, whence he has returned positively charged with information on the subject of central station lighting work. He was followed by Mr. Swinburne, who described the sad fate of a young man who took to "mixed mathematics," and who eventually succumbed to something in the nature of a calculus. This amusing sketch was well received. An account of a visit to the Oerlikon works, and of the dynamos now being constructed there, was given by Mr. Kapp. Mr. Swan spoke of the good effects of the Electric Lighting Act, which he thought, although not by any means an unmixed good, had checked immature work, and Mr. Crompton and Prof. Fleming described some novel applications of electric lighting in connection with ballet dancing. A dramatically narrated ghost-story, from his own experience, was contributed by Mr. Macfarlane Gray, who vouched for its truth. "An angel's nose," was the subject of a communication from Major-General Festing; and Mr. Spagnoletti gave a capital rendering of "I cannot sing the old song now!" Amongst the company we noticed Sir David Salomons, Prof. Adams, Messrs. Garcke, Webb, A. Snell, Wollaston, Mordey, Albright, Heaphy, and Beaumont.

Electric Lighting Apparatus for Lighthouses.—A correspondent writes from Paris as follows :—"Messrs. A. de Méritens and Co. have just sent to Copenhagen two alternate-current magneto-electric machines, three Le Baron arc lamps, a current distributor, &c., designed for Hanstholm lighthouse (Denmark). All this apparatus is installed at the Copenhagen Exhibition. The machines are of the well-known De Méritens pattern, and of the same type as those supplied for Macquarie (Australia), Lizard (England), the United States, Mikail and Berdiausk (Russia), Da Roca (Portugal), Tino (Italy), Dunkerque, Calais, Gris-Nez, La Cauche, Cayeux, Ailly, Fécamp, Creac'h (Isle of Ouessant), Les Baleines, Planier (France). At St. Catherine (Isle of Wight) and Isle of May (Scotland) the De Méritens machines are of the largest size hitherto made. The Le Baron arc lamp is specially constructed for very large alternate currents, 300 to 400 amperes, but works quite satisfactorily with the very small amount of 25 to 50 amperes. The upper and lower carbon-holders are balanced by chain and train of wheelwork, and the movement is regulated by a solenoid connected in shunt. The current goes direct to the lower carbon by a very good sliding contact, preventing injury to the lamp from heating. When the carbons are burnt, the circuit of the coils is broken mechanically. All its functions are automatic, and the adjustment of the arc is so that it remains unchanged in position or size, the regulation being absolutely independent from the weight of the carbons. Whatever the current may be, the result is all that can be desired as regards steadiness and regularity. The current distributor consists of horizontal brass plates upon a polished mahogany table. These plates are connected with the terminals of the magneto-machines. Two vertical bars at the back of the table can be jointed with plates by means of screw plugs. Thus, currents of 60, 120, 180, 240 amperes can be utilised by turns in the lamp above described. These novel features have been chosen in France, where a current of 25 amperes is to be used in very clear weather, and currents of 50, 75, 100, or more amperes, according to atmospheric conditions, with the same machinery."

United Kingdom Postal Telegraph Clerks' Association.—The seventh annual conference of this association was held at the Green Dragon Hotel, Leeds, on Saturday. The delegates had been entertained at dinner by the Leeds staff on Friday evening, and the conference assembled on Saturday morning. Delegates were present from nearly all the large offices in the United Kingdom and from many of the smaller ones. Mr. T. C. Plackett (Leeds) was elected chairman. He gave a cordial welcome to the delegates, and trusted that their deliberations would be marked by that spirit of moderation which was essential to success. They were met together to discuss matters of vital importance to their organisation, and he hoped they would arrive at such decisions as would ensure the soundness and stability of the society. With reference to the redress of grievances, they were bound to admit that many of the grievances which had been complained of in former years had been remedied, that valuable concessions had been made, and that in no grudging spirit. But there were still questions unsettled, however, and he asked them in dealing with these matters to exercise a wise discretion, and to see that that respect was paid to others which they themselves expected.—The annual report for the year ending the 3rd of May was read by Mr. Scott (Liverpool), which showed that the association was in a very much improved financial condition, the balances in hand having increased very considerably. The numerical condition of the association was practically unchanged. The report on the whole was favourable. —A proposal by the Birmingham members, introduced by Mr. Whittall, materially affecting the insurance branch, and proposing a lower rate of insurance benefit, was warmly discussed, and after nearly three hours' debate was adopted with certain modifications.—A resolution in favour of forwarding a united petition to the Postmaster-General on the subject of unredressed grievances was negatived, it being considered desirable that the statement of affairs which has been placed in the hands of the Civil Service Commissioners should not be supplemented by any other petition which would be likely to imply a want of confidence.—A resolution from Leeds, proposed by Mr. Richardson, and seconded by Mr. Clarkson, was supported by delegates from Hull, Preston, and Southampton, and eventually carried as amended—"That the present scheme providing for annual leave of absence is unsatisfactory and unacceptable as a settlement of the holiday question." Mr. Taylor (Bristol) called attention to the progress of the agitation in favour of Sunday pay, and read letters from several members of Parliament who have promised support in the House of Commons. It has been arranged that this matter shall be brought forward on the Estimates. A resolution was adopted expressing the appreciation of the conference at the energetic action of the Bristol staff, and pledging the support of the association. Several resolutions were proposed making alterations in the rules of the association, and after discussion agreed to. A resolution was adopted conveying the thanks of the conference to the editor of the *Telegraphist* and the press generally for their advocacy of the claims of the clerks. The following officers were elected for the ensuing year :—Trustees, Mr. Whittall (Birmingham), Mr. Rickwood (Manchester), and Mr. Scarborough (Belfast). The general secretary, Mr. Scott (Liverpool), was re-elected unanimously, with Mr. Hoolihan (Liverpool) deputy-secretary. On the invitation of the Bristol staff it was decided to hold the 1889 conference in that town. After a vote of thanks to the chairman and to the members of the Leeds staff the conference terminated. The delegates were afterwards driven to Roundhay Park, where they spent an enjoyable evening. By the courtesy of the Postmaster and Superintendent of Telegraphs at Leeds the delegates were permitted to inspect the Leeds office.

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CONTINUOUS-CURRENT TRANSFORMATION.

(*Concluded from page 734, Vol. XX.*)

BY R. PERCY SELLON.

Lane-Fox's Patent of July, 1883, is followed by that of Scott and Paris, No. 6,260, of April, 1884. This patent also has reference to the broad question of distribution by means of continuous-current transformers. It deals with the placing of these in parallel, both as regards their high-tension and low-tension circuits, and a claim is made to "the arranging of transformers, both in the high-tension and the low-tension circuits in parallel, so as to be independent of one another, substantially as hereinbefore described with reference to the accompanying diagram."

It will thus be seen that this Patent differs from the preceding Patents of Edison and Lane-Fox in respect of the suggested disposition of the primary circuits of the transformers in parallel.

Messrs. Scott and Paris have been closely associated with continuous-current transformers in this country for some time past, and they are among the very few who have been sufficiently inspired by the courage of their convictions to commit those convictions to the test of practice. It will be remembered that they showed one of their transformers at the Newcastle-on-Tyne Exhibition last year, and this attracted some considerable amount of attention. Full descriptions of their system have appeared in this journal under the issues of October 28th and December 2nd of last year, and it is therefore unnecessary to refer at greater length to it at this point.

Three months later, Zipernowski and Déri took out a Patent, No. 9,982, 1884, upon this subject.

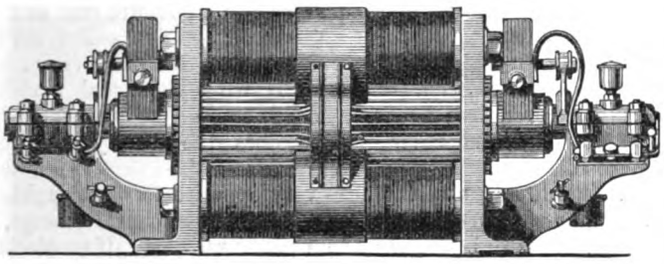

Fig. 1.

This specification is a very full one, and deals with the application of continuous-current transformers [or "rotating secondary generators," to use the patentees' words] to a variety of purposes—lighting, motive power, electric traction. Means for externally regulating and controlling their speed or output, and for measuring the work done, are also set out at some length.

The claims, however (which are 18 in number), would appear to indicate that this Patent was filed in ignorance of what had gone before upon the subject.

Patent No. 3,525, of March, 1885, R. P. Sellon and J. S. Sellon, follows that of Zipernowski and Déri. This Patent deals with various methods of winding and connecting up continuous-current transformers, in order to obtain automatic self-regulation. Where the conditions of supply are to be those of constant potential, the transformer-fields are to be compound wound, a shunt winding to be connected with the "motor," or receiving armature coils, and a series compensating winding in connection with the "generator" armature coils.

The author turned his attention to the construction of continuous-current transformers in the year 1884, and about the period of the above Patent the machine illustrated in Fig. 1 was completed. Following this, negotiations were opened for lighting a town in South America by means of continuous-current transformers; but, for reasons unconnected with the technical aspects of the question, the matter was ultimately abandoned.

Cabanellas, in a Patent No. 2,880, of February, 1886, deals with improvements in continuous-current transformers. The specification is voluminous, and in the nature of a treatise upon details of construction of dynamo apparatus. The specification is, however, hardly sufficiently lucid to enable a strict definition of the nature of the improvements in continuous-current transformers to be set out.

In the following month Bollmann, Biedermann and Monnier patented (No. 3,945, March, 1886) a continuous-current transformer of a somewhat different type to the dynamo transformers which have been considered. The device consists of a series of stationary ring or closed-field magnets, divided up into two separate circuits. By means of an independent commutator, to which revolution is imparted in any convenient way, such as by an electro-motor or shafting, the connections of the two circuits are alternately changed. Thus, at one moment the primary current is passing through one set of magnet coils in series, thereby inducing a current in the second set of magnet coils, which are momentarily connected by the commutator in parallel, with the result of producing a current of diminished tension and increased volume in the supply circuit.

Upon the revolution of the commutator the functions of the two circuits are reversed. In this way the primary and secondary currents flow successively in each circuit, but always in the same direction. It will be seen that this is, therefore, an intermittent current transformer.

There is a subtle fascination about this idea that has "bitten," to the author's knowledge, more than one electrician in this country. The barrier to success, however, disregarding all outside considerations, seems to lie in the wear and tear arising from sparking in this class of apparatus. Messrs. Bollmann, Biedermann, and Monnier wrestle with this difficulty in their specification, but how far successfully in the practical outcome it is not easy to forecast. The author's scepticism arises out of the fact that he also believed himself to have "discovered" this idea some years ago; but his enthusiasm was cooled at the very spot indicated, viz., that at which the heating and sparking were found to result on trial.

Following the above, we have the Patent of Jehl, No. 2,130, of February, 1887. The work of Messrs. Jehl and Rupp, and many of the ingenious and carefully thought out designs suggested by them for continuous-current transformers have already been described at length in this journal, under the issues of October 28th and November 11th of last year.

It is therefore unnecessary here to do more than record the existence and date of Jehl's Patent, and to mention that the forms which have been described in this journal are to be found, and in some cases are claimed, in the above Patent.

Finally, in Patent No. 6,682 of May, 1887, Mr. James Swinburne addresses himself at some length to the problem of continuous-current transformers. The specification deals principally with means for attaining self-regulation, or "compounding," the transformers, which it is proposed to effect under certain conditions by using two separate sets, both of armatures and field-magnets, and adapting special windings to these. In this way also, says the patentee, the difficulty of leakage between the high and low tension windings may be effectually obviated.

This concludes the substantial history of continuous-current transformation up to date. The dominant feeling left in the mind after a careful perusal of all the Patents referred to is one of unmingled astonishment at the system upon which the average patentee goes to work. He glories, apparently, in drawing up his Final Specification and Claims with a cheerful disregard of the state of public knowledge up to date, despite the fact that he has had the better part of a year in which to make himself acquainted with it before drawing up the Final.

The net result is to be seen, and felt, in much subsequent heartburning, concurrently with litigation of the order with which we are just now only too familiar.

The fact that several gentlemen have been more or less patenting the same thing—or, at any rate, the same thing with microscopic differences—is purely a personal matter, however, and does not affect the main question which impresses itself upon one—that a large amount of careful thought has been already expended upon continuous-current transformation, which should bear good fruit when the opportunity for practically testing the system arises.

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The practical application of continuous-current transformers is not surrounded by the same difficulties from within as would be the case where apparatus involving totally novel principles or combinations of physical laws might be concerned. The dynamo is sufficiently well understood to enable us to forecast with considerable precision where the difficulties with continuous-current transformers would arise for the purposes of electrical distribution; and while it is in the very nature of things that there will be, and ultimately must be, departures from the accepted ideas for the ordinary dynamo machine when dealing with continuous-current transformers, those departures will not be fundamental, but merely in matters of relative detail.

The author has reason to hope that before long some such practical outcome may be looked for.

ON THE TRANSMISSION OF ELECTRICAL POWER APPLIED TO RAILWAYS.

BY H. COERPER, OF COLOGNE.

The employment of electrical propulsion for cars is more and more drawing to the front. In America there are already electrical railways at work in not less than twenty towns, while on the Continent several lines have been in operation for some time.

Now, whether the electrical energy be supplied from outside or by means of storage batteries placed in the car, there are three distinct questions to solve. In the first case we have to consider the most suitable form of motor, the most reliable kind of transmission between motor and car, and the best mode of supplying the current. In the second case we have to ascertain what is the best accumulator, the best motor, and the best gearing. The mode of supplying the current to the car will not be considered here, a few remarks on the motor, accumulator, and gearing only being made.

Up to the present time high-speed dynamos of the most varied construction have, as a rule, been employed as motors, their power being transmitted to the axle by means of toothed wheels, friction wheels, belts, chains, wire spirals, worm gearing, &c. Immisch and Holt fasten the motor to the axle of the car, the wheels running on collar-boxes; one wheel is connected with a toothed crown wheel, into which fits the small tooth wheel on the axis of the dynamo. This gearing did not answer, however, and a new method is now tried. A satisfactory solution of the matter has not yet been arrived at, owing principally to the very nature of the thing. It is very rarely possible to count on uninterrupted runs of definite duration in the case of tramways; when it *is* possible to do so, arrangements may be made such as are in force on the line near Schwabing. At the terminus the car runs up an incline 18 metres long, it is stopped at the top, and on restarting downwards attains a great speed before it is necessary to switch on the motor. In most cases, however, such an arrangement is impossible, because the car is frequently obliged to stop and restart, without any regard to the construction of the line, so that the motor is often called upon to make the greatest effort under the most unfavourable circumstances. A firm coupling between motor and axle is mechanically indispensable. Trials on a line perfectly level and in the best condition have now proved that a car which will obtain a velocity of 5 metres per second (11 miles per hour) with a traction force of 120 kilogramme-metre-seconds (1·6 horse-power) requires 345 kilogramme-seconds (4·6 horse-power) to start. With the line in a worse state, and with curves, inclines and uneven loads to contend with, the relation becomes even more disproportionate.

In order to comply with practical working requirements, the motor ought, therefore, to develop the maximum power when starting. This, however, with all motors hitherto devised is not the case. On starting, when the current is switched on, the motor, owing to its firm coupling to the axle, starts but very slowly. The current, although so excessive as to endanger the insulation of the motor and cause great sparking on the commutator, develops in the motor but a small fraction of the power which it develops when working under normal conditions, and only when the car has attained a certain speed does the motor work under the best conditions, which is, however, when the heat power is necessary. Another drawback to the present arrangement is the mode of transmitting the power from the motor to the axle. Worm gearing, tooth gearing, &c., all cause great loss of power, as is shown by the rapid depreciation of the working parts. Belts, wire spirals, &c., also cause a considerable loss of energy. The higher the speed of the motor the greater does this loss become. We have further to take into consideration the inferior safety of the ordinary arrangements. Breakdowns are of frequent occurrence, and the expense of repairs is considerable. Unfortunately it is the electrical arrangements which are generally blamed for these interruptions, and not the defective mechanical arrangements.

Resuming, we find that under present conditions the motor works under the most unfavourable circumstances when starting; that it has the least power when it requires the most; that it develops the greatest power when it requires the least; that the gearing and belting entail a considerable loss of power; and, finally, that the mode of transmission is unsafe, expensive, and detrimental.

If accumulators furnish the motive power, then we must take into account the frequent damage they are exposed to. An accumulator is almost indestructible if properly charged and discharged, and every possible effort has been made to fit them for tramway work; rather unreasonably, however, since any good accumulator will do if not over-worked. As long as the present type of motor is used overstrains must necessarily occur. Nothing hurts an accumulator more than a short circuit; yet this is what practically happens every time a start is made, the current being only moderated by the copper resistance of the motor, and not by the counter E.M.F. In the present state of technical science it is an easy matter to construct an accumulator equal to a 50-kilometre run and to place it on a car, but it is a thoroughly useless endeavour to try and make an accumulator to stand 50 to 100 short-circuits in a 50-kilometre run. Yet this is what the usual working conditions require; hence, as the dynamo gets overheated by these constant short-circuits, so does the battery get over-strained.

All these circumstances, the very opposite to what ought to be, point with irresistible force to a fundamental change, if the future is to belong to the electric railway. If no electric railways existed the engineer would probably propose the following conditions:—

(1) The motor to develop the maximum power on starting.

(2) The transmission of power from motor to axle by means of worm gearing, &c., is inadmissible on account of the great wear and tear, the insecurity of the working, and the loss of power.

(3) Neither accumulator nor motor must be exposed to short-circuits, because they destroy the accumulator and endanger the motor by overheating and sparking on the commutator.

With a view to embody these *desiderata* the arrangements shown in Figs. 1 and 2 have been adopted by the Helios Company. The magnetic field *c* of the motor is fixed upon the propelling axle itself, so that the turning of the magnetic field involves the turning of the axle of the car. The armature shaft *a* and the brake wheel *e* are placed on the hub *f*, which is mounted upon the axle by means of collar boxes. The magnetic field carries brushes mounted on the spindles *g g*, which bear upon the commutator *h*. The latter is mounted upon the armature shaft and is also attached to the brake wheel. Upon the hub of the brake wheel are two contact rings, *i i*, by which the current is conducted to the armature coils. Upon the other side of the shaft at *k k* there is another pair of contact rings by which the current goes to and from the magnetic field. Upon the magnetic wheel *b* and the brake wheel *e* there is the speed-reducing gear *l m*, which is regulated by a lever, *n*. If the lever *n* is turned towards I then by pushing the brake block *m* against the brake wheel *e*, the brake wheel and armature are stopped, and *vice versa*. When the lever *n* is turned towards I I the wheel *b* is stopped, the brake wheel *e* and the armature are freed. According to very accurate trials made by myself, a properly constructed motor makes, with uniform

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supply of current and the same output, the same number of revolutions, no matter whether the magnetic field or the armature is made to turn. If armature and field are left to run simultaneously in opposite directions, each makes half the usual number of revolutions. If, therefore, the propelling axle *a* rests in the bearings *o*, we can by braking the armature cause the field alone to exert the propelling power, or, by merely moderating the speed of the armature, we can give a proportionately lower velocity to the magnetic field and consequently to the axle of the car.

The effect of the above arrangement is as follows:—When the car stops the brake must have been applied to the car-wheel, thus liberating the brake-wheel *e* and the armature. If the circuit is now closed the armature at once attains its normal speed, preventing a short-circuit of either motor or accumulator. To start the car the conductor must free the car-wheel, thereby braking *e* and the armature *d*. In proportion, however, as the speed of the armature is reduced, that of the field increases, so that finally, when the brake-block *m* completely stops the wheel

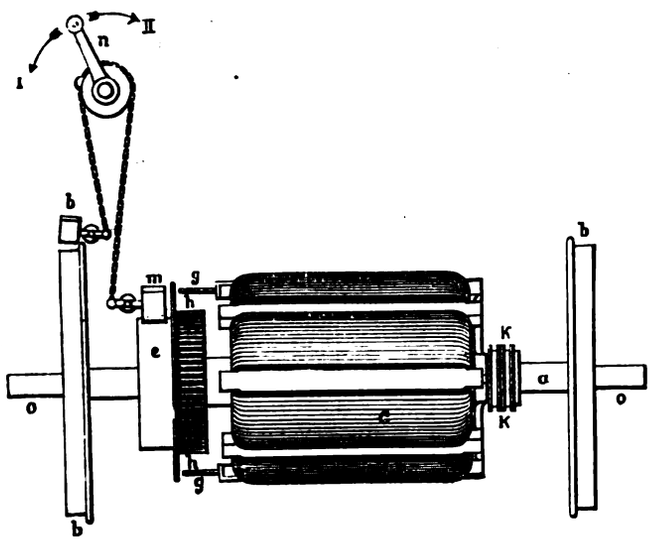

FIG. 1.

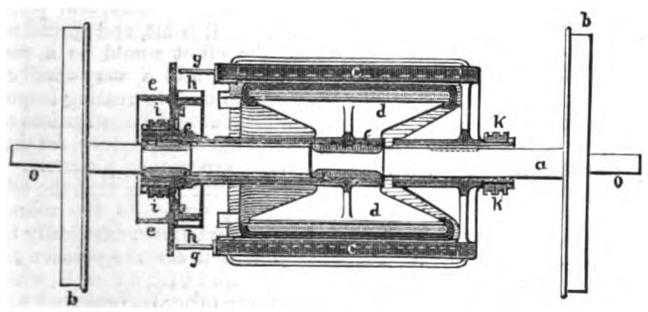

FIG. 2.

e, and with it the armature *d*, the magnetic field *c* alone propels the car. To stop the car, the lever *n* is turned towards I, the armature is freed, and, having no power to exert, at once runs at the normal velocity, whilst the tractive force of the field ceases, and the brake can immediately arrest the motion of the car.

It is clear that the braking gear can be varied, the predominating idea of this arrangement always remaining the same, viz., the firm connection of either armature or field to the propelling axle, and the freely movable arrangement of the other, controllable by a special braking gear. The direction of the motion is controlled by the direction of the current.

Let us now examine how far our list of necessary conditions has been complied with.

1. The motor attains its normal velocity instantly the circuit is made, even if the car is at rest; so that it develops its maximum power at the moment of starting.

2. All gearing is dispensed with by fixing the motor upon the axle.

3. Neither accumulator nor motor is short-circuited on starting, because before the car can move the brake has to be taken off *e*, allowing the armature at once to assume its normal velocity.

Objection may be made to the moving brushes and to the necessarily slow speed of the motor, involving an inferior efficiency. The first objection is pointless, since whether the brushes are fixed or movable they could not be adjusted whilst the car was in motion. The second objection brings us at once face to face with the electro-technical dogma that "slow-speed machines are less efficient than high-speed ones." I always ask, what machines these are? The slow-speed machines built by the Helios Company at Ehrenfeld according to my specification, and running at from 80 to 120 revolutions a minute, all possess an electrical efficiency of over 90 per cent. When running the machines hardly get warm, the current density in the coils being never greater than 1 to 15 amperes per square millimetre sectional area. Run off Helios engines of 80 or 100 horse-power our dynamos, when fully loaded, give a very high number of watts per indicated horse-power. There are, however, many difficulties in the way of testing machines when not loaded. I will therefore refrain for the present from giving a precise result of the effective horse-power. I maintain, nevertheless, that no high-speed machine gives a better commercial result. Measurements taken from a few small machines are, in my opinion, valueless.

As things are, the objections to slow-speed machines mounted on the axle apply only in the case of badly constructed motors. The arrangement, however, is quite unobjectionable when a properly constructed machine is used. In the present case a tramway motor is the object in view. The diameter of the wheels is 750mm., the circumference is therefore 2·35 metres. The car is to run 300 metres in one minute, hence the wheel makes 125 revolutions a minute. To do this we have a series motor with an electrical efficiency of 86 per cent. I hardly think that anyone, after an examination of the practical working conditions, would assert that this slow-speed machine gives an inferior commercial efficiency as compared with a high-speed machine, the power from which has to be transmitted to the axle by means of toothed wheels, worm wheels, chains, belts, &c.

I am of opinion that only the plainest views concerning the construction of machines can lead to practical solutions of electrical problems. The chief thing is to provide good mechanical arrangements. The wrangling over fractions is beside the point, especially if the public are left in the dark as to whether the efficiency claimed is merely a paper electrical efficiency or an actual commercial efficiency. Hence, I believe that the arrangements above described, avoiding, as they do by their simplicity as far as possible all the present defects of electrical railways, will further the introduction of electricity in this direction, notwithstanding academic considerations of efficiency.

NEW EXPERIMENTS ON THE ELECTRIC ARC.

Dr. Lecher, in the *Centralblatt für Electrotechnik*, No. 3, 1888, gives an interesting Paper on the above subject. Dealing first with the nature of the apparent resistance of the arc and the fact that it does not increase in resistance proportionately to the increase of distance between the carbons, he remarks that the theory of a counter E.M.F. was started by Edlund in 1867, and upheld more recently by Lang and Arons. Fröhlich and Peukert hold the same view in a modified form, and consider that only part of the apparent resistance is due to back E.M.F., and that the remainder is due to a resistance such as occurs at the electrodes of a Geissler tube. Wiedemann attributes the resistance to discontinuous discharge, and the author himself points out that the non-increase of resistance may be partly due to the fact that the arc spreads out and increases in cross-section when it lengthens.

An experiment mentioned affords strong evidence against back E.M.F., though founded on one of Edlund's to prove its existence. In the adjoining figure (Fig. 1) D is a dynamo, working an arc lamp, L; *g* is a permanent magnet ammeter, furnished with a stop, retaining the needle at zero when the current is in one direction, but leaving it free to move when reversed. The current is then switched on from the dynamo

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in the direction to hold the needle against the stop. The switch A is then closed, short-circuiting the dynamo, and at the same time leaving a closed circuit through the arc and ammeter so that if there were any back E.M.F. it would move the needle away from the stop. An extremely slight movement *was* observed, but as just as much was obtained when B was closed instead of A, it could only be attributed to the spring of the needle. It may be suggested that the resistance between the carbons was so high that no current could pass. It was found, however, that this resistance did not increase very rapidly when the arc was extinguished. To prove this the primary of an induction coil was placed in the lamp circuit. When the carbons were suddenly torn apart a spark was obtained from the secondary; but if the carbons were fixed and allowed to burn out of themselves no spark was obtained, showing that the resistance increased but slowly on extinction.

In 1869 Edlund first expressed the E.M.F. at the terminals of the arc in the form $a+b\,l$, where a and b are constants, l the length of the arc, $b\,l$ being the simple ohmic resistance. The constant a may be either a back E.M.F., as Edlund considers, or may be due to a certain initial work done at the electrodes in maintaining the arc quite apart from the actual resistance of the arc itself.

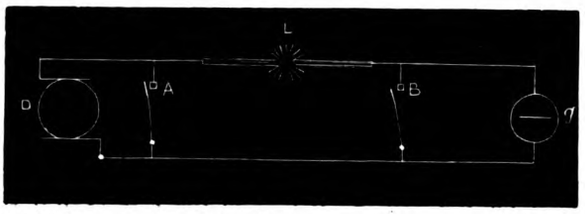

FIG. 1.

In order to see if the difference of potential of the arc is dependent on temperature, three series of tests were made—

1. With the carbons horizontal, and one heated with gas blowpipe.
2. Carbons horizontal, with the electrodes bound round with fine copper wire almost up to the arc, to conduct the heat away.
3. The electrodes vertical, the lower one sunk in a large mercury bath almost up to the arc, for cooling.

Difference of potential measured by electrometer current in all experiments 5 amperes, and, except when mentioned, the arc was 2 mm. in length.

In (1) the normal difference of potential was 42 volts; this rose to 48 volts when the positive, and 52 volts when the negative, was heated. These were the highest results obtained.

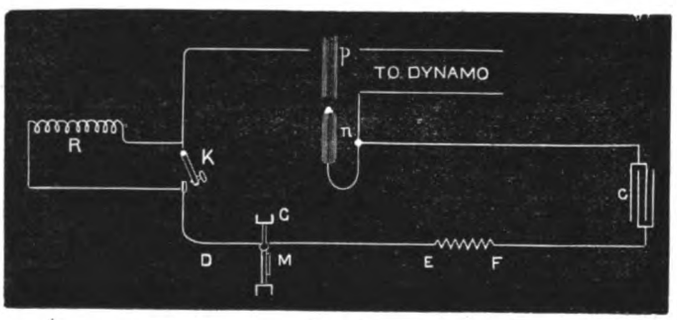

FIG. 2.

Much depends on the intensity of heat applied. If the carbons are vertical the upper one is warmed by the lower, and it was found that with the upper carbon positive the difference of potential was 47 volts, and with the upper carbon negative 46. If the lower carbon be cooled with mercury the difference of potential falls to 43 with negative below, and 41 with the positive below. This last figure was obtained by interpolation, as the arc could not be maintained steady at such a low difference of potential. The carbon in the mercury burnt to a blunt point instead of forming a crater or sharp point.

To represent the results in the form $a+b\,l$ we have

		a	$b\,l$	
Carbons horizontal uncooled...Difference of potential =		33	$+4{\cdot}5\,l\pm1{\cdot}5$	volt
,, vertical	,,	$35{\cdot}5$	$+5{\cdot}7\,l\pm1{\cdot}5$	,,
,, horizontal with copper cooling		25	$+5\;\;l\pm3$	,,

It is therefore evident that with carbon electrodes the difference of potential distinctly *is* affected by temperature; this will account for the fact that thick carbons, which remain cooler than thin, require a smaller difference of potential for a given length of arc.

With 5 mm. platinum electrodes (horizontal) the difference of potential was about 35 volts, with 2 mm. arc reduced by copper-wire cooling to 26 volts. For uncooled electrodes difference of potential $=28+4{\cdot}1\,l\pm1{\cdot}8$.

The results with iron electrodes 5·5mm. diameter were not very reliable;

$$\text{difference of potential} = 20+5\,l\pm3.$$

Difference of potential appeared to increase slightly with rise of temperature.

Copper electrodes, 4·4 mm. The temperature was already so low that only heating effects were tried. Difference of potential with 2 mm. arc about 26 volts, and rose about 2 volts when the electrode was heated (rather greater effects from heating negative than positive).

Silver electrodes, 4·9 mm.; horizontal, difference of potential = 20 volts, positive carbon heated 23 volts, negative carbon heated 28 volts.

With both silver and copper the results are very trustworthy, but in both $\frac{a}{b}$ appears to be comparatively small. With silver difference of potential appears to be about $8+6\,l$ volts.

A very possible explanation of the unsteadiness of the ordinary arc is that the point where the arc leaves the carbons becomes very strongly heated, the potential of difference rises, and the arc consequently keeps on moving to cooler parts.

INVESTIGATIONS ON THE INTERIOR OF THE ARC.

A pointed carbon rod, 1·5 mm. diameter, connected to one terminal of the electrometer, was introduced into the arc itself (2·5 mm. long), and the difference of potential thus taken between various parts of it and the carbons. It had been found by previous experiments that this had no appreciable effect on the difference of potential between the carbons.

The difference of potential between the + and − carbons was 46 volts. The difference of potential between the + carbons and *any* part of the arc differed but very slightly from 36 volts. The constant b, therefore, must be very small indeed, and could not be anything like 4, as above assumed, as this would have given a difference of about 10 volts, which could not have been overlooked. The total difference of potential appears to be made up of two—one of 36 volts at the hot + carbon, and one of 10 volts, not in the arc itself but at the cool − carbon.

With metal electrodes the E.M.F. of the arc itself lay very nearly half-way between those of the two electrodes, possibly because there was not nearly such a difference of temperature between them as between carbon electrodes.

The author here again refers to the fact that as the arc lengthens it thickens, so to speak, or increases in cross-section, and points out that if it left the carbons at a very small point, and spread out to a very great extent between them, the effect would be a very high resistance at the carbons themselves, and a very small resistance of itself, which would not increase with increasing length. The author then described some less satisfactory investigations on the discontinuity of the arc, the evidence being rather for than against discontinuity when the electrodes are iron or platinum.

It has already been found by other investigators that the telephone is not available for this purpose, owing to the minute fluctuations of the steadiest arc. Fig. 2 shows diagrammatically the method which Dr. Lecher adopted; p and n are the positive and negative electrodes; one of these is connected with a coil, R, which has a large self-induction coefficient; the other is connected with the condensers C and C^1. E F is a spiral spring, one end of which is attached to the terminals of the condensers, and the other end is fixed to a fine wire D E, which is connected with the coil R, and is kept stretched by the spring. This wire at its centre makes a turn around the steel axle G H, to which is also fixed a light mirror, M. It will therefore be seen that when the tension of the spring varies the mirror undergoes an angular deflection, and this is rendered visible by a beam of light reflected from the mirror in the usual way. The coil R is provided with a short-circuiting key, K, by which it can be cut out of the circuit.

Now, if the discharge between the electrodes is discontinuous, the fine wire D E will be traversed by currents of charge and discharge from the condensers; the wire will therefore be heated, and the contraction of the spring E F will cause the mirror M to be deflected, and the amount of discontinuity can thus be estimated. In the experiments with carbon electrodes and a condenser of one microfarad capacity, it was found that with the coil R short-circuited the deviation of the luminous ray reflected upon a screen placed at five metres distance amounted to 40 mm. when the arc was hissing.

The addition of a second condenser doubled the deviation. When the distance between the carbons was increased, the deviation diminished, and became zero as soon as the arc was silent. If while the arc is hissing the key K is opened, bringing the coil R

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into circuit, the deflection immediately disappears owing to the attenuation of the current waves by the self-induction.

With electrodes of iron instead of carbon the deflection was produced even with a very long arc, but it diminished in proportion as the length of arc was increased. With platinum the phenomenon is still more marked. If the condensers are dispensed with the length of the arc can be reduced to any extent without producing these effects.

It is evident from these experiments that the oscillating charge and discharge of the condensers plays an important part, but they are on that account none the less interesting. It may be hoped that a further study of the phenomenon will throw light upon questions which are at present but little understood.

The author remarks in conclusion that of course quantitative experiments must be made before any definite result can be arrived at, but he claims that his qualitative investigation shows that—

1. There is no proof of back E.M.F. by any return current.
2. Difference of potential is affected by temperature.
3. If the negative electrode is platinum or iron the discharge is discontinuous.

EXPERIMENTAL CURVES OF ALTERNATING CURRENTS.

From a paper by Dr. Louis Duncan and Messrs. Hutchinson and Wilkes, in the *Electrical World* of New York, we reproduce the adjoining curves of alternating currents which have been experimentally obtained. Fig. 1 represents the current through the

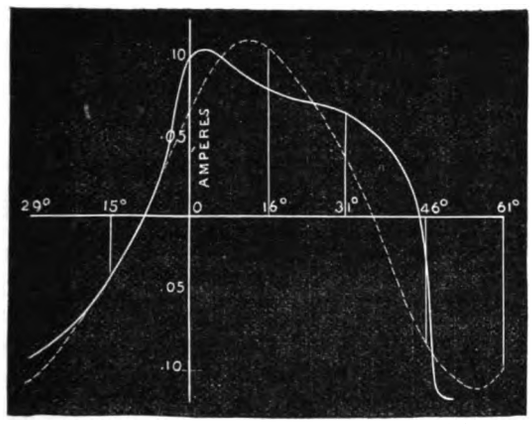

Fig. 1.

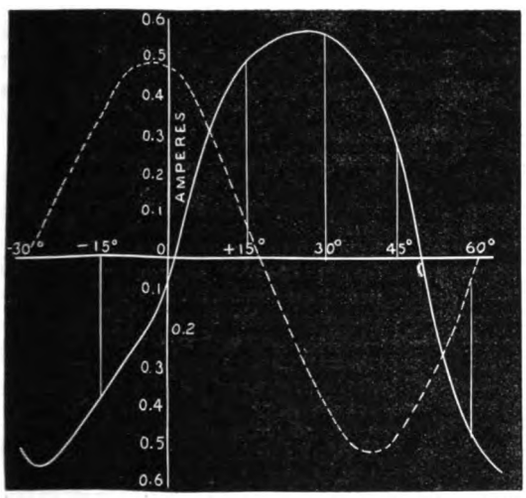

Fig 2.

primary coil of a Westinghouse transformer, and Fig. 2 is the corresponding current through the secondary. The method adopted for obtaining the curves is not given in the paper from which we copy them. The dotted curves represent sine functions; for the primary current the sine curve is drawn to the same maximum ordinate and so as to cross the axis at the same point; for the secondary current the sine curve is drawn in the position corresponding to that of the primary. The smoothing down of the irregularities of the primary is very marked in the secondary. But we fear that the shape of the primary curve does not say much for the design of the machine from which it is derived. Dr. Duncan, however, accounts for the form of the primary curve by saying that changes in the coefficients of induction—at different points on the curve—produce a considerable effect on the primary, while changes in the absolute values of the self and mutual coefficients, *provided they are in the same proportion*, do not greatly affect the values of the secondary. On this subject we may also refer the reader to a recent discussion at the Physical Society on a Paper by Mr. Sumpner, reported in our issue of April 27th, and to a Paper by Prof. Elihu Thomson in our issue of February 17th.

MEETINGS OF SCIENTIFIC SOCIETIES.

(TO-NIGHT) FRIDAY, June 1st.

ROYAL INSTITUTION.

9 p.m. "Earthquakes and How to Measure Them." By Prof. W. DEWAR.

SATURDAY, June 2nd.

ROYAL INSTITUTION.

3 p.m. Lecture, "Count Tolstoi as Novelist and Thinker" (1). By Prof. C. E. TURNER, of the University of St. Petersburg.

MONDAY, June 4th.

ROYAL INSTITUTION.

6 p.m. General Monthly Meeting.

TUESDAY, June 5th.

ENGINEERING SOCIETY (King's College, London, W.C.).

4:15 p.m. Paper on "Transformers." By Mr. PREECE.

ROYAL INSTITUTION.

3 p.m. Lecture, "Conventions and Conventionality in Art" (3). By Mr. SIDNEY COLVIN, M.A.

THURSDAY, June 7th.

SOCIETY OF TELEGRAPH-ENGINEERS.

Students' Meeting. Paper on "Belts and Belt-Driving for Dynamos." By Mr. J. N. COOPER. Prof. J. PERRY, D.Sc., F.R.S., in the chair.

CHEMICAL SOCIETY.

8 p.m. Meeting.

ROYAL SOCIETY.

4 p.m. Meeting. Election of Fellows.

ROYAL INSTITUTION.

3 p.m. Lecture on "The Growth and Sculpture of the Alps" (3). By Prof. T. G. BONNEY.

FRIDAY, June 8th.

ROYAL INSTITUTION.

9 p.m. Lecture on "Phosphorescence and Ozone." By Prof. DEWAR, M.A., F.R.S., M.R.I.

SATURDAY, June 9th.

ROYAL INSTITUTION.

3 p.m. Lecture, "Count Tolstoi as Novelist and Thinker" (2). By Prof. C. E. TURNER.

PHYSICAL SOCIETY (Normal School of Science, Exhibition-road, South Kensington).

3 p.m. "On the Analogy between Gases and Substances in Dilute Solutions." By Prof. J. H. VAN 'T. HOFF. Communicated by Prof. W. RAMSAY. Exhibition of a Lantern by Mr. W. LANT CARPENTER.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Hernosand Central Station.—A correspondent writes as follows:—"The town of Hernösand, Sweden, one of the first towns in Europe in which the streets were lighted by electricity, has now under contemplation extending this mode of illumination to house lighting. The cost of a central station with motive power has been put at 42,000kr.; the annual expense has been calculated at 8,000kr., and the revenue at 14,000kr. The corporation will probably take the matter in hand."

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The Electrician.

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THE DIRECTORY FOR 1888 IS NOW READY.

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THE MUNICIPALITIES AND ELECTRICAL ENGINEERING.

Notwithstanding the uncertainty which continues to obscure the precise character of the future relations between local authorities and the "undertakers" of electric lighting, there has never been a period when so much active interest has been displayed in the subject by the local authorities. During the last six or eight months our columns have recorded the proceedings of some twenty-four or twenty-five town councils, local boards, or vestries in which the matter has been under discussion. In almost every case the proposals have met with a reception of a more or less favourable character, and at the present moment there are at least ten or a dozen places where a practical outcome may more or less confidently be anticipated. At the same time, it is impossible to read the reports of the discussions in these assemblages without becoming painfully aware of the exceedingly dim and hazy character of the ideas of electric lighting which are still entertained by the average vestryman or town-councillor. Not many years ago we had the pleasure of meeting a gentleman, whose name we have since recognised as that of an ardent champion of local electric lighting, and who held, and still holds, an honoured position in the councils of the local senate in a certain cathedral city. This gentleman assured us that to him personally belonged the honour of introducing the electric light into the West of England, but that "until he bought one and brought it home and tried it for himself" he never did or could believe in the possibility of electric lighting. Our curiosity having been thus aroused, we were invited to inspect the arrangements at his place of business. We went there, and were shown—an electric gas-lighter!

But this was years ago; and since then our friend has doubtless learnt a good deal more about electric lighting, as, indeed, it is to be hoped we all have. There is, however, one

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point at least upon which the municipal mind still remains in a singularly unenlightened condition. That is as regards the difference between incandescent and arc lighting. We should be glad if it were more widely understood that a vast difference exists from a technical point of view between carrying out a programme of street lighting by arcs, and that of a complete system of incandescent lighting for the interior of buildings. An installation of arc lights is a simple straightforward practical piece of work, into which no element of uncertainty can enter, and complete success ought always to be positively assured; and we may add that from an electrical engineering point of view when accomplished there is absolutely nothing in it to boast about, and very little of technical interest. More than one well-known firm in this country have successfully carried out the lighting of Exhibitions in this and other lands—often at very short notice—upon a scale which would amply suffice for the lighting of the principal streets of a town of 50,000 to 100,000 inhabitants. The only point which requires special consideration on the part of the local authorities is that of the wiring. In Taunton and Waterford, where installations of this character exist, the lamps are mounted upon tall poles, and the wires are carried from one to the other without so far entailing either difficulty, inconvenience, or unsightliness. Where it is necessary to cross the street the wire may either be taken up to the level of the house roofs or, if preferred, may pass underground. We feel sure that, if it were once fully realised how simple and satisfactory a job can be made of arc lighting, its employment would be rapidly extended throughout a very large number of our provincial towns. And in order that this may be fully apprehended it is necessary to insist upon the fact that the question stands upon a wholly different footing from that of incandescent lighting, which has difficulties of its own to contend with, as well as merits of its own to recommend it.

Two objections to the arc light still linger in the public mind. The first arises from the blinking and flickering which it is perfectly true still characterises many public or semi-public installations. But it is a great mistake to suppose that blinking and flickering are inseparable characteristics of the arc light. These effects are nearly always due either to the continued use of obsolete types of lamp, or else to a mistaken economy in the burning of inferior qualities of carbon. There are several lamps in the market which, when provided with good carbons, will burn with a steadiness certainly exceeding that of the gas flame, and which may fairly be compared with that of the incandescent lamp itself. Carbons of the cheap and nasty type will ruin the reputation of any arc lamp. The second objection which is sometimes raised to the arc is that the light is not sufficiently diffused. The usual remedy consists in enclosing the lamp in an opaline or ground glass globe; but this is not altogether satisfactory, as it considerably diminishes the total amount of illumination, and does not always give the needful diffusion. We think it a pity that greater use is not made of the very ingenious and highly successful system of distributing the light over a wide area which is well known to electrical engineers under the name of the "dioptric lens." With the aid of this, or possibly of some equivalent appliance, a very pleasing and uniform illumination may be secured.

There is another branch of electrical engineering which will force itself more and more upon the attention of our municipal authorities, and especially those who are interested in local systems of tram lines. It is one, moreover, which admirably lends itself to employment in conjunction with the lighting of the streets; we refer, of course, to electric traction. Whether this be carried out by the supply of current direct from the machines or by the use of secondary batteries, a great saving may be effected in either case by the combination. To a considerable extent the same plant and same engine-room staff may be made available for both services, and the economy thus effected in the lighting account would go far to balance the increase of cost compared with gas lighting; in fact, we fully anticipate that, under circumstances of an even moderately favourable character, the saving would be more than sufficient to turn the scale in favour of the electric light. We shall not at present go into any details upon the subject of electric traction from the municipal point of view; but for the information of those interested we may state that it is now an ascertained fact that the cost of electrical traction does not, under average conditions, exceed 4d. per car mile, while we have good reasons to believe that in many cases it may even fall below 3d. per mile. For horse traction, on the other hand, 6d. per car mile may be taken as a low figure. These figures include interest and depreciation on the capital outlay in each case. Facts, such as these, if brought home to the municipal mind by practical demonstration, will go far to remove any remaining doubts as to the economical uses of electricity in many of our most populous towns.

EDISON AND SWAN ELECTRIC LIGHT COMPANY v. HOLLAND AND OTHERS.

On Wednesday last the further hearing of this action was proceeded with before Mr. Justice Kay.

The ATTORNEY-GENERAL proceeded with the re-examination of Mr. SWAN. Witness said he could not say when he first began experimenting with heating the lamp before sealing. He patented the method in the beginning of 1880, and he thought it had been used for a considerable length of time in his lamp before patenting. He did not know at the time that the same process had been described by Mr. Edison, nor did he know of it now. Asked whether he knew of any publication of carbons of wood splints for incandescent electric-light lamps before Edison's patent of 1879, witness said he thought King's specification might be construed to embrace wood splints. In the various patents he had taken out his object had, of course, been to secure some monopoly in the lamps. He used platinum caps all through 1879, and to that extent he had departed from the elements of F J B 1. There had been a good deal of trouble experienced when the platinum wire was simply taken through the glass, arising from the cracking of the glass where the wire was sealed in. That defect was one which could be explained now. These caps were adopted as a means of preventing this accident, and they did prevent the cracking.

Mr. CHARLES HENRY STEARN, in reply to the ATTORNEY-GENERAL, said he was managing director of the Swan United Company's foreign business. In 1877 he was residing at Rock Ferry, near Birkenhead, and he was then a clerk in the Bank of England. He had experimented with the Sprengel pump since 1872. From the end of 1877, during part of 1878, and through 1879 and 1880, he was engaged with Mr. Swan in experimenting. He first had some discussion or correspondence with Mr. Swan on the matter in August, 1877, and from that time down to the end of the year 1879 he at intervals had received carbon from Mr. Swan. Fred Topham used to blow the bulbs, and no one besides him had blown the bulbs before the fire, which occurred at the end of 1879. It was suggested by Mr. Swan that they might obtain elasticity in the carbon. In the first case it would be seen that the strip of carbon was rigidly fixed at the ends, whereas in this case each piece of carbon was free to move a little. That gave room for expanding and contracting without breaking, and it afforded an easier method of mounting for the glass blower. In the first case the carbon was a very thin fragile piece of carbon, and the glass blower, while fusing the wires at either end, was very apt to break them, because, while he was fusing one the other was hanging loose. Of course, with the skill attained at the present day, there would be no difficulty whatever.

Witness was then referred to his letter of the 24th June, 1878, in which he spoke of the carbon filaments being too fragile for commercial purposes. Witness explained that his impression was that if these filaments were sold on a large scale, they were so delicate that they would be inevitably broken in carriage. That was his opinion for a long time, until, in fact, the filaments had been strengthened by the Cheesborough process. From an account which he delivered to Mr. Swan of his out-of-pocket expenses in this matter, it appeared that he paid the glass blower from 2s. to 3s. per lamp. Among the lamps charged for in that account were four large experimental lamps, one of which contained a piece of asbestos, which was used for the purpose of insulating the coils—it was placed between two convolutions of the wire—a coil inside and outside. He did not use carbonised thread up to the 12th January, 1880. The lamps they

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were making had platinum caps. The use of copper necessitated the use of platinum caps, because they could not seal the copper to the glass. Referred to his letter of the 29th July, in which he suggested that the pencil should be put on blocks, by which means the only apparent source of danger would be removed, witness said the carbon pencil was let into two larger cylindrical blocks at the end. They were of larger diameter, for the purpose of reducing the temperature of the carbon at the point of contact. The carbon pencil had been let into the blocks by drilling. The effect of heating and cooling was to cause it gradually to rupture the contact. Before writing that letter he had not tried the thinning of the carbon in the middle. In his letter of 3rd October, 1879, he had referred to Mr. Edison's experiments in the use of platinum wire in vacuo. There were two points in connection with those experiments to which he wished to draw Mr. Swan's attention. The first was that Edison was expelling occluded gas from the platinum; the other was that he was using a vacuum for his lamp, as distinguished from nitrogen or open air. At that time it was understood that Mr. Swan should take out a patent when they had thoroughly investigated the ground. He did not at any time before then know the details of Edison's proposals. Referred to his letter of the 19th November, 1879, in which he proposed to try the lamps with the Birkenhead Corporation's engine, witness said that prior to that date he had only tried them with batteries. He had not used carbon threads or carbonised cotton before May, 1880. It was not true that in 1879 he had alight in his house thread lamps made out of blocks of fibre of hemp twisted. They had no loop lamps before the year 1880; certainly not until quite the end of 1879. The circular lamp may have been made in December, 1879, although exhibited in 1880. Through the year 1879 they were using platinum caps. In March, 1880, he took another house for the purpose of a laboratory to enable him to conduct the experiments on a larger scale. Before then he had not had any dynamo. The Cheesborough process was first used in December, 1880.

Did you know Cheesborough at the time?—No.

Had you thought it out for yourself?—I think the origin of it was that some time before—I do not know how long—I had sent a thread lamp to Mr. Swan, and Mr. Swan reported to me that it was entirely different from any that he had had before, that its resistance was lower, and that it had a bright silvery appearance. He asked how it was done. I never knew how it was done; it was accidentally obtained.

Cross-examined by Mr. FINLAY: He had written a Paper for publication in the *Electrotechnische Rundschau*; and in January, 1885, a Paper was published in that magazine in German, with his name affixed to it. The Paper was never sent to him for correction, and he was not at all responsible for it. The original article was much longer; he could not read the German, but he could not accept the English translation from the German (which was in court) as his article. The original manuscript had been returned to him, but some portions of it were now missing. Witness was then cross-examined upon several passages in the article. Asked in reference to one passage, was there any essential principle of incandescent lighting which was not known before November, 1879, witness said it all depended upon what the "essential principles" were defined to be. Of course, essential principals and the carrying of them into effect were two different things.

Is it not the case that all that remained to be done in November, 1879, was the perfecting of the details and the carrying of those principles into practice?—I should say so.

Witness, continuing, did not think the necessity for or desirability of a thin carbon conductor for an electric lamp was generally recognised in 1877; or, rather, the necessity for it had been, but not the method of production.

The necessity was well known to everyone of making the carbon conductor as thin as possible?—Yes.

Witness was then examined upon the statement in the article that during the years 1878 and 1879 he had used "other kinds" of carbon. Witness referred to the original manuscript and found that he had used the phrase "other kinds," but explained that that was a careless expression. What he meant was, "other forms," such as those shown in the various drawings that had been put in—paper carbons and round Carré carbons.

Witness here explained that an illustration of Lane-Fox's lamp had been put in by the editor, but the editor had acknowledged that he had used the illustration of a lamp of a later date than that referred to in the article. That was a very material alteration, as it would suggest that Lane-Fox had used a filament as early as 1878.

Witness was then examined upon this passage: "It appears that this lamp (Edison's patent of November, 1879) had no practical success; it was never reduced to practice." On referring to the original manuscript he found that the words he had used were "no practical success appears to have attended this early lamp." That of course was to a considerable extent a matter of opinion and information, but he was not aware of lamps made according to the details described in the patent having been used commercially.

Do you think it likely?—That, of course, is a matter of conjecture. I have not seen them nor heard of them being sold. I can say no more.

Besides attending to the management of your own company you pay some attention to what has been going on in the electrical world?—I must say for some time past I have been unable to do so; so much litigation has been going on in both countries that it takes up all one's time.

When you wrote that passage had you not reason to believe it was true that it had never been successfully made or sold?—I said it was not in commercial use.

Apart from subsequent improvements, did you ever know of any lamp being made under this patent?—I think it has commonly been made. I was confining myself entirely to the commercial use.

Mr. JUSTICE KAY: Do you know of any lamp?—I believe several lamps have been put in in the course of this trial.

Mr. FINLAY: Did you ever hear of any lamp being made under this patent until Mr. Gimingham made it for the purposes of investigation?—I think I heard previously that lamps made according to the particular description in the body of this patent had been brought over from America, but I had never seen them.

Were the lamps brought from America, bamboo lamps?—I was told not. I was told lamps with a carbon filament had been brought from America.

Witness was then examined upon another part of the article, in which he was made to say that to Edison must be assigned one of the chief and most important positions in the band of inventors, but that his scientific results did not precede in any manner, either in invention or merit, those of other eminent inventors. Witness said that he had not the original manuscript of that portion of the Paper, but probably that was substantially what he had written. The words, "in any manner," were perhaps going a little too far, and he hardly thought that they represented what he actually wrote.

Did you say in substance that Edison had not been before other inventors in this matter of the incandescent lamp?—Most probably I did, or something to that effect, in regard to the general principles of the incandescent lamp.

General principles, I understand you to say, Edison did not anticipate?—It certainly was my opinion that he did not.

And that is your opinion now?—Yes; that is my personal opinion, for what it is worth.

Did not Edison anticipate any of the details?—There are a good many details in that patent, and I could not answer you offhand.

Having read the patent when you wrote that paper, did you not regard that patent as unimportant?—Yes; but you must remember I am dealing with the German patent. I am not dealing with the English patent.

In reply to further questions witness said that Mr. Turner was in the habit of coming to his house in 1879. He could not swear that he did not show some incandescent lamps to Mr. Turner in the summer of that year, but he could not remember doing so; certainly Mr. Turner did not then see the carbon conductor in a horseshoe form. He remembered Mr. Allon being employed to fit up batteries for him. He could not fix the date exactly, but he thought it was later than the summer of 1879. He had no doubt that Mr. Allon had been introduced to him in 1878 or 1879 by Mr. Turner. He was not, however, prepared to contradict Mr. Allon if that gentleman stated he had been at the house in August, 1879, and seen incandescent lamps.

Will you swear that he did not see the carbon conductor in August, 1879?—I have a general recollection that we did not use the arched forms until we had the hair pins.

Did you hear Mr. Swan say that he ordered the hair pins in the spring of 1879?—Ordering them and getting them are two different things. Mr. Swan gave the order to Carré; secondly, as those are unusual things to make, it would be some time before Mr. Swan would receive them; a still further time would elapse before Mr. Swan had time to attach them to conductors and send them to me, and a further time would elapse before I did anything with them.

When do you say these hairpin conductors were first mounted? I can only answer that by reference to the letters. On the 26th of November I find they are mentioned. My recollection, confirmed by the correspondence, is that we did not use them before that date, or only a few days before.

The Court then adjourned for luncheon.

On resuming Mr. STEARN was asked whether Mr. Swan during 1879 was reducing the size of the carbon as much as possible. Witness said his first interview with Mr. Swan turned entirely on the question of the size of the carbon conductor.

You and he thoroughly understood that the great *desideratum* was to get the conductor very much thinner?—As thin as possible.

The question of a thin carbon was the first before you?—A thin conductor if a high electromotive force was got.

That was in October, 1877?—Yes.

You use the term filament to denote extreme thinness?—Yes.

Did you not show Mr. Turner and Mr. Hannen, in 1879, lamps with carbon conductors of extreme thinness?—I have no recollection of showing them anything, but at that time I did use such lamps.

Have you any doubt they saw them?—Probably I had them there.

Would not thread light be a correct description of the lamps you were trying in 1879?—It would be a correct description.

Did you make conductors of the arched form in 1879?—I should say not.

Are you prepared to say, upon your oath, that in the summer of 1879 you had not lamps with the conductor of an arched form?—My belief is not, but I cannot swear to it.

The provisional specification taken out in January, 1880, by Mr. Swan for the use of paper—had you not, during the year 1879, been trying lamps made by Mr. Swan somewhat in the fashion indicated?—I had not tried any lamps made by Mr. Swan.

I mean the form. Now, I ask you whether you had not, during 1879, been trying conductors made in the form therein described—horseshoe form?—No, I do not think we had.

When did you first try the horseshoe form?—In December, 1879, or the beginning of the following January. I remember exhibiting it in January.

Paper you had been using from 1877 onwards?—Certainly.

Re-examined by the ATTORNEY-GENERAL, witness gave details of his applications in various letters and from his diary to Mr. Swan for carbons for experiments. He had a distinct recollection of being annoyed at being kept waiting for carbons.

Have you any connection with the plaintiff company at all?—Only as a shareholder in the Swan Company.

In the German Paper were you advocating Swan?—I was endeavouring

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to overthrow Edison (laughter). I was endeavouring to educate opinion in Germany.

What did you mean when you spoke of "extremely thin?"—An extremely small cross-section. If it is a thread it will be a circular section; if it is not it will be a rectangular section.

CHARLES FREDERICK TOPHAM, examined by Mr. BREMNER, said that he assisted Mr. Stearn in his laboratory work. Witness was given paper carbons, which he mounted in tubes for Mr. Stearn. Cases of breakage occurred in the mounting. He was next occupied with putting carbon pencils in bulbs. He thought about six were given him.

Mr. JUSTICE KAY several times complained that the replies were inaudible.

Witness said that he remembered the various removals of Mr. Stearn's laboratory. Before it was moved downstairs the shape of the conductors given to him was straight. No other shape was used in the upstairs laboratory. After the removal of the laboratory downstairs the next change witness remembered was to carbon rings made of paper. Witness remembered a fire at Mr. Stearn's, and it was about that time that the rings were adopted. He remembered having thread filaments given to him to mount, and that was after a removal to another house. He mounted no thread filaments at the old house.

Do you remember any change in the nature of the carbon paper after the fire?—No.

Except from the places you were working at have you any recollection of the dates?—None whatever.

About how many lamps do you believe you delivered to Mr. Stearn before the removal downstairs?—About eleven or twelve.

And after the laboratory was shifted until you went into the new house?—I could not say.

Mr. Roberts used to come to Mr. Stearn's house occasionally?—He did.

Cross-examined by Mr. FINLAY: He would be about 15 years of age at the time, and he had no recollection of the various dates.

When did you have your memory refreshed about all these things that occurred so many years ago?—About a week or a fortnight ago.

And you recollect them all?—Yes.

Which happened in 1879?—Yes.

Have you got any notes?—No. He knew the carbon rings were made of paper from being told by Mr. Stearn. His eye would not have told him that.

Can you fix the time of being given the hairpin conductors?—About the time of the fire. Certainly not before the time of the fire.

You were spoken to a week ago about this; how do you profess to recollect the things so precisely?—I have thought over it since. I have made drawings. I made drawings about three weeks ago, and others about eighteen months ago.

Were the latter for the Woodhouse and Rawson trial?—I do not know. Those are the only drawings I have made.

Witness, continuing, said he had been engaged during a number of years blowing lamps, and he might say 100,000 had passed under him.

Now, have you got anything whatever to enable you to fix the different kinds of conductors?—Only the numbers that were exhausted in the different rooms.

Re-examined by Mr. ASTON, witness said he took an interest in the work, and he had no doubt about what he had mentioned so taking place. He blew the bulbs himself, and was in the habit of taking them to Mr. Stearn himself, and his memory was distinct.

Mr. JOHN IMRAY re-called, examined by Mr. MOULTON, was the next witness.

You have had experience as a manufacturing engineer?—From 1850 to 1867.

You have heard the evidence as to using charcoal powder during carbonising; was that common ordinary knowledge in 1879?—I am sure it was, long before.

Can you give an example of the use of charcoal powder for the purpose of preventing oxidation?—In tempering fine steel works such as the hair-springs of watches. That is a common thing. I succeeded to the business of the Patent Axletree Company, and we had to caseharden the axles.

Mr. JUSTICE KAY, upon witness's going into details of the process, intimated to Mr. Moulton that he did not think it would throw any light on the case.

Witness, continuing, said that he had made an experiment, taking two crucibles, each of a capacity of 200 cubic centimetres. He put into each of them chips of wood, small strips of paper, pieces of thread and vegetable fibre—Mexican fibre. Having put the articles loosely into the crucibles, he poured sand upon them so high as to nearly fill the crucibles. One of the crucibles he left dry, and in one he poured water, so as thoroughly to soak the sand. The lids were then secured, a hole being made so as to allow gases and steam to escape. He then heated the crucibles to a sharp heat, and then examined the contents. He should mention that before putting the contents in the crucibles he tried to get electricity through them, but could not get a spark. Afterwards he found them fair conductors, and could send electricity through any of them. The product of the carbonisation of the wetted one took a current up to 30 volts.

With regard to sand for the purpose of carbonisation, was that common knowledge before 1879?—Yes. In the very first number of the *Mechanic's Magazine* for the year 1823 there is a passage describing the preparation of charcoal for drawing, which employed it. On the 28th of May he saw carbonisation done at the plaintiff Company's works. In the first place he saw a boy making filaments from a putty of lampblack and tar, rolling them between two pieces of glass. That was done rapidly. They were then cut into short lengths, and short pieces of platinum were attached to the ends. He saw strips of bamboo with platinum attached, in the same way pieces of thread, and thread with the putty. A number of these were put into a small iron box, laid loosely, and subjected to gas heat, and upon being opened all were found to be well carbonised. All were quite fit for electric lamps. He found, upon testing, a thread smeared with lampblack fitted with platinum wires gave a resistance of a million ohms. He then tried heating it with a spirit lamp, but it never got to red heat.

Mr. JUSTICE KAY: None of these experiments were at a heat equal to a coke furnace?

Witness: No. He took it out and found it to be partially carbonised, giving a resistance of 38,000 ohms. After being replaced and subjected to a sharp white heat for twenty minutes it became thoroughly carbonised, with a resistance of 175 ohms, and it was mounted in a lamp. The gas muffle was the ordinary furnace for laboratory purposes, and gave what was called a sharp red heat. Witness saw other lamps made, filaments of the putty run out and coiled upon a helix of copper wire. He was shown a number of lamps burning—twenty-five—of which four were helically coiled. They all burned well during some four hours. The effect of the helix seemed to him to be the best lamp of all. That was a matter of taste, but it was a sort of central star. It had a pleasing effect upon the eye.

From what you saw at the works, what conclusions did you draw as to the mode of manufacture given in Edison's specification?—I saw no practical difficulty about it; a little care in manipulation—that is all.

Do you think there is any direction in Edison's specification which is not the result of actual trial?—I am satisfied that everything that is described by Edison is the result of practical trial by himself. With respect to filaments in which the tar had not been sufficiently extracted, samples of which were submitted to the Court, witness did not think the presence of an attenuated vapour in it would affect the light seriously; but it was a question of degree.

At this point His LORDSHIP said the Court would adjourn until the next day rather than commence a new point.

THURSDAY, MAY 31ST.

EXPERIMENTS TO BE MADE IN EDISON'S SPECIFICATIONS.

On the Court re-assembling on Thursday, His LORDSHIP suggested to Mr. Moulton that it would be useless taking the opinions of many scientific witnesses, there being so many facts before the Court, and he should, so far as he was concerned, decide upon facts.

Mr. MOULTON replied that he would compress the evidence as much as possible.

The cross-examination of Mr. IMRAY by Mr. FINLAY was then proceeded with.

Mr. JUSTICE KAY intimated that he was satisfied that there had been previously no trade in which carbonising things so fine as filaments was carried on.

Mr. FINLAY said he would not go into that point then. To the witness: With regard to sand, what kind did you use?—Ordinary sand, such as chemists use in sand baths—silicious sand, of no particular selection. The crucibles he had referred to would be about 13 cubic inches—3 inches high, 2 inches at the mouth, and 1½ inch at the base. He did not know that that was much smaller than those used in the manufacture of filaments commercially.

Would there not be oxygen between the interstices of the sand?—Yes.

Would not one-third of the cubic contents of the crucible be air?—Possibly; it would depend upon the fineness of the sand.

Would not the carbon filaments under such circumstances be consumed?—The oxygen would not get to the filaments.

Mr. MOULTON here mentioned that the crucible referred to was just twice the size of the one used by Mr. Crookes.

Mr. FINLAY (to the witness): Would not the oxygen get intermingled with the gases given off in the process of carbonisation?—In the course of time. The experiments, witness said, took from half-an-hour to an hour, but he was unaware of the time occupied in the commercial process. In nine or ten hours there probably would be combustion in a large crucible.

How was it that in your experiments the gases were not consumed?—I do not know, except that they were not.

Can you suggest any explanation of the phenomenon?—The quantities of gases given off were sufficient to neutralise the oxygen.

Mr. JUSTICE KAY asked why keeping it at a white heat for eleven hours would have the other effect?—Witness explained that in that time there would be sufficient diffusion of gases to enable oxygen to get in the box from the outside.

Mr. FINLAY: Packing is not required?—I do not think it is at all necessary.

Mr. JUSTICE KAY asked the witness his views as to the nine or eleven hours' process, which had been mentioned as being far too long?—Witness expressed his inexperience of that length of time in that process, and Mr. Justice Kay said he would mark the question as not answered.

Mr. FINLAY (to witness): Do you seriously suggest that these filaments could give off gases to the extent of more than 1,500 times their own volume?—No; I say they drive enough oxygen out to prevent combustion.

You were a witness in the Woodhouse and Rawson trial; did you hear evidence given there that the carbon in lamp F J B 1 had been carbonised before being introduced in the form of a pencil?

The ATTORNEY-GENERAL, interposing, said there had not been evidence to that effect.

Mr. FINLAY, in support of his question, then read extracts from the evidence given in the Woodhouse and Rawson trial. From Sir Frederick Bramwell's evidence: "I have no doubt it has been worked down from a thicker piece of carbon. It would be a lamp of low resistance;" and from Dr. Hopkinson's evidence as to conductors being carbonised before being put into their final shape.

After an intimation from the ATTORNEY-GENERAL that the passages

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required to be read in their connection with others, the point was not further pressed.

Re-examined by Mr. MOULTON: In your experiments were any unusual precautions taken to prevent the destruction of the fibre?—No; the experiments could be easily repeated.

With regard to the process of carbonisation used now in manufacturing, have you any experience?—No.

Mr. JUSTICE KAY: Do you know enough of the commercial manufacture of filaments to be able to tell me whether they are carbonised in gas mufflers or not?—No.

Did you take any note during the carbonisation?—Yes; I have the book. The box and filaments were put in the muffle at 12:20, the heat being then on, although not fully; it remained ten minutes at a moderate heat, and was then put full on. The box was taken out at 1:20, left to cool, and opened at 2:5.

Can you explain why your experiments succeeded and some of Mr. Crookes's did not?—No, unless he kept them a very long time heated.

Mr. CHARLES HENRY GIMINGHAM was the next witness examined by Mr. MOULTON. He was, he said, the superintendent of the manufacturing department of the plaintiff company, and had been in their employ some seven years. In the course of the manufacture witness said that when gas was used, it was an ordinary furnace, but coke was afterwards returned to. So far as he knew the heat would be just about the same as that used by Mr. Imray when gas was used. A long period for carbonisation had been found to give inferior results. With regard to packing, a mixture of lampblack and charcoal powder was used about seven years ago, but since then a good deal of plumbago powder had been used.

What was the heat when the gas muffle was used?—It would easily melt brass, but would not melt cast iron. It would melt copper. I have carbonised a great number of filaments in the manner described by Mr. Imray.

You have also carbonised with charcoal packing?—Yes.

Will you tell his lordship if, in your opinion, all the ways referred to in Edison's specifications will yield practical results?

Mr. JUSTICE KAY: I will not take opinions. If you will give me what has been done I will take it.

A list of the lamps in the boxes in court was then handed to his lordship, and lamp No. 51, described as "tar putty spiral," put in.

Will you tell his lordship what, in your opinion, are the advantages of the spiral lamps?—The spiral lights, in my opinion, give a more pleasant light than the single loop lamps. The pleasantness comes from a more uniform light, and the eye not being liable to distinguish the hairpin shape of the carbon.

Mr. JUSTICE KAY: I do not know what Mr. Finlay thinks, but I think it would be more satisfactory if experiments were tried before experts on behalf of both sides.

The ATTORNEY-GENERAL: I have no objection.

Mr. JUSTICE KAY: I should like all that is suggested in Edison's patent made in that way, and whatever is made tried.

Mr. FINLAY: I think that would be more satisfactory.

The ATTORNEY-GENERAL: These lamps (now in court) should be tried, too. There is one guarding observation I would make—that I do not at all agree with my learned friend that the fact of the defendants' working improvements has the slightest bearing on the question of the validity of this claim.

Mr. JUSTICE KAY: I am only speaking on the evidence. It will be a great deal more satisfactory to me if the manufacture is carried out in the presence of both sides. Seeing that there is now a serious conflict of evidence I should like to have the results tried.

The ATTORNEY-GENERAL: It shall be done in the presence of anybody named by your lordship.

Mr. FINLAY: What the Attorney-General suggested, to test the lamps already made, would hardly meet the case.

Mr. JUSTICE KAY: Certainly. Now, if you can get some eminent experimental witnesses to make a joint report——

Mr. FINLAY: How long would it take?

Mr. JUSTICE KAY: Before Monday, surely.

The ATTORNEY-GENERAL again suggested the testing of the lamps already made.

Mr. FINLAY: That is no use.

The ATTORNEY-GENERAL: His lordship will say.

Mr. JUSTICE KAY: I am in face of a very direct conflict of evidence.

The ATTORNEY-GENERAL: It is your lordship's wish an independent person shall be there as well—Sir William Thomson.

Sir Horace Davey now entered the court, and, addressing the learned counsel,

Mr. JUSTICE KAY said: I should like it conducted in this way; six or more lamps made, and the whole manufacture from the beginning—enclosing the carbon in the lamp, exhausting it, and so on—should be carried out according to Edison's description in his specifications, and I want witnesses to see that it is fairly done, a "moderator" I may call him, who will give me his independent report. Do you see any objection?

Sir HORACE DAVEY: It seems to be an advantageous course to take.

Mr. JUSTICE KAY: I should think two expert witnesses.

Mr. FINLAY: Of course, if the lamps are to be run for duration.

Mr. JUSTICE KAY: They will have long enough if they run until the case ends (laughter).

The ATTORNEY-GENERAL: The question of duration I think my friends will find will not avail them.

Mr. JUSTICE KAY: Run them until they break.

Sir HORACE DAVEY: The selection of the "moderator"?

Mr. JUSTICE KAY: I thought you would relieve me from that.

The ATTORNEY-GENERAL mentioned Sir Henry Roscoe's name.

Mr. FINLAY: Is there to be packing?

Mr. JUSTICE KAY: You may do it both ways. It would be most satisfactory to me.

The ATTORNEY-GENERAL: Three ways—sand, charcoal, and without.

Eight or nine cases, containing about 300 lamps, were then put in, manufactured by the plaintiff company, considerable time being occupied in their manufacture being formally proved by Mr. Gimingham, and their being given into the charge of the officials of the court.

Sir HORACE DAVEY: I understand, my lord, that a case containing 150 exhibits has been put in *en bloc*. How it is possible to cross-examine upon that I cannot conceive.

Mr. JUSTICE KAY: Upon this part of the case, as to what is practicable under Edison's specification, I shall pay more attention to what is done by the gentlemen who are going to meet and experiment.

The cross-examination of Mr. Gimingham by Mr. BREMNER was then proceeded with.

You never made any filaments for sale without using plumbago?—Without using packing, I think not, at no time in my experience.

You tried lamps for duration at 10 watts per candle-power?—That was an excellent efficiency in 1879.

What is the efficiency to-day?—3½ to 4 watts.

With an ordinary sixteen candle lamp have you tried how much one made by you will give out at 10 watts per candle-power?—I have not tried; probably not more than 8 candle-power.

Would it not be nearer four or five? Are you in a position to contradict that?—No.

What is E G 59? (the lamp being taken from one of the cases put in).—20 per cent. of oxide of zinc wound between a copper helix. My brother made it.

You would not call him an ordinary working man?—Yes, I should.

Do you suggest it is a close spiral such as is shown in Edison's drawing?—I do.

Sir HORACE DAVEY: Perhaps your lordship will look at it?

Mr. JUSTICE KAY, to witness. Is it as close as is shown in Edison's drawing?—I think so, my lord.

Mr. BREMNER was proceeding to question witness as to its being what Edison meant by "coil," when

Mr. JUSTICE KAY said that that must be left to him.

Mr. BREMNER (taking another of the lamps put in to witness): E G 62, what is that?—20 per cent. oxide of zinc coated with silicon.

Did you make it with your own hand?—I did not.

Did your brother coat it with silicon?—Yes, I saw him.

What silicate did he use?—Not silicate at all; pure silica.

What part of Mr. Edison's specification did you consider that was carrying out?—When he tells you to use a "non-fusible, non-conducting substance," I believe his words are.

Take J 18, put in as a lamp made in sand. Do you call that a good commercial lamp?—It is an amateur's lamp (laughter).

Replying to his lordship, witness said that the furnace was at times kept going for 13 to 14 hours, because that gave more carbon from each thread. It was raised to a white heat at the end. It brought the carbon to its final resistance.

I want to know the advantage of keeping it for two hours at a white heat?—To facilitate the measurements in order to make lamps of the various kinds required. The carbon being brought to its final state, the measurement of its diameter can be taken, and its resistance taken, and it can be brought to the E.M.F. and candle-power required.

Then this raising of the heat conduces to the duration of the carbon when used?—No; it does not.

I understand you always do it now?—Yes.

And is the sole advantage the one you have described?—It is a very important advantage.

It comes to this, that you are more easily able to measure?—The resistances are more uniform, and we can make our calculations with more certainty, owing to that. It makes them denser, harder, and better to handle.

Mr. EDWARD GIMINGHAM confirmed the last witness's evidence.

Mr. R. T. GLAZEBROOK, examined by Mr. MOULTON, said he had made various experiments with Bunsen batteries and carbons of various sizes.

Cross-examined by Sir HORACE DAVEY: The result of one experiment, tried with a carbon one millimetre in diameter and twelve in length, was that it swelled suddenly to three times its size, and fused.

Then, the result of what Deprez did producing a carbon, which was denser, harder, brighter, and tolerably solid—my lord will say whether it was the result, or not—you cannot have pursued the same process?—I did not succeed in so doing. Witness said that he had referred to Blavier's works, and the experiments were conducted before electrical measurements had attained their present accuracy.

Re-examined by Mr. MOULTON: Blavier took his measurements before ohms were invented, and his method was not correct.

This concluded the witnesses for the plaintiffs, and

Mr. JUSTICE KAY said that he should like notes to be taken during the experimental manufacture.

Sir HORACE DAVEY said that Prof. Crookes and Prof. Silvanus Thompson were selected as experts by his side.

Mr. ASTON said that, in the absence of the Attorney-General, he could not mention the names for his clients, but he would settle with his learned friends on the other side.

After some discussion as to when it would be convenient to resume the hearing of the case,

Mr. JUSTICE KAY said that it had better be mentioned in court to him to-day (Friday), when the arrangements for the experiments were completed.

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REVIEWS.

A Key to the Mysteries of Water, Electricity and Heat. By WILLIAM BOGGETT. (London: Trübner and Co.)

Mr. William Boggett, the author of this treatise, is the fortunate possessor (as he assures us on page 1) of a copy of Chambers' "Encyclopædia," and in the article on "Water" he finds the following passage:—"It is now known that water is a compound of oxygen and hydrogen, in the proportion of one equivalent of each." In the true spirit of scientific caution, Mr. Boggett observes that "unless this statement was in accord with the admitted belief of scientists it is very improbable that the writer would have assumed it to be a fact;" and Mr. Boggett "therefore feels justified in so regarding it." We are glad to be in a position to assure Mr. Boggett that his conclusion as to the belief of scientists is fully justified. But Mr. Boggett himself does not share this belief; he recalls the fact that water is a fluid, and "conceding, for the sake of the argument," that oxygen and hydrogen are its only constituents, he proceeds to inquire "from which of them, or both, does its fluidity proceed?" They are, he says, "simply two dry gases, and could no more produce a fluid than they could produce gold." This is a bold assertion, but possibly not too bold on the part of one who possesses a key to the mysteries of water, electricity and heat. We might stay to remark here that, according to accepted definitions, oxygen and hydrogen and other dry gases are themselves fluids, although not liquid at ordinary pressures and temperatures; but this might savour too much of impertinent quibbling, and it is better to learn from Mr. Boggett what is the true constitution of water.

We gather, then, that water consists of "oxygen, hydrogen, electricity and heat," in proof whereof Mr. Boggett adduces the well-known endiometer experiment, in which it is palpable to everyone that the oxygen and hydrogen do not unite to form water until electricity and heat are added. Only one consideration hinders us from at once accepting this argument as a triumphant vindication of Mr. Boggett's position. But Mr. Boggett has himself taught us to inquire from whence does the fluidity (or, as we should prefer to say, the liquidity) proceed. On this point we are still left entirely in the dark. If we could only feel convinced that either heat or electricity, or both, were liquids, or even semi-liquid, we think we should almost be prepared to endorse Mr. Boggett's views. Meanwhile, we cannot but feel that for us electricity is a mystery still.

Geneva.—The inhabitants of Geneva are at last awake to the fact that the Rhone as it leaves the lake affords an admirable source of natural power. Three large turbines are already at work, by means of which a high-pressure hydraulic system has been effected. One of the first uses it is intended to make of the several thousand horse-power which will be available when the works are complete is to drive the dynamos at a large central station. The Conseil Administratif are already considering the plan of their president, M. Turettini, for lighting the town theatre, which is about 700 yards from the central station. It is proposed to instal 2,400 lamps in place of the present gas-burners, and at the theatre itself to have a dynamo and accumulators capable of running an additional 100 lamps in case of emergency. The mains are to have a cross-section of about 400mm., so as to reduce the loss in transmission to 10 per cent. Low-potential dynamos of 210 or 220 volts are to be used. M. Turettini's estimate amounts to 150,000fr. (£6,000); he allows £576 for the 1,400 yards of main cable, £156 for the laying of the same, £4,800 for the 2,400 lamps, fittings, &c., the balance of £468 being absorbed in etceteras. The annual cost of the installation is about £1,120 for 210 representations per annum.

"The Progressive Age."—The leading American gas lighting journal, which appears under the title of *The Progressive Age*, has removed its offices from Philadelphia to New York, and will appear fortnightly instead of monthly as hitherto. *The Progressive Age* devotes a great deal of attention to electric lighting matters, and will compare favourably with any journal of the same class published on this side of the water.

BOOKS, &c., RECEIVED.

"Rotazioni Elettrodinamiche Prodotte per mezzo di Correnti Alternate, nota del Pro. Galileo Ferraris." (Turin: Ermanno Loescher. 1888.)

"J. W. Colburn and Co.'s Price List and Handbook of Ready Reference" (Vest-Pocket Edition). (Fitchburg, Mass., U.S.A.)

"Betrieb der Galvanoplastik." By OTTOMAR VOLKMER. (Vienna: A. Hartleben.)

"Sections of Mouldings, &c." By SAMUEL ELLIOTT. Newbury.

"The School of Mines Quarterly." Vol. IX., No. 3. (Columbia College, New York.)

"*Proceedings* of the Royal Society." Vol. XLIV., No. 266. (Harrison and Sons.)

"Storage Batteries for Street Cars, Electric Lighting, &c." (The Gibson Electric Company, New York.)

"*Transactions* of the Institute of Engineers and Shipbuilders in Scotland." (Glasgow.)

JUVENILE LECTURES.

THE APPLICATION OF ELECTRICITY TO LIGHTING AND WORKING.*

BY W. H. PREECE, F.R.S.

Lecture II.

(Continued from page 85.)

We will now go back to some of the other purposes, and the one purpose that I wish to refer to is the power that electricity gives us to utilise the waste powers of Nature. Wind, tides, and falling water are to be found everywhere, and if they can be utilised economically will certainly be so used. I have shown you, in the case of the Portrush Railway, how water-power is utilised in this way. In the Bessbrook and Newry Railway water-power is utilised in precisely the same way. At Craigside, near Newcastle-on-Tyne, Lord Armstrong is able, by means of the energy of a waterfall in his grounds, to light up his house and to do various other things. In France M. Felix has used this same property for ploughing.

Again, at the Paris Electrical Exhibition, there was a Siemens lift worked by electricity, by which people were raised from the floor to the gallery; Dr. John Hopkinson has also worked in this direction. This system of lifts (Fig. 12) worked by electricity is utilised at the present moment in London at at least two banks—the River Plate Bank and the Bank of Rio Janeiro—for carrying books and bags between the various floors of the premises. This power of electricity is more easily applicable for lift purposes than almost any other.

There is an experiment which I wanted to show you earlier, and as it is rather a pretty one I will show it you now; it is the power that electricity has to draw or raise a weight. This was used by Marcel Deprez in Paris for an electric hammer. I have here a weight that will pass up through a coil of copper wire. When a current of electricity is sent through the coil the weight is sucked up, and there you see, by means of electricity I am able to produce blows, and it only requires more electricity and a heavier weight to produce the effects of a hammer.

There is another application of electricity that has been attracting a good deal of attention at Brighton. Mr. Volk, who has done a great deal towards the application of electricity down there (he has laid an electric railway along the beach), has started an electric dog cart. He has fitted a dog cart with batteries, and it goes bowling about Brighton without a horse. He, his wife, and daughter, are to be seen taking their airing along the Parade in a vehicle that looks like a dog cart, but there is no horse in it.

When I was last in America, Mr. Edison, who is one of the most ingenious men alive, gave me what he calls his electric pen. It is in the form of a pencil, but instead of lead, the core of the pencil consists of a very fine needle, which has an up and down play of about $\frac{1}{16}$th of an inch, and by its movement backwards and forwards, caused by a little electro-motor, the

* A course of two Lectures delivered before the Society of Arts on January 4th and 11th.

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point makes small holes in the paper. I write "W. H. P." To take copies of what is written, I should simply rub an ink-pad over the little holes, when I should have "W. H. P." printed on the paper, and could strike off as many copies as I liked.

The motor that Mr. Volk uses for his dog-cart in Brighton is also used for ventilating. I have here a fan, which is moved by an Immisch motor, which rotates at the rate of 500 or 600 revolutions per minute. As I showed you before, this same power of electricity can be used for working sewing machines.

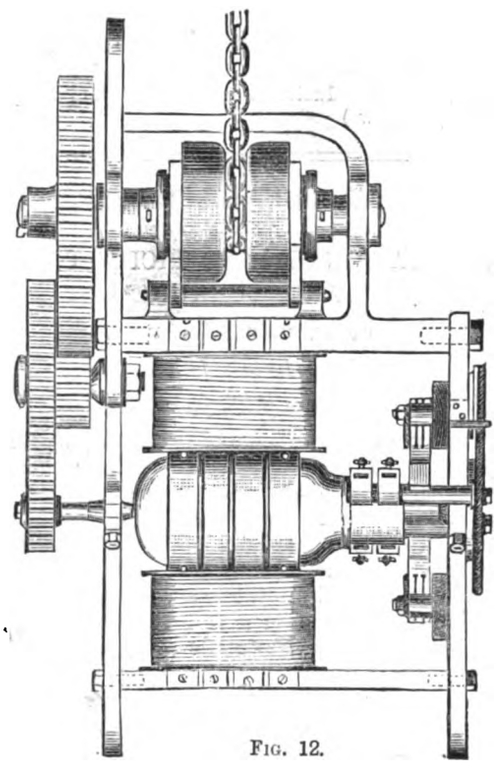

FIG. 12.

This sewing machine is worked by an electro-motor, and it must be a comfort to those who constantly use such machines for domestic purposes, as by the use of electricity much fatigue is prevented.

Electricity has been applied to boot cleaning, to knife

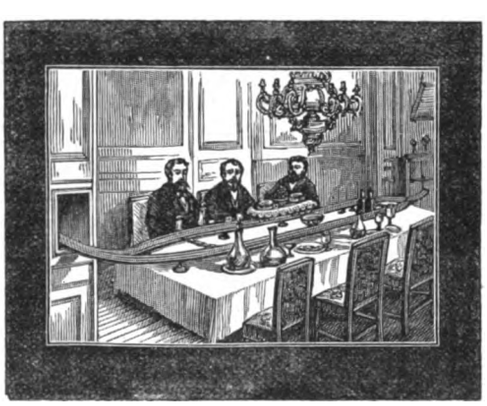

FIG. 13.

cleaning, and there is no reason why it should not be used for churning. It can be used, as you have seen, for ventilating. It can be used for sweeping. The same power can be used for mowing machines, and many other purposes. Sir David Salomons has devoted his whole life to scientific pursuits, and his house is fitted up with electricity. He has a workshop fitted with all the latest and most perfect tools, all of which are worked by electricity. We are going at such a pace in the diminution of labour, that one of these days I should not be at all surprised to see that electricity will work the dirty iron ore from the mines of Bilbao into a magnificent 10in. gun, better than anything that the establishment at Woolwich has produced. For toy purposes we have lots of things on the table, ships, electromotive engines, zoetropes, and all sorts of things worked by electricity, but they are for your merriment after the lecture, rather than for your instruction during the lecture.

A distinguished electrician has dispensed with waiters at the dinner table by the use of electricity (Figs. 13, 14,). He has fitted a small electric railway on the dining table, along which the courses are carried and removed as required, and you now see a picture of the arrangement on the screen.

The clipping of horses can be done by this electric power better than by the hand process, with less injury to the animal, and far better than the old singeing process.

Electricity is also used for propelling boats, and you see a picture of the "Cygnus," a boat used at the Paris Electrical Exhibition of 1881; a little Trouvé motor works the screw. Now you see a picture of the boat "Electricity" (Fig. 15), and the

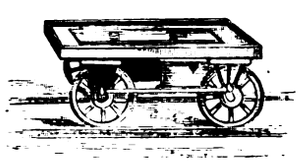

FIG. 14.

rate at which these boats are propelled is pretty considerable. There is a diagram on the table of the electric launch recently tried at Havre by the French navy; it is not a very elegant looking boat, but I believe it goes with great velocity, and gives satisfaction. I have had the pleasure of going up the Thames in an electric boat made for the Duke of Bedford, and I have been up the Danube in another electric boat. I am looking forward to the time when we may have electric boats on the Thames. It only wants some enterprising firm to establish machinery at charging depots at Teddington, Reading, and other places, to enable boats to be propelled by electricity.

All the applications of electricity that I have shown you have been by way of peaceful purposes, but the same power can also be used for the destruction of our enemies. I have here a miniature ship in a bath containing water. It represents a pirate vessel with its black flag and skull-and-crossbones ensign flying, sailing along seeking its prey. On the pan containing the water there are two marks, and when the boat gets between them I know it is in the vicinity of a submerged torpedo, and on sending an electric current the torpedo explodes, and blows up the ship and all its crew to destruction. That concludes the experiments that I intend to show you.

FIG. 15.

I have shown you various ways in which it is possible, by the proper utilisation of electricity, to economise labour; but there is always this fear—that if too many means of economising labour are introduced it may lead to idleness and evil. Still, when labour is saved in one direction it is given in another direction, and the result must evidently be beneficial in the long run.

I have brought before you some effects of one of the great powers of Nature, and I have shown you in these two lectures, in a very rough and hasty manner, how it is applied to useful

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purposes. Every single purpose which I have shown you was in itself deserving of a lecture occupying a whole evening; but, however, to the best of my ability I have endeavoured to bring these matters before you, and I have been assisted in them by the very generous way in which others have come to my help. My friend, Mr. Lant Carpenter, has helped me considerably; Mr. Probert, Mr. Heather, Mr. Davenport, and others have all assisted. Mr. Immisch and Mr. Binswanger have been kind in their loan of motors, and our Chairman this evening has been the means of my carrying out several of the experiments, and others have come forward with a liberality that is really overpowering. I am only too glad to think that I have succeeded in keeping your attention together for these two nights, and, I hope, shown you something that you have never seen before, and which, I trust, may lead you to see a good deal more of in the future.

The CHAIRMAN proposed a very hearty vote of thanks to Mr. Preece for the lectures he had delivered. He said that those who hear lectures had very little idea of the enormous amount of labour and forethought, as well as devotion of time and energy, necessary to get together everything that is necessary for the lectures to work smoothly. The chairman added that they must not forget, as Mr. Preece had reminded them, to thank Mr. Lant Carpenter and others for the voluntary services they have rendered in order to make these lectures the success which they most assuredly had been.

Mr. PREECE acknowledged the vote of thanks, and the meeting then adjourned.

The engravings (Figs. 16 to 22) were prepared to illustrate Mr. Preece's description of the process of manufacture of incandescent lamps in Lecture I., when the various processes were shown in operation by Mr. Donaldson (see *Electrician*, May 4th, p. 737). Unfortunately the sketches did not reach us in time for insertion in that number. We append the following brief description, and must refer our readers to the issue of May 4th for a fuller account. In Fig. 16 we see the fine filaments of parchmentised cotton wrapped round a block of wood ready for carbonising. After being placed in a furnace and carbonised, the filaments are "mounted" (Fig. 17), *i.e.*, they are connected to platinum wires, placed in oil, or some hydro-carbon gas, and a strong current is passed through them; the hydro-carbon thus is decomposed, and carbon is deposited on the filaments, especially around their junction with the platinum wire, thus cementing the two together. In Figs. 18, 19, and 20 we have depicted the process of preparing the tube for the lamp-bulb and the blowing of the bulb. In Fig. 21 we see the finished bulb ready to receive the filament. The mounted filament is now fixed in the glass globe, and the platinum and glass are fused together. The next process is to exhaust the bulb, and seal it up, and in Fig. 22 is the finished lamp with a possible life of 4,000 to 5,000 hours before it.

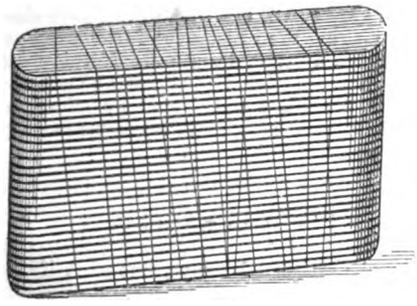

FIG. 16.

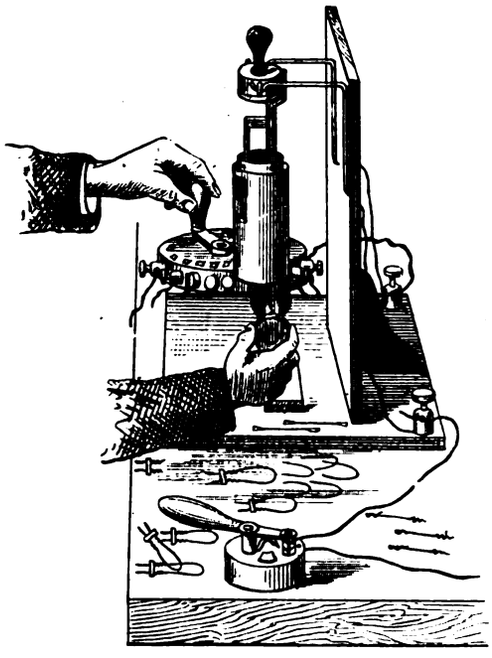

FIG. 17.

FIG. 21.

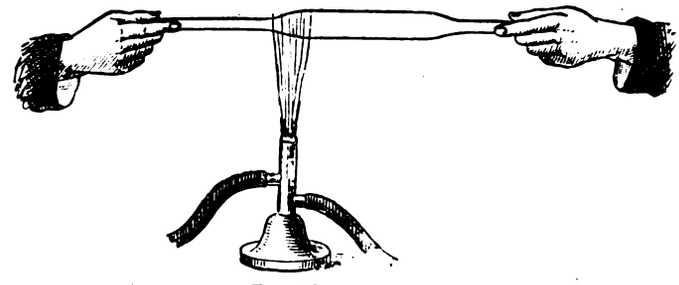

FIG. 18.

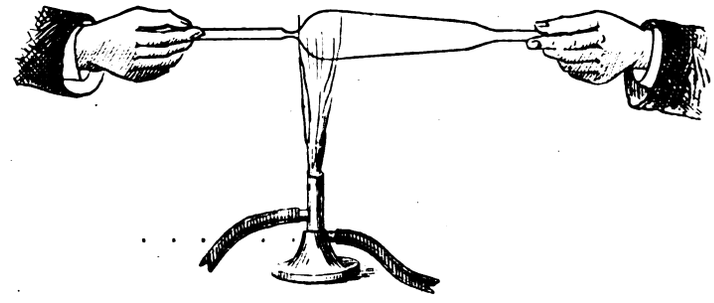

FIG. 19.

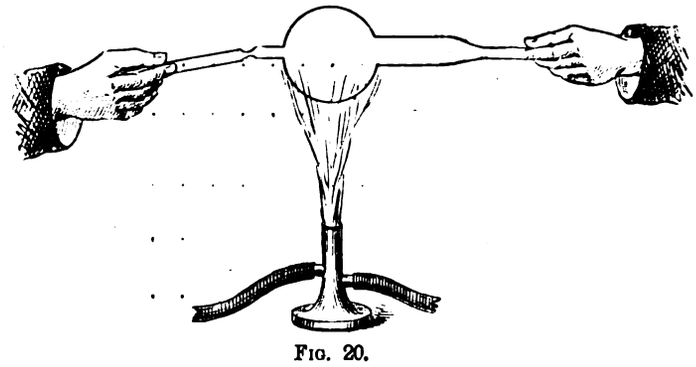

FIG. 20.

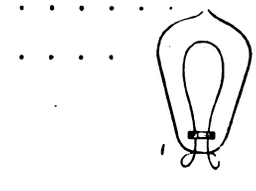

FIG. 22.

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THE PHYSICAL SOCIETY.

At the meeting of this Society on Saturday, May 26th, Prof. AYRTON read a note by Prof. PERRY and himself, of which we have prepared the following abstract:—

"On the Governing of Electromotors."

In 1882 the authors worked out and published a method of maintaining constancy in the speed of an electromotor with a varying load, based on a combination of a motor which converted electrical into mechanical energy with a brake dynamo which reconverted the surplus mechanical energy into electrical energy.

After passing through various stages of development the arrangement finally adopted consisted of an electromotor having the field-magnet wound with a shunt and a series coil traversed by the current in opposite directions, so that the magnetisation of the field-magnet was that due to the difference in the number of ampere turns in the two coils.

This method had been re-invented in France by M. Deprez, and in America by Mr. Sprague, and had been submitted to exhaustive tests by Dr. Frölich; but the authors had not attempted to develop it further owing to the great defect of causing a considerable waste of power, which was necessarily involved in the use of a demagnetising coil. The original method was applicable either to the supply of constant current or of current at constant potential difference, but the authors noticed recently that in the former case the original equations were capable of giving a solution in which the demagnetising coil was dispensed with, and therefore a constant speed obtained, together with the high efficiency of a well-made dynamo. As it was only required to determine whether or not a certain combination would give a certain required result, the equations are simplified by neglecting saturation, and, therefore, the results obtained for critical speed, &c., cannot be applied without correction to actual practice.

Let E be the back E.M.F. in the armature of a motor running at a speed of n revolutions, p a term depending on the permanent magnetism of the iron of the field-magnet, S the current through the series coil, q the number of turns in it, Z the current through the shunt coil, and t the number of turns in it.

Then
$$E = n(p \pm q S \pm t Z) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$
the upper or lower sign being given to either the second or third term, according as the current in the corresponding coil assists or opposes the permanent magnetism.

Let S and Z be the resistances of the series and shunt coils respectively, a the resistance of the armature, and A the current in it. Then for a short shunt machine
$$E = Z z - A a \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$
and for a long shunt machine
$$E = Z z - A (a + s) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$
and in both cases, if C is the constant current supplied to the motor,
$$C = A + Z \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$
In the former case C = S, so that equations (1), (2) and (4) give
$$n\{p \pm q C \pm t(C - A)\} = (C - A) z - A a \quad . \quad . \quad (5)$$
In the latter case S = A, so that equations (1), (3) and (4) give
$$n\{p \pm q A \pm t(C - A)\} = (C - A) z - A (a + s) \quad . \quad . \quad (6)$$
When n and C are given, equations (5) and (6) have to be satisfied for all values of A.

Thus for a short shunt
$$\pm n(-t A) = -A(z + a) \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$
and for a long shunt
$$\pm n(q - t) A = -A(z + a + s) \quad . \quad . \quad . \quad . \quad (8)$$
Now n, t, q, z, a, and s are all necessarily positive, and t is always larger than q, so that the positive value of t in equation (1) is the one which must be taken—that is, whatever the arrangement of the series coils, the shunt coil must be a magnetising and not a demagnetising one. In the Paper on "Electromotors and their Government," by the same authors in Vol. XII. of the *Journal* of the Society of Telegraph-Engineers, they had already shown that the solution for constant current was a shunt-motor with a series demagnetising coil; but the authors point out that in a standard English treatise the only solution for constant current with which they are credited is the *impossible* one of a series motor with a shunt demagnetising coil, which would require the speed to be negative, or the armature rotation to be reversed, which would simply mean the combination of a shunt-motor with a series demagnetising coil.

In another important English work the method is given correctly; but it is stated that it would not work, because if a greater load were put on the motor would slow down, the back E.M.F. would decrease, and less current would flow through the shunt coil, thus weakening the field-magnet, and therefore further diminishing the speed of the motors, which would thus be brought to rest or possibly reversed. But it is now well known that a weakening of the field does not imply a diminution of speed; and the explanation of the apparent anomaly that to maintain the speed of a motor constant the field must be weakened when the load is increased is, of course, that the power depends on the current through the armature as well as on the strength of the field, and when the latter is diminished the former is much increased.

For a simple shunt motor supplied at constant potential difference V, $V = Z/z$, $E = Z z - A a$, and also
$$E = n(p + t Z) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$
so that
$$n\left(p + t\frac{V}{z}\right) = V - A a \quad . \quad . \quad . \quad . \quad (10)$$
The left-hand side of this equation is constant when n and V are given, while the right-hand side is variable as A depends on the power given out by the motor. A solution which makes the equation true, independently of the value of A, is clearly the well-known one of making a very small, but the authors have elsewhere given reasons against making the resistance of the armature of a motor as small as that of a dynamo armature. If this solution is rejected, a negative term proportional to A must be added on the left-hand side, and this is most simply done by adding a series demagnetising coil, when equation (9), and (10) in its more general form, become respectively
$$E = n(p - q A + t z),$$
and
$$n\left(p - q A + t\frac{V}{z}\right) = V - A(a + s).$$
The latter will always be satisfied for any value of A if
$$n = \frac{a + s}{q}.$$
When the supply is a constant current the equations for a simple shunt motor are
$$E = n(p + t z)$$
$$E = Z z - A a$$
$$C = A + Z$$
which give
$$n\{p + t(C - A)\} = (C - A) z - A a \quad . \quad . \quad . \quad (11)$$
which will always be satisfied if
$$n = \frac{z + a}{t} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$
so that a series demagnetising coil is *unnecessary*. Substituting this value of n in equation (11) gives as the current for which the motor governs
$$C = \frac{n p}{z - n t} = -\frac{n p}{a}.$$
The terminals of the motor must therefore be reversed. This will reverse the currents round the field-magnet, but it must not reverse the residual magnetism, or p would also become negative. The core of the electric magnet must, therefore, be of steel so strongly magnetised that the shunt current does not reverse the polarity, and the permanent magnet and rotating armature will form a brake dynamo, while the shunt coil and the armature will form the motor. This is simply one of the solutions (theoretical, of course, not practical), given in the Paper referred to.

To obtain a practical solution, alter this equation so that when the speed equation (12) is satisfied, equation (11) gives a positive value of the current, which may be done by adding to the right hand side of the equation (11) a positive constant term e, numerically greater than $n p$, for then
$$n = \frac{z + a}{t} \quad \text{and} \quad C = \frac{e - n p}{a}$$
for all values of A.

This may be effected by introducing accumulators of E.M.F. e into the armature circuit, joining them up in such a manner as to assist the main current C.

The resistance of the armature will then be increased by a value a', the resistance of the accumulators, so that the final equations to determine the speed and the constant current at which the motor governs will be
$$n = \frac{z + a + a'}{t} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$
$$C = \frac{e - n p}{a + a'} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14$$
The solution is a practical one, and, moreover, it does not require many accumulators, for $n p$, the back E.M.F. of the motor, due to the residual magnetism alone, will be small if the core of the field-magnet is of soft iron, and a and a' need not be large, so that C can be made as large as required, without giving a very large value to e.

The essence of this method consists in combining a shunt motor with a store of electric energy in the armature circuit, this energy being, as shown by the equations, automatically dealt out to assist the motor exactly in proportion to the power required to keep the speed constant as the load is varied.

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The store is easily maintained by reversing the connections of the accumulators when they are disconnected from the motor and the motor is at rest, and leaving the accumulators to be charged, without supervision, by the constant current which is continually supplied.

Prof. RÜCKER observed that the method was certainly novel and extremely interesting. He would like to know, in case the motor did much work, what would be the relation between the number of accumulators required and the amount of work, and whether any inconvenience would be experienced in replacing them.

Prof. AYRTON, in reply, pointed out that accumulators will discharge, at a fairly steady rate, for 7 or 8 hours, and the discharging current is less than the charging current, so that no difficulty would be experienced in running the motor for 15 or 16 hours a day with the single set of accumulators, though if required to run continuously two sets would, of course, be required.

The SECRETARY then, in the absence of the author, read a note by Prof. S. P. THOMPSON,

"On the Formula of Bernouilli and of Haecker for the Lifting Power of Magnets."

Bernouilli's empirical rule ("Acta Helvetica," III., 233, 1758) is given by the formula

$$P \propto \sqrt[3]{W^2}$$

where P is the lifting power or pull exerted by the magnet in contact with its keeper, and W the mass of the magnet. Haecker (Poggendorff's *Annalen*, LVII., 321, 1842) wrote the formula

$$P = a\sqrt[3]{W^2},$$

and taking the German pound as the unit of mass found that a varied, according to the quality of the steel and the intensity of the magnetisation, from 8 to 10, and double these values for horse shoe magnets; so that a steel horseshoe magnet weighing one pound would lift from 16 to 20 pounds.

The formula was found to be fairly correct for magnets weighing from 1·120 pounds up to 40 pounds.

Van der Willigen ("Sur le Magnétisme des Aimants artificiels," par V. S. M. Van der Willigen, Haarlem, 1878) repeated the investigations with Haecker's own magnets and others, and arrived at the formula

$$P = b\,K\sqrt{A}\cdot\sqrt[4]{\frac{L}{\sqrt{A}}}\cdot\frac{L}{l},$$

where b is a constant depending on the quality of the steel and the intensity of magnetisation, K the perimeter of the polar surface, A its area, L the distance between the poles, and l the mean of the interior and exterior lengths of the bar.

For similar solids $K\sqrt{A}$ is proportional to the surface A, so that according to this formula the lifting power of similar magnets is proportional to the polar surface multiplied by a correcting factor depending on the proximity of the poles.

Van der Willigen found that b, which is virtually identical with Haecker's a, varied from 19·5 to 22·5.

Now in similar magnets, the linear dimensions are proportional to the cube root of the mass, and the polar surface is proportional to the square of the linear dimensions.

Therefore, for similar magnets, both formulæ mean simply that the lifting power is proportional to the polar surface, which we know from Joule's and subsequent researches to be approximately true for equal intensities of magnetisation.

In the light of more recent researches on the magnetic induction in closed circuits, the same conclusion is arrived at, for if the magnetic induction B has been carried to an equal degree in the metal, the tension in dynes per square centimetre, at any point of the circuit, is (Maxwell's "Electricity and Magnetism," Art. 643)

$$T = \frac{B^2}{8\pi},$$

and the element of pull over the area d A is

$$d\,P = T\,d\,A = \frac{1}{8\pi}B^2\,d\,A;$$

so that

$$P = \frac{1}{8\pi}\int B^2\,d\,A,$$

which can be determined if the law of distribution of magnetic induction through the cross-section is known. Assuming this to be uniform, we have

$$P = \frac{1}{8\pi}B^2\,A.$$

This formula gives a convenient method of determining B from measurements made of the pull on a given polar surface, the ormulæ becoming

$$B = 5000\sqrt{\frac{P\text{ kilos}}{A\text{ sq. cm.}}} \qquad B = 1317\sqrt{\frac{P\text{ lbs.}}{A\text{ sq. in.}}}$$

The a of Haecker's formula may therefore be considered to be simply proportional to the square of the magnetic induction through the surface of contact, or

$$a = \frac{1}{8\pi}B^2 d^2 c,$$

where d is the density of the steel, and c the ratio of the polar surface to that of the face of a cube of volume equal to that of the magnet.

According to Haecker, a is twice as great for a horseshoe magnet as for a bar magnet; according to Van der Willigen, three or four times as great: showing that in the former case, owing to the great resistance offered by the long return path through air of the tubes of magnetic induction, the steel magnet was only able to produce a much smaller induction (the ratio 1 to $\sqrt{2}$, according to Haecker's results) than when the circuit was closed.

Lifting power being proportional to surface, with a given intensity of magnetic induction, explains the greater lifting power of small magnets in proportion to their weight, without assuming, as is often done, that small pieces of steel can be more highly magnetised than large ones.

For electro-magnets a simplification is introduced by the principle of the magnetic circuit.

Assuming the material of the core and armature to be similar in permeability and cross-section, B is independent of the value of the latter, and is given by the formula

$$B = \frac{4\pi S i \mu}{10\,l},$$

where μ is the permeability, l the total length of the magnetic circuit, i the current in amperes, and S the number of convolutions in the coil.

For values of B between 8,000 and 16,000 μ for a certain quality of good wrought iron is approximately given by the formula

$$\mu = \frac{16000 - B}{3{\cdot}2},$$

which gives for the approximate lifting power of such an electro-magnet

$$P\text{ kilos} = A\text{ sq. cm.} \times \left(\frac{3{\cdot}2\,S\,i}{S\,i + 2{\cdot}56\,l.\,cm.}\right)^2,$$

or

$$P\text{ lbs.} = A\text{ sq. in.} \times \left(\frac{12{\cdot}2\,S\,i}{S\,i + 6{\cdot}5\,l.\,in.}\right)^2.$$

The net result of this Paper is that Haecker's formula is merely a clumsy way of stating that the lifting power of a magnet is (for equal intensity of magnetisation) proportional to the polar surface.

Prof. AYRTON observed that he would have liked to ask Prof. Thompson how far he had considered the surface between the armature and the magnets, as he thought there would be a good deal of resistance at the junction. It was certain that a great difference could be produced in the lifting power by merely scraping the surfaces, without any alteration in the air-gap. He mentioned that the curious fact had been observed that while an ordinary electro-magnet only requires a small force to detach the armature after the current had stopped, it was found that if the pole-pieces were carefully scraped a very large force was required, and if the armature were left in contact with the magnet, the force required to separate them would continue to increase with the time during which they were left in contact, after the current had been turned off. This increase had been observed to continue for a month or longer.

A Paper by Messrs. Gee and Holden on

"Experiments on Electrolysis"

was also read. We shall give an abstract in a subsequent issue.

FIFTY KILO.-WATT GOOLDEN-RAVENSHAW DYNAMO.*

The present tendency in dynamo building is in the direction of increased size. Some five or six years ago, when the manufacture of dynamos was with most firms but an infant industry, machines capable of running 100 or 200 glow-lamps were considered fairly large, and constituted productions of which the manufacturer was justly proud. Compared with the original Gramme machines, a 200-lighter was undoubtedly a great achievement; but at the present time such a machine is considered almost a toy as compared with the powerful dynamos which are now made as regular articles of commerce. The three machines required for the Bradford in-

* From *Industries*, May 25th.

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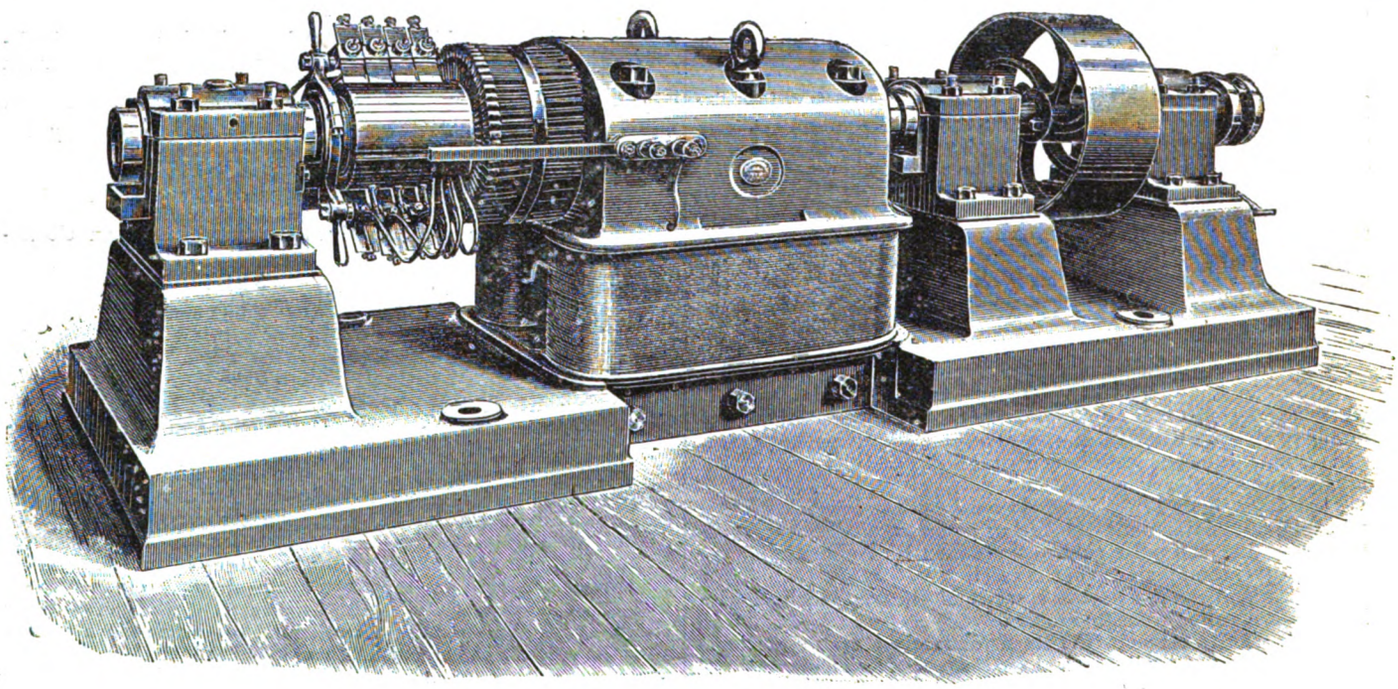
stallation, for instance, will each have an output of 85 kilo.-watts, and we recently saw in a Continental works two machines in course of construction, each for an output of 120 kilo.-watts; and 100 kilo.-watt Edison machines for central station lighting are by no means unusual at the present time, to say nothing of alternating-current machines, the power of which is expressed by thousands of glow-lamps. In most cases large dynamos are direct-driven by special engines; but occasionally belt driving is resorted to, and we illustrate above a belt-driven machine made by Messrs. Goolden and Co., of Halifax, to the design of Mr. W. H. Ravenshaw. This machine is interesting, not only on account of its size, but also because it contains several contrivances which the increase of size rendered necessary.

As will be seen from the illustration, the machine is of the "over" type, with the yoke in the bed-plate and the armature above. It has an output of 500 amperes at 102 volts pressure when driven at 375 revolutions per minute. The armature is of the drum pattern, with internal ventilation, and the conductor consists of six 192 mil. wires in parallel, there being 120 conductors counted all round the armature. Its resistance is ·0066 ohm, and the resistance of the field-magnets, which are plain shunt-wound, is 6·3 ohms. The total useful induction through the armature core is about 2,300 English lines. The armature core consists of the usual iron discs, which, however, do not fill the whole interior, but are of the same dimensions as used by Messrs. Goolden and Co. for Gramme armatures, and are mounted upon the spindle in the same manner. There is thus gained an internal space for ventilation, and a sleeve is fixed over the shaft on the pulley side, leaving an annular space for the admission of air, which is drawn through the armature by means of a fan placed between the commutator and the armature core. By an ingenious method of winding the ends of the armature are left flat, and not bulging out as in the Hefner-Alteneck winding, thus economising in length of wire. The magnet cores are of wrought iron, bolted to the bed-plate, and the pole-pieces are of cast iron, fastened to the magnets by strong bolts, as shown in our illustration. The exciting coils are made with their long sides slightly bulged, so as to cause the wire to lie tightly, and at the same time provide ventilation between the surfaces of the magnets and the internal surfaces of the exciting coils, a suitable slot being left in the flange of the pole-piece, as shown.

In this machine a special device has been introduced for giving to the armature a definite to and fro motion lengthwise, in order to keep the bearing surfaces and the surface of the commutator in good condition. It will be remembered that in some of the early Edison machines a similar rocking motion was introduced by means of a spring pressing against the end of the shaft, and several dynamo makers have adopted the rule to allow the shaft a little play endways between the bearings, relying on the side motion of the belt to keep the armature rocking to and fro. This plan, although it works fairly well in certain cases, is not always satisfactory. The armature is often found to rock too violently, and thus produces knocking between the collars on the shaft and the ends of the bearings. To overcome this difficulty and yet obtain the advantage of a variable position of contact between the brushes and the commutator, Mr. D. Halpin has devised a special brush holder and gear by which the brushes are slowly shifted backwards and forwards in a direction parallel to the spindle; but a more simple plan is to make the clearance between the collars and bearings larger than the distance through which the armature rocks. The field-magnets exert an attraction upon the armature in the direction of the spindle if the centre of the core of the armature does not exactly coincide with the centre of the pole-pieces. If the armature be shifted out of this position of symmetry, the field-magnets will pull it back, and the force thus exerted is quite sufficient to limit the oscillation to either side of this normal position. This plan answers well in small and medium-sized machines, but for very large machines it is obviously better to prescribe the path through which the armature shall rock, and this is done in the present design in the following way:—To the end of the shaft outside the bearing is fixed a cast-iron disc, and between this and the bearing there is loose on the shaft a second cast-iron disc, with an inclined face. On a spindle at right angles to the shaft, and secured to the fast disc, is a loose roller touching the opposed surfaces of the two discs. The external diameter of these discs is slightly different, and against their periphery is pressed, by means of a spring, a paper roller running loose on a stud. The centre of the armature core is set slightly back as compared to the centre of the field-magnets, so that the magnetic attraction tends to pull the whole armature forward towards the commutator bearing, thus keeping a certain pressure between the two discs and the roller. It will now readily be seen that, as the armature revolves, motion is imparted to the paper roller by the fixed disc, and the paper roller in turn causes the loose disc to revolve at a speed which is slightly different from that of the shaft and fixed disc. The diameters of the two discs are so chosen that the relative movement of the loose disc against the fixed disc is two complete revolutions per minute, and the whole armature receives, therefore, two complete out and in motions per minute, by which means the position of the brushes on the commutator is continually varied lengthwise, and scoring is entirely prevented. The longitudinal motion has also the advantage of preserving the bearing surfaces in perfect condition. The total weight of the machine is six tons.



The Goolden-Ravenshaw Fifty Kilo.-Watt Dynamo.

ALTERNATING v. CONTINUOUS CURRENTS.*

BY M. M. M. SLATTERY.

A few days ago when I had the honour of receiving an invitation to read a paper before this club to-night, relating to the alternating system in parallel arc, to be in reply to Mr. Leonard's Paper,† I felt, understanding Mr. Leonard's proclivities, that the usual stereotyped attack would be made upon a system which has alike elicited

* Paper read before the Chicago Electric Club, March 19th.

† See *The Electrician*, page 604, April 6th, 1888.

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the admiration of those who have disinterestedly given the subject some thought, and the most rancorous feeling on the part of those whose business has been placed somewhat in the background by the rapid developments which have taken place in this comparatively new field of electric lighting. In a moment of unguarded enthusiasm I accepted the invitation. As some of you may know, I am practically engaged in the alternating branch of electric lighting, and my time is so much occupied therein as to almost entirely preclude me from having any to either write or read papers. I regret, therefore, that in this short Paper I shall not be as comprehensive as I should wish, and will principally confine myself to replying to some of the salient points in Mr. Leonard's Paper.

We are told that the following are the sum total of the vital factors in a general supply system of electric energy, viz. :—

1st. Cost.
2nd. Economy (efficiency and depreciation).
3rd. Reliability.
4th. Safety to life.
5th. Variety and value of the possible sources of revenue.
6th. Effects upon existing property.

The factor of distance over which you have to transmit the electric energy is conspicuous by its absence, not being considered of sufficient importance to be enumerated in the list ; we shall see presently of what value this factor is. Of course Mr. Leonard, as is customary with advocates of the low-tension systems, starts out with explaining the transcendent merits possessed by the three wire systems, and expresses in the usual terms the 33 per cent. saving over the two-wire system.

In the Paper read by Mr. Leonard elaborate tables of figures are given, into which I will not attempt to follow him in detail to-night. It would only weary you, and, as you are aware, if the premises are once granted, almost anything can be proved by figures. All I would say is, examine those figures yourselves, but do not *assume* that the *data* are correct.

It is a very ingenious rhetorical device to take the cost of the Edison system for distribution over a small area, and compare it with the cost of the alternating system over a small area, and thus show that, taking price of converters into consideration, the Edison is the cheaper. This is avoiding the question. The chief claim made for the alternating system is that it can reach customers and supply a market that the low tension *never* can.

Another point to which I would call your attention is this : Mr. Leonard assumes the cost of copper to be 16 cents per pound ; *he had to* so as to bring his estimates at all within bounds. Now, we all know that the price of copper is more like 25 cents than 16 cents. The variation in the price of copper affects the low-tension system much more seriously than it does us—another point in favour of the alternate-converter system. It may be said, "Yes, but you have to use copper wire in your converters as well as your lines." True, but only to a limited extent ; the cost of the converter is also largely made up of the iron and the labour. The quantity of wire in a good converter is but small.

Another reason why I do not care to take up your time with a detailed discussion of these figures and tables is that the field has been pretty well covered by Mr. Stanley in a Paper recently read by him in Boston, and also for the reason that Prof. George Forbes, who is recognised as one of our best authorities, has said with regard to the theoretical economy of the three-wire system that "this may suit American financiers, but is *not* electrical engineering."

Mr. Leonard is not warranted in assuming a thing in order to enhance the value of his claims. He says we may look forward to improvements in the incandescent lamps which will result in 30 per cent reduction in the cost of conductors in the three-wire system. I have been engaged in the manufacture of incandescent lamps for some twelve years, and as I have to follow the subject up closely, I trust I ought to know a little about the improvements which have been made in the past and the possibilities ahead for the future, and I find that for the four years just past very little has been done towards improving either the life or the efficiency of incandescent lamps. A so-called improvement by a well-known company, the Edison, has lately been trumpeted in every direction. Why, Swan has been making such a lamp in England for some five years; and so could this same company have made them if they only employed methods which are equally within the reach of all.

The reason for this recent claim is obvious—it is an offset to the large number of lamps per horse-power claimed for the induction system.

With regard to this claim put forward on behalf of the Edison Company of being able to obtain twelve 16 candle-power lamps to the horse-power, I will not dispute it, but simply say that the gentleman who was for four years the mechanical engineer of the Edison Electric Light Company has, within the past six months, given sworn testimony in these words :—"In the direct-current, central station system the maximum which, to my knowledge, has so far been obtained is between six and seven lamps to the horse-power."

Now, gentlemen, a 100-volt lamp, such as is the Edison, could certainly be made which would run, say, 12 to the horse-power, yes, 15 or 20 ; but what would the life of those lamps be ? In all probability, as far as our present knowledge goes, *very brief*. I prefer, in a case like this, to reply upon an absolute statement of fact rather than upon any promises or guarantees or possibilities.

The limit of voltage at which a lamp can be made so as to have a reasonable life has, it seems, been reached in its upward direction at about 110 volts. It was anticipated a few years ago that a high-volt small-current lamp was the great desideratum. Scarcely any progress in that direction has, however, been made for some time, as I have just said, and the tendency, in fact, now appears to be the other way, *i.e.*, towards low-resistance lamps—say 50 volts.

The continuous-current system is far more susceptible to heavy fluctuations than the alternating, owing to the total absence of automatic regulation in the former, and, when it is remembered that the light intensity of an incandescent lamp does not vary as the potential difference at its poles, but in a much greater ratio, it will be readily understood that the fluctuating system has a much more hurtful effect upon the delicate incandescent lamp than the non-fluctuating system. I am supported in this statement not by the opinion, but by facts deposed to by the gentleman referred to. He says :—"The usual percentage of loss in the carrying wires of a direct-current system is 15 per cent., and even with this heavy loss the carrying wires attain a stupendous weight. The practical result from the introduction of this loss in the main wires of the direct-current system is that when such a plant is running fully loaded the E.M.F. at the dynamos will be 15 per cent. higher than at the lamps, whereas, when only lightly loaded, the difference in E.M.F. at the dynamos and lamps runs down to a much smaller figure; therefore, in order to maintain the lamps at a uniform brilliancy, the E.M.F. at the dynamos must be carefully watched and adjusted to suit the varying requirements of the load, as in the absence of such care the brilliancy of the lamps will fluctuate and give rise to serious lamp breakage. This regulation of the E.M.F. is accomplished partly by regulating the field-magnets of the machine and by the introduction of artificial resistances in the main carrying conductors. The attention to secure these results is expensive, and the devices for accomplishing them are very costly."

There is another matter in connection with central station arrangements which, it seems to me, disposes of the question of the relative commercial merits of the two systems in a conclusive manner, and that is this :—The advocates of the low-tension systems admit that as far as actual wire goes, the 1,000-volt distribution is more economical than is the 100 or 200-volt—that is a palpable matter. But, say they, in addition to the danger and other objectionable features of your plan, the cost of your converters is so great as to neutralise whatever advantages you may have in this way. Without going into that point for the moment, it will be seen that the converter itself costs no more whether the current supplying it comes from 1,000 or 10,000ft. away ; that being so, the difficulty which stares the Edison system in the face is the practical necessity of picking out for their central station about the most expensive piece of real estate in the district to be lighted. They *must* be near the centre ; they say so themselves. On the other hand, with the high-tension induction system, you may have your central station in the outskirts of the town on cheap land, perhaps on a canal bank or railway siding, so as to unload your coal direct into your boiler room, which may itself save many hundred dollars per annum, while the extra length of the comparatively small conductors would be but a bagatelle compared with the real estate investment in the centre of the town.

That I am not speaking off the book in this matter will be seen when I quote a passage from a document issued by the Edison Company, entitled "Information to Agents," and relating to the desirability of centrally locating the station. It is as follows :—

"*Note.*—In a given district to be lighted, the best conditions of economy in street installation are fulfilled when the station is located in the centre of the district. If the station is moved one-quarter of a mile away from such centre the cost will be about doubled. If the station is moved one-half mile away from centre the cost will be about quadrupled. . . . There need be no hesitation in locating it in the most central locality. A few hundred dollars increase in cost of lot will often save thousands in cost of street installation."

The reasons for the prominence which a 50-volt lamp is now acquiring are four-fold, namely, cheapness in manufacture, efficiency, reliability, and that while it is the lowest limit in volts that we should allow ourselves (for distributing reasons) it exactly suits the most efficient construction of converter.

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The fewer the number of turns of wire in a converter the better, within proper limits, and as in a 50-volt converter we have only half the number of turns that we should have in a 100-volt, the advantages of the 50-volt lamp for our purpose will be apparent; the fact also is that, while the manufacture of the 100 and 110-volt lamp has received the greatest attention by manufacturers for obvious distributing reasons, the 50-volt lamp has received comparatively little notice, not being recognised as a factor in a general system of distribution.

The Fort Wayne Jenney Company are now making a 40-watt 16 candle-power 50-volt lamp. This lamp could just as well have been made long before this, but there was no demand for it such as there now exists. If such improvements as Mr. Leonard predicts for the 100-volt lamp are likely to take place, and the ratio of the present efficiency of the 100 and 50-volt lamps holds good, we might look forward to a corresponding increase of efficiency which would enable us to reduce the cost of our converters in nearly the same proportion—that is to say, the cost of a 40-lamp converter would be very little more than for the present 25. There would also be the proportional saving in the cost of interior wiring.

Much has been said and written by the opponents of the induction system about the respective first cost of an induction installation and a low-tension continuous-current installation, viz., that the low tension is cheaper for very short distances.

This sounds very much like a man who had a continually growing business requiring an engine saying that a small engine was cheaper for him than a larger, because the smaller engine just then met his requirement, and after a little time he finds it necessary to dispose of his small engine at a considerable discount for a larger one that will be more adequate to his growing needs. Why not put in at the first that system in which will meet any and every illuminating requirement for all time, both at points near to and remote from the source of generation.

I do not know whence the information has been derived, but the theory does exist that with a reduction of the load in the multiple arc induction system there is not a proportional reduction of the energy supplied to the circuit, and that consequently the loss of energy in the line does not decrease proportionately with the load. While this theory would and does apply to a series system of transformers it does not apply to the multiple arc induction system, the latter standing in the same relation with regard to the energy supplied to its circuit as the low-tension multiple arc. Upon another occasion I trust to have an opportunity of bringing forward mathematical deductions and power curves incontestably proving this fact.

No doubt a system cannot be considered a reliable one unless you are able to multiple arc your dynamos; well, we are able to do this. It used to be regarded as difficult, but, gentlemen, with a great many of those apparent difficulties we need only to understand their nature to overcome them, and, although at the present moment we cannot couple as many together as we should wish, I venture to say that by the time such a necessity arises we shall be ready to meet it. It is stated that we cannot multiple arc dynamos economically, as occasionally one dynamo will shift the load and the other dynamo not only will take it, but will drag the other. In an incomplete system this is just what takes place, but a device is brought into operation that varies the speed of the engine according as any variation therein takes place, thus maintaining the speed of all the dynamos coupled in multiple and their potentials uniform.

A good deal has been said from time to time as to these dangers of the alternating system, and notwithstanding the repeated explanations and statements of those who are acquainted with alternating currents and their use, yet only a week or two ago Mr. Leonard in his Paper read before this club attempted to resuscitate this scare, which we supposed had been forgotten.

Prof. Elihu Thomson has publicly stated that he has taken a 1,300-volt alternate current without serious inconvenience. I have myself, as have several of my friends, taken 1,000 volts, and in all the cases with which I am acquainted nothing more than some temporary discomfort followed.

The most serious case of which I ever heard was that mentioned by Mr. T. Carpenter Smith, at the Boston Convention. In that case the man was not permanently injured, although under the influence of the current for quite a considerable time. Although I would not go so far as to recommend the use of the 1,000-volt current as a morning beverage, yet it is absurd to let the impression now, as to the lamp, go abroad that it is necessarily or even probably fatal.

We recognise the fact that an electric current of 200 volts is less dangerous than one of 1,000 volts—of course we know that. Does it therefore follow that we shall throw to the winds every advantage that this higher pressure gives us? Because a buggy is less dangerous than a locomotive do we therefore abandon railroads? Because an arc-light system requires more than 100 volts pressure, are we, therefore, to abolish every arc light in the country? These questions answer themselves.

There is nothing to prevent us placing our lamps upon existing gas fixtures, unless it be ignorance or not employing the proper precautions to render the work absolutely safe. It is suggested by some that in order to prevent the high-tension primary current being dangerous to life, in the event of a leak between the primary and secondary coils taking place, to ground the secondary; then if a leak took place from the high-tension circuit to the low-tension circuit, and there happened to be a ground somewhere else on the primary circuit, no harm whatever could occur to a person taking hold of the terminal of an incandescent lamp and at the same time touching a gas fixture. While this arrangement makes the use of the lamps by the customers absolutely safe it subjects the entire system to a strain on the insulation which I do not think is quite wise, and, instead of grounding the secondary, I think the better plan would be to ground a sheathing of metal interposed between and carefully insulated from the primary and secondary. So far as safety to life is concerned this is just as good, but has the recommendation of not subjecting the insulation throughout the system to any strain whatever, and has been used for some time with satisfactory results.

A charge laid at the door of the alternating system is that of want of reliability, and a few small breakdowns which have occurred are exaggerated to a considerable extent by those interested in other systems. Such matters are liable to occur in all new installations, the Edison not excepted. They are simply boyish indiscretions, errors of youth, and not faults of the system as such. In a very short time the experience we have gained in this respect will bear due fruit, and the alternating be just as reliable as the continuous system. In the absence of gross carelessness there is no reason to the contrary, and, indeed, down to the present time even, accidents have been rare.

With regard to an alternating-current dynamo of 1,000 volts being more liable to burn out than a low-tension continuous-current dynamo of 110 volts, and that the depreciation of the latter is less than the former, this seems to me to be nonsense. Understanding the nature of the work that a dynamo has to do, and with proper experience in construction, there should exist no reasonable doubt about making one dynamo to work as reliably as the other; this is purely a mechanical matter, and the ingenuity of our mechanics is equal to any such emergency as that. And as to depreciation, I venture to say—in fact, I know—that the armature of an alternate-current dynamo of the kind I have had any experience of, at full load, does not arrive at anything like the temperature a low-tension Edison dynamo does under the same conditions; and we all know what high temperature in a wire has to do with the deterioration of its insulation. Furthermore, by reason of the small quantity of wire necessary in the armature of the alternate-current dynamo (for instance, in an 800-light machine made by the Fort Wayne Electric Light Company, there are only 20lb. of wire), we can afford to occupy more space, and thereby have less crowding of the wire; thus we have an opportunity of increasing our insulation in proportion to E.M.F. required.

There has been some little uncertainty about the action of converters in respect to the fuses enclosed in the converter box frequently and mysteriously melting. This, however, I find is attributable to the temperature of the converter at full load not being calculated as a factor with the current for the melting point of the fuse, and I think it will be much better us for to be satisfied with an external double pole fuse at the point of junction of the primary coil with the primary line, and a double pole fuse on the secondary circuit as close to the converter as possible; this arrangement thoroughly protects the system, and a possibility of a failure of the converter becomes a very remote one.

It is said that the operating of motors by alternating currents is not a success. Well, it may be admitted that at the present time the commercial operation of alternate-current moters has not attained very large dimensions; but who is presumptuous enough to say that, when the present systems of alternate-current supply are as old as the continuous, there shall not be as many and as satisfactory motors running on alternate currents as on continuous? Is it for any gentleman connected with the Edison Company to stem the river of invention, to say that the acme of perfection is reached in the triune system of that august body, and to thunder forth electrical excommunication on all heretical expounders of the faith? I trow not. Alternate-current motors have been made which have in them the elements of success, and the subject is daily attracting more and more attention from some of our most talented workers in that direction, both practical and theoretical, as examples of which I may mention the valuable Paper read quite recently by Dr. Louis Duncan before the American Institute of Electrical Engineers,* and the earlier one read some months ago by Prof. Elihu Thomson,† with which no doubt most of you are familiar.

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* See *The Electrician*, March 9th, 1888.
† See *The Electrician*, June 10th, 1887.

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The mere fact that motors will work on an alternate current is of course well known. The difficulties are in the regulation, the degree of economy, and other matters. But a *difficulty*, gentlemen, is merely a "thing to be overcome." That is what difficulties are for. *These* will be overcome, as have so many others in the grand field of electrical progress. Why, I remember hearing Dr. Werner Siemens say with his own lips that it was hopeless to expect to make a dynamo with a higher efficiency than 50 per cent. ! He lived to see himself mistaken, and perhaps others may do the same. Not ten years ago the "divisibility of the electric light," as it was called, was ridiculed as the chimera of an enthusiast's over-heated imagination, but nevertheless where are we to-day?

The objection to the alternating system on this motor question is based on the assumption that it is a desirable thing to operate motors on the same circuit as lights. Now, although at first sight this would seem to be the case, and although I am not prepared with any formal objections to that course, yet I do know of one company that has been running motors on the same circuit as lights, but are now running a separate motor circuit instead, in addition to their lighting circuit. So that there is such a difference of opinion on the question that it cannot be fairly disposed of by any *ex cathedra* utterances of the advocates of any particular system.

One curious fact, which I think is not very generally known, though the information is public property, would seem to show that the Edison Company do not regard the alternating systems as such insignificant opponents as they would have us believe. The advocates of the Edison system profess to regard all these alternating-current high-tension systems as inferior to their own, and as almost beneath contempt; yet, singularly enough, I find that 12 months and more ago the Edison Electric Light Company of New York thought enough of one of these systems—the Zipernowsky—to acquire the exclusive right in North America to use all the patents on that system, and to obtain an option to purchase for $20,000 these Zipernowsky patents, so soon as they are granted a broad controlling claim in a United States patent, on transformers for alternating currents used on the multiple-arc principle. To say the least, it is strange that a company should be willing to pay such a large sum of money for so worthless a system as they pretend that it is.

Does it not rather show that they are more frightened than they say, and are providing for themselves a *locus penitentiæ*? I think it does.

It may be considered that my remarks sound like a direct attack upon the Edison Company's system, but I have admitted wherein the induction system is weak, and only claimed such advantages for the latter as are warranted by fact; and when we know of cases where after large installations had been put in and paid for—such, for example, as that of Tyrone, Pa.—the investors found upon careful consideration of the question that they could make more money by setting aside their original investment and change over from low-tension continuous (three-wire at that) to high-tension induction, then I have not spoken too strongly. But, gentlemen, whatever I or anybody else may say in favour of one system and in condemnation of the other system will, from a commercial point of view, affect the subject in dispute very little, and we may rest assured of one thing—that the public at large, whose business it is to study these questions, have discrimination enough and practical knowledge sufficient to enable them to make a wise selection. The respective systems, low-tension continuous and high-tension induction, are now before the public, and the ascertaining of their respective values is within the reach of those who desire to know them. They will perceive that claiming a thing cannot be done will not make it so, for they will see it being done, and the great question with the public will be, what does this cost, what profit can I make upon my investment? Be confident that the public will not go far wrong when the information it seeks is placed within its easy reach.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *May 19th*, 1888.

There has been considerable movement in electrical circles in New York during the last week. On Saturday evening an entertainment was given at the Electric Club, when Mr. E. T. Gilliland exhibited the latest form of Mr. Edison's phonograph, and read a Paper on the subject. There was a very large gathering, and the reproductions by the phonograph of the pianoforte, cornet and other musical instruments, as well as songs and ordinary speech, were excellently given, and were received with the utmost interest and enthusiasm. In point of fact, it would seem that the instrument has not gained very much in clearness of reproduction and articulation, but the apparatus has been greatly simplified and reduced in size, and has been rendered far more available for general use. One of the most striking exemplifications of its handiness was given in a small room fitted up like a printing office, where a compositor set type from phonographic dictation, starting the machine with a pressure of his foot to dictate a new sentence, stopping it and then starting it again. It will thus be seen that busy literary men, such as the editors of daily papers, can dictate their editorials or news paragraphs right into the phonograph, and have no other bother about it than the reading of the proof from the compositor's galley. In order to gratify the general interest in the subject the Edison Phonograph Company has had three or four of its instruments on exhibition all the week at the Club House.

During the present week the American Institute of Electrical Engineers has entered upon its fifth year, has had its election of officers, and has held its annual gathering. The new president, who was unanimously elected, is Mr. Edward Weston, of Newark, who, though born in England, has been so long with us, and of us, that we regard him as a first-class American in the best sense of the word. As an electrical engineer Mr. Weston is in the first rank. At present he stands practically without any affiliations, and is therefore in a position of independence rarely enjoyed by such prominent men in this country, it being generally the case that our leading inventors are throughout their careers actively engaged in, and associated with, large business enterprises. Mr. Weston has always had, I believe, a warm interest in the welfare of the institute, and may be counted upon for doing it good service during his tenure of office. It would not be surprising if he brought before it some of the many results obtained in his investigations at his fine laboratory at Newark. The institute during the past year has, as the secretary states, more than doubled its membership, having now over 320 members in all parts of the country and in all parts of the world. The increase is steadily maintained, and the accretions are of the best class. At the general meeting, held on Wednesday last at the house of the Civil Engineers, there was a very good muster of the members. The programme of the meeting has already appeared in your issue of May 25th.

While this has been going on in New York a very interesting meeting has been held in Philadelphia by the Franklin Institute, at which Mr. Emile Berliner, just referred to, read a Paper on his "Gramophone," which has already been illustrated in the electrical journals. This instrument, as will be remembered, practically etches the human voice, and reproduces speech by mechanical means. Mr. Berliner causes his recording stylus to move under the influence of sound waves, parallel with and barely touching the surface of a disc which is covered with some such material as lampblack. This record when made on the disc is fixed by varnishing, and can then be reproduced in a solid resisting material, such as metal, either by the mechanical process of engraving or by chemical deposition or by photo-engraving. The copy thus obtained can be multiplied to any desired degree. I have myself had the pleasure of listening to Mr. Berliner's gramophone, in which the record was made on a disc of plate glass, and the reproduction was excellent.

Among those who have grappled with the problems of aërial navigation is a Dr. De Bausset, whose ideas have been before the public for some time, and who proposes to use as his air-ship a huge metal cylinder, in which a perfect vacuum has been created, and to actuate all his machinery by electric-motor and storage battery. Dr. De Bausset has now succeeded in obtaining a favourable report on his air-ship from the Committee of Ventilation and Acoustics of the House of Representatives. The Committee recommend the appropriation of $150,000, and the use of the navy yard, provided that $75,000 of private capital is also put in. Should the scheme be carried out it will be watched with much interest. There is some scepticism as to the ability of the doctor's enormous cylinder to serve its purpose. If it is built up with thin plates

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it may be unable to stand the pressure, and if made of thick plates it will be too heavy to lift.

A little while ago, I mentioned in this letter the fact that the Edison Company had made a movement to secure from the United States Circuit Court here a more favourable interpretation of the operation of that portion of the revised statutes which has been held to limit American patents by the term of corresponding patents taken out abroad. Judge Wallace, before whom the matter was heard, has, however, declined to upset the comity of the Courts in this matter, and the question must therefore await, I suppose, adjudication by the Supreme Court.

CORRESPONDENCE.

ELECTRIC OSCILLATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the interesting Paper by Dr. Fleming in your issue of 11th May, on Electrical Oscillations, the graphic representa-

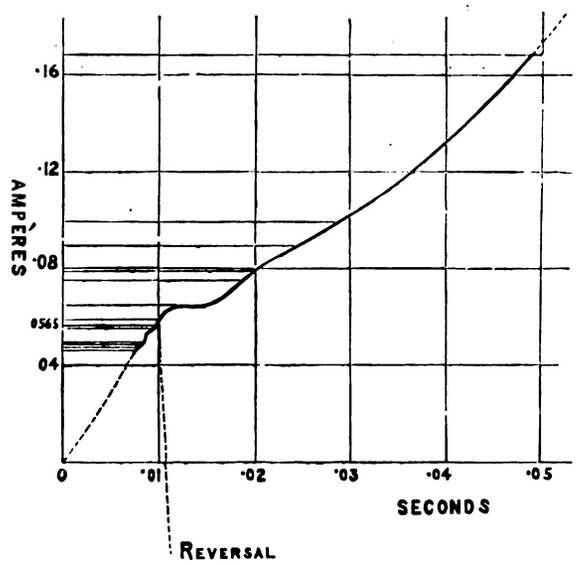

FIG. 1.

tion of the establishment and cessation of an electrical current in an inductive circuit—presumably an electro-magnetic one, as

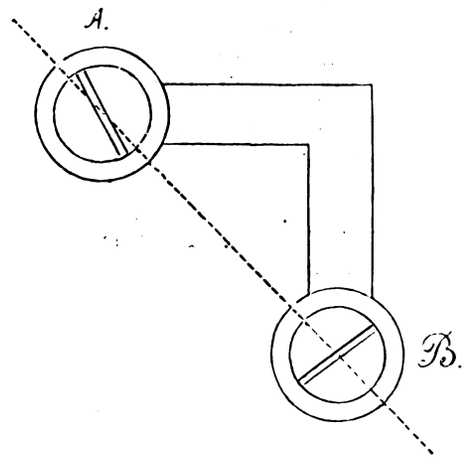

FIG. 2.

an induction coil is mentioned—does not agree with my observations on the curve in the magnets of type-printing telegraphs—at least as regards the cessation of the current.

In the case of the apparatus I refer to, the annexed diagram shows the increase of current, which is not uniform.

The cessation and complete reversal of the direction of the magnetism in the case of our working speed take place within the limits of the time shown by the thick and dotted line, or $\frac{1}{343}$th sec., the time line during which the battery is applied being $\frac{1}{100}$th sec., and the mean strength of current reached ·056 amperes, the maximum steady current in the circuit being 0 28 ampere.

It appears, therefore, that the phenomena vary somewhat with the arrangement employed; but in ordinary cases the cessation of the current is more abrupt than is shown in Dr. Fleming's diagram.

The experiment mentioned on page 8, paragraph 2, by which a discharge from Leyden jars takes the direct route through air instead of through the long wire connecting the two coatings, is what may be observed in case of all discharges which are of potential sufficient to jump through $\frac{1}{400}$th inch of air. For example, if two binding screws in such a circuit be connected together with a strap of brass ·002 of an inch thick, as in the full-sized drawing attached, a part of the discharge will, upon placing a straight conductor loosely across from A to B, jump through the imperfect connection, and cause a spark.

This spark increases enormously with any increase in deviation of the fixed connection from the straight path between the binding screws and independently of the resistance of the conductor. If a wire two inches long and less than $\frac{1}{350}$th ohm in resistance be made into a spiral, and placed in the circuit between the binding screws instead of the rectangular brass strip, then the sparks given off upon laying a straight iron conductor across the binding screws will be sufficient to mark the metal, and cause $\frac{3}{4}$in. of coruscation.—Yours, &c.,

17, Cornhill, E.C., May 29th, 1888. F. HIGGINS.

THE LEAMINGTON CENTRAL STATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to the remarks which you made reflecting on ourselves in your issue of the 25th, in the first place we cannot refrain from telling you frankly that if you felt any of the "moral responsibility" about which you write you would not have made, on *ex parte* statements, the injurious comments in which you have indulged. There was ample time between the meeting of the Leamington Council and your publication of the 25th for you to have ascertained whether the statements to which you give currency were fair and impartial accounts of the position of affairs. Of course, as a matter of fact, they were nothing of the kind, and were not to be taken seriously as criticisms on electric lighting, but only as illustrations of personal pique or of trade rivalry or phases in the exigencies of local party warfare. Our installation at Leamington has now been running on a commercial basis for a little over three months. It will, to put it mildly, compare very favourably with any similar undertaking in Great Britain in a similar stage of its history. We have not lost a single customer since we commenced our supply, but, on the contrary, we are steadily increasing the business month by month, and enlarging and improving the plant. As to the Town Council and their street lighting, we are much more likely to give them notice than they are to give it to us. It is not we who would lose by this. Supplying the public lamps as we do at the cost of gas our contract can at the best only be described as selling twelve pence for a shilling. The Council, on the other hand, would lose the advantage of having two strings to its bow, and would be once more delivered up to the tender mercies of the Gas Company, who would re-establish their monopoly of public lighting.

We cannot accept your suggestion that we should give a history of our works; we are too busy to do it as a recreation, and if it were necessary to do anything to protect the reputation of our company a newspaper correspondence is not the method we should adopt.

We should, however, be very pleased to take you over our central station, and to show you our system in operation, and leave it to you to write from personal knowledge an impartial account of your experience.

We are certain if you accept this offer you will not again make the mistake of describing as a failure an installation

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which Mr. Preece told our Mr. Hookham was unequalled in England.

Should you accept our offer and make arrangements with us to visit our works and see for yourself we leave it in your discretion to publish this letter or not; but if you decline our offer we have to request you to publish this letter and to give it the same prominence that you have given to the remarks of which we complain, and we should further request that you should not in future insert in your paper reports likely to injure our reputation or business, or make comments thereon through which we sustain injury, unless you have first satisfied yourself that such reports are true in fact, and that your comments are fair, reasonable, and justified by public interests.—Yours, &c.,

(For CHAMBERLAIN AND HOOKHAM, LIMITED.)
JOSHUA BROWN, Secretary.

Birmingham, May 29th, 1888.

[Our remarks on the above letter will be found in this week's "Editorial Notes."—ED. *E.*]

THE INVENTION OF THE ELECTRIC LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you allow me, in acknowledging your kind remarks on my letter on the above subject, to say, with regard to the patents of Mr. Edison and Dr. Siemens, that the thought of anticipation on the part of my father was suggested by one of Mr. Edison's specifications, No. 4,226, 1878, which contains this claim:—"The rod will expand in proportion to the heat of the coil, or in proportion to the heat developed by the passage of the current, and forms the principal feature of my invention." My father's device, as already described, was "based upon the heating and expansion of metals by the current to be regulated." Urquhart further adds, after mentioning "the self-same principle employed by Mr. Edison," "Dr. Siemens has constructed a regulator of a strip of platinum. The action is the same as that employed by Messrs. Staite and Edwards." Of the similarity or dissimilarity of these descriptions you will judge. May I suggest, with reference to your remarks, that in such a case as mine "the mischief is past remedy," that it would not be so if those gentlemen who are unconsciously using my father's improvements, and the public who are adopting them, felt that a claim existed, and were willing to respond to it?—Yours, &c. G. H. STAITE.

Sutton Cheney Vicarage, Hinckley, May 29th, 1888.

TAVENER'S COULOMB METER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The paragraph in the letter of your American correspondent, May 11th, giving Prof. Elihu Thomson the credit of being the first to utilise the heating effects of the current in conjunction with the differential thermometer, for the purpose of measuring and registering the quantity of current passing in a circuit, did not escape my notice. I should have called attention to the misstatement at once, without leaving the vindication of my claim to others, but felt that as you had so recently pointed out the novelty of my invention, which is substantially the same, it must be still fresh in the minds of your readers, who could not be misled by it. Since it has been stated that my invention is prior to Prof. Elihu Thomson's by more than four years there is only left me to say that had there been no patent to fix the priority of my claims, I could have brought ample testimony that for some time previously to 1884 I had been experimenting with the object of adapting the heating effects of the current in the construction of an electric meter, as it appeared to afford the only means of making a generally useful instrument applicable to both alternating and direct currents, which resulted in my adaptation of the tube with bulbs as the only solution of the difficulty of using the heating effects of the current in the way I have with a varying surrounding temperature and pressure.—Yours, &c.,

J. TAVENER.

South View, Basingstoke, May 29th, 1888.

ACCUMULATOR SWITCH-BOARD AND NEW METRE BRIDGE.

We illustrate herewith (Fig. 1) a switch-board made by the Woodhouse and Rawson Electric Supply Company (Limited), which is intended for a small installation with dynamo and accumulators. At the top is an ammeter of the Davies type and a voltmeter also of the Davies type. In the centre is an accumulator switch. On each side of centre is a two-way, G, switch, which are used for

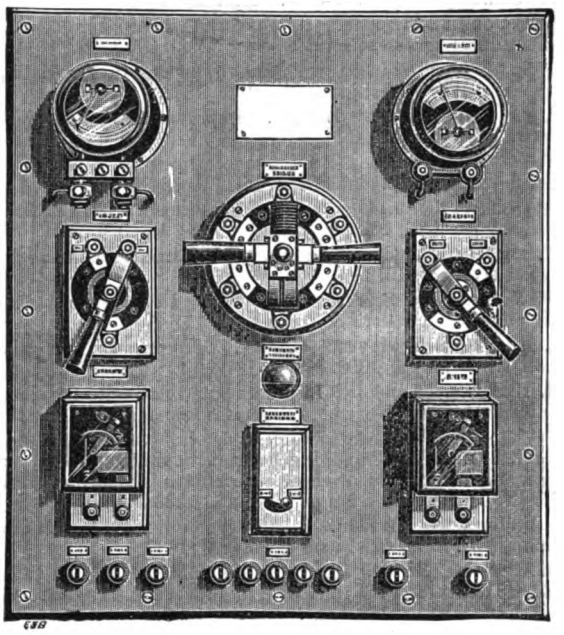

FIG. 1.

sending current from dynamo to line or accumulators, or from accumulators to line, or both at once. At the bottom are two magnetic cut-outs, one for dynamo and the other for accumulator circuits. There is also a voltmeter switch and fusible cut-out. The whole are mounted on slate base.

We also give an illustration (Fig. 2) of a portable form of metre bridge constructed by the same firm. The metre wire is wound on an ebonite cylinder, on which a thread is cut to receive it. Contact with the wire is made by a sliding piece fixed inside a collar, which is threaded inside to fit the screw thread in which the wire is wound. This collar is divided into millimetres and indicates the position of the point of contact, a small vertical scale giving the number of complete revolutions.

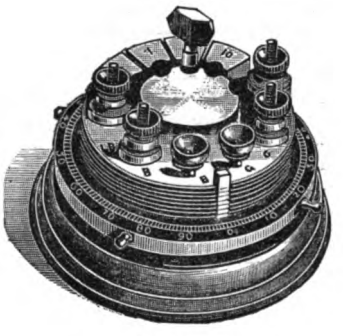

FIG. 2.

Standard coils are included in the instrument, and are connected to the brass blocks, shown at back, with a plug for putting them in or out of circuit. Two keys are placed in front, one for the battery and the other for the galvanometer circuit. Terminals are provided for galvanometer and line, battery and line, &c., which are exactly equivalent to those of an ordinary metre bridge, so that the whole arrangement is compact and portable, only occupying a space of 5½in. by 3½in. deep.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended May 25th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,366.

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PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

6,237. A. MILLAR. Glasgow. Improvements in jars or cells for primary or secondary electric batteries. April 27, 1888.

6,270. H. C. JOBSON. London. Improvements in clips for attaching or fixing insulators to telegraph poles. April 27, 1888.

6,314. J. P. HALL. Manchester. Improvements in or relating to dynamo-electric machines. April 28, 1888.

6,322. P. R. DE F. D'HUMY. London. Improvements in galvanic batteries. April 28, 1888.

6,344. W. DAVIES. London. An improved means of conveying telegraph, telephone, and similar wires. April 28, 1888.

6,373. L. DILL. Berlin, Germany. Improvements in electric batteries. April 30, 1888.

6,382. W. MILLAR. London. An improved electric automatic delivery box. April 30, 1888.

6,390. W. MACKIE and S. SHARP. London. Improvements in electrical switches. April 30, 1888.

6,416. L. HOPPE and G. HOPPE. London. Improvements in galvanic batteries. May 1, 1888.

6,481. H. H. LAKE. London. Improvements relating to the electrical transmission of power and to apparatus therefor (N. Telsa, United States). May 1, 1888.

6,502. H. H. LAKE. London. Improvements relating to the generation and distribution of electric currents and to apparatus therefor (N. Telsa, United States). May 1, 1888.

6,578. J. Y. JOHNSON. London. Improvements in incandescent electric lamps (C. Philippart, France). May 2, 1888.

6,580. D. A. AIRD. London. Improvements in or connected with locks, catch latches, and the like, with means for releasing the bolt or catch by hand or electricity. May 2, 1888.

6,609. W. CHADBURN. Liverpool. Improvements connected with mechanical telegraphs for use in navigable vessels. May 3, 1888.

6,613. S. MILLER. London. Automatic resistance for electric-light circuits. May 3, 1888.

6,614. E. G. CRAVEN. London. Improvements in electrical illumination of clock dials and apparatus in connection therewith. May 3, 1888.

6,627. G. A. TABOURIN. London. A combined generator of electricity and electric lamp. May 3, 1888.

1,851A. J. Y. JOHNSON. London. A sound-conveying tube for telephones, graphophones, and like instruments (The Volta Graphophone Co., United States). February 7. Note—This application having been originally included in No, 1,851, dated February 7, 1888, takes, under Patents Rule 23, that date.

6,657. B. D. WILLIAMS. Bristol. Improvements in secondary batteries or electric accumulators. May 4, 1888.

6,740. J. T. ARMSTRONG and A. SERRAILLIER. London. An improved portable electric lamp. May 5, 1888.

6,834. A. P. CHATTOCK. Liverpool. An instrument for the measurement of the coefficients of electro-magnetic induction. May 8, 1888.

6,836. W. E. AYRTON, J. PERRY and D. COOK. London. An electrodynamic relay for constant or varying currents. May 8, 1888.

6,876. H. ARON. Liverpool. Improvements in apparatus for measuring electric currents. May 8, 1888.

6,889. O. FIRTH and E. W. CRABTREE. Bradford. Improvements in dynamos and motors. May 9, 1888.

6,893. E. C. WALKER. Darlington. Improvements in electro-magnetic and magneto electric generators. May 9, 1888.

6,907. M. IMMISCH. London. Improvements in storage batteries. May 9, 1888.

6,909. E. J. HOUGHTON. London. Apparatus for use with dynamo machines. May 9, 1888.

6,910. E. J. HOUGHTON. London. A system of electric lighting. May 9, 1888.

6,927. M. R. WARD. London. Improvements in electrically propelled vehicles and appliances connected therewith. May 9, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

May 5, 1888.

7,235. F. C. PHILLIPS and H. E. HARRISON. London. Improvements in the safety mechanism or cut-out of electric arc lamps or other electrical apparatus. May 18, 1887.

7,834. H. EDMUNDS. London. Improved means of controlling, transforming, regulating, synchronising, and registering electric currents. May 28, 1887.

8,214. W. P. THOMPSON. Liverpool. Improvements in telephone systems (E. Mauritius, Germany). June 8, 1887.

9,256. J. L. YULY and H. W. ANDREWS. London. Improvements in and apparatus for regulating the speed of dynamos employed on railway trains for lighting the same. June 29, 1887.

13,069. F. VAN RYSSELBERGHE. London. Improvements in or relating to harmonic telegraphy. September 27, 1887.

14,062. E. PULLAR. London. Improvements in automatic medical electrical apparatus. October 17, 1887.

15,537. R. W. PAUL. London. Improvements in electric switches. November 14, 1887.

17,047. F. KING. London. Improvements in secondary batteries. December 10, 1887.

137. J. C. PURTHNER. Vienna, Austria. Improvements in apparatus for producing induced electric currents. January 4, 1888.

3,075. A. W. SOUTHEY. London. An improved clutch for regulating feeding rods in electric arc lamps. February 29, 1888.

3,215. J. W. OLDROYD. London. Improvements in electric incandescent lamps. March 2, 1888.

3,235. G. MIOT. London. Improvements in multipolar dynamo-electric machines. March 2, 1888.

4,277. A. J. BOULT. London. Improvements in electro-mechanical movements (J. F. McLaughlin, United States). March 20, 1888.

4,929. W. GILLETT and G. HAZELTINE. London. Improvements in magneto-electric generators. April 3, 1888.

May 12, 1888.

6,400. J. R. SCHILLER and C. MEYER. London. Improvements in electro-magnetic apparatus for the automatic lighting and extinguishing of gas lamps. May 2, 1887.

7,189. W. H. AKESTER. London. Improvements in secondary batteries. May 17, 1887.

8,206. D. H. DAVIES and J. M. TOURTEL. London. Apparatus for effecting, by insertion of a coin, the production of electric light for a certain time. June 7, 1887.

8,495. A. M. CLARK. London. Improvements in electric lamps (C. Bertow, France). June 13, 1887.

9,598. J. A. TIMMIS. London. Improvements in electrical apparatus for working railway signals. June 7, 1887.

3,246. F. WALKER. London. Improved electrical lamp and projector, and method of applying same for maritime and other purposes. March 2, 1888.

3,303. H. H. LEIGH. London. Improved apparatus for registering the consumption of electric energy (J. L. Clerc, Paris). March 3, 1888.

PATENTS SEALED.

May 4, 1888.

2,819. H. NERLINGER. Germany. An improved method of combining and arranging apparatus operating electric lamps for signalling and other purposes. February 23, 1887.

4,549. A. FEATHERSTONHAUGH. London. Improvements in electric incandescent lamps. March 26, 1887.

5,199. W. LOWRIE and C. J. HALL. London. Improvements relating to the distribution of electrical energy for purposes of locomotion. April 7, 1887.

5,303. H. W. RAVENSHAW. Halifax W. T. GOOLDEN and A. P. TROTTER. London. Improvements in dynamo electric machines. April 12, 1887.

5,505. H. W. RAVENSHAW. Halifax. W. T. GOOLDEN and A. P. TROTTER. London. Improvements in dynamo electric machines. April 15, 1887.

637. A. SIEMENS and E. F. H. H. LAUCHERT. London. Electrical controlling apparatus. April 18, 1887.

5,833. F. W. CROSSLEY. Manchester. A combined gas motor engine and dynamo electric machine. April 21, 1887.

6,177. A. MARCILHACY. Paris. Apparatus for adapting electric lamps to the helmets of divers. April 27, 1887.

14,204. J. R. HARD and T. WILSON. United States. Improvements in medico-electrical apparatus. October 19, 1887.

1,078. S. BERGMANN and J. T. DEMPSTER. United States. Improvements in switches for making electrical circuits. January 24, 1888.

May 11, 1888.

4,225. G. HOOKHAM. Birmingham. Improvements in electricity meters, parts of which improvements are applicable to dynamo-electric generators and motors. March 21, 1887.

5,562. W. MAXWELL. London. A system of generating, reproducing and distributing electricity. April 16, 1887.

5,709. A. J. GRAVIER. Paris. Improvements in dynamo-electric machines. April 19, 1887.

5,867. W. KINGSLAND. London. Improvements in secondary batteries. April 22, 1887.

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6,168. H. F. JACKSON. London. Improvements in or connected with telephones for checking payment for the use of telephones. April 27, 1887.

6,294. A. WATT. London. Improvements in the electrolytic treatment of zinc and its ores. April 29, 1887.

7,704. A. C. HERTS. London. An improvement in telephones. December 23, 1887.

SPECIFICATIONS PUBLISHED.

6,221, 1887. SHIPPEY, A., and HAMILTON, W. J. L. Governing by electro-chemical action, &c. (Price 11d.)

6,581, 1887. MANVILLE, E., and MADGEN, W. L. Holders for electric lamps. (Price 8d.)

7,265, 1887. ADER, C. Phonic reception of electrical signals. (Price 8d.)

9,853, 1887. WATT, H. Dynamo-electric machines. (Price 8d.)

16,709, 1887. EDISON, T. A. Electrical generators. (Price 8d.)

633, 1888. COERPER, C. Dynamo-electric machines. (Price 8d.)

734, 1888. NOAD, J. Galvanic batteries. (Price 8d.)

3,483, 1888. SCHMIDT, F. T. Electrical switches. (Price 6d.)

3,685, 1888. SHARP, S., and others. Electrical switches. (Price 8d.)

6,204, 1887. MULLER, W. J. Induction coils and transformers. (Price 8d.)

7,553, 1887. GEORGE, F. Dynamo-electric machines. (Price 4d.)

8,181, 1887. TAYLOR, H. A. Testing submarine electric telegraph cables, &c. (Price 8d.)

8,708, 1887. OPPENHEIMER, J. Fixing telegraph posts. (Price 8d.)

8,710, 1887. NORDENFELT, T. Electrical apparatus for firing ordnance (Price 8d.)

8,855, 1887. JULIEN, E. Electric piles. (Price 11d.)

LEGAL INTELLIGENCE.

The Brighton Electric Railway.

A special sitting of the Brighton County Court was held on Wednesday last, to hear a motion *in re* Magnus Volk, in which Mrs. Pryce Hamilton sought to set aside a decision of the Official Receiver (Mr. A. Mackintosh), rejecting a proof she had tendered for £1,539. 12s. 5d., for money lent and interest. The money had been advanced for the purposes of the Electric Railway, and the matter really raised the issue whether, under the terms on which Mrs. Hamilton lent the money, she was a partner in the concern, and therefore not entitled to move in competition with the other creditors. Mr. Rutherford, representing Messrs. Miller, Peal and Co., of Liverpool, appeared in support of the motion; Mr. Muir Mackenzie (instructed by Mr. Henry Prince) for the Official Receiver, and Mr. Treacher (representing Mr. J. K. Nye) for the debtor.

HIS HONOUR ultimately said the matter came before him in a peculiar manner. It was still undecided whether there should be a bankruptcy or a composition on certain terms, and the creditors were considering a proposal under which Mr. Volk's railway would be restored to him. If the property were re-vested in the debtor, the right of Mrs. Hamilton would remain the same under the agreement; and in the present state of affairs, no trustee having been appointed, he did not think he should determine the position of the parties. All that he thought it necessary for him to determine was whether Mrs. Hamilton had a right to prove as a creditor or not, and he thought not. If a creditor, she was only a creditor within the liabilities of Bovill's Act. He refused the application, with costs.

COMPANIES' MEETINGS & REPORTS

Oriental Telephone Company (Limited).

The adjourned eighth ordinary annual general meeting of this Company was held on the 25th May at the City Terminus Hotel, Cannon-street, under the presidency of Mr. B. St John Ackers.

The SECRETARY (Mr. Alex. B. Chalmers) read the notice convening the meeting.

The CHAIRMAN: Gentlemen, I have first to regret the absence of our Chairman to-day. He is abroad, and the rest of the Directors have requested me to take the chair in the absence of Mr. Addison, who has also written to me to the same effect. I can only say personally that I regret that you have not your Chairman with you to-day. On the last occasion when we met it was the ordinary annual general meeting, and our legal adviser, Mr. Joseph Addison, of Linklaters, rose and told us that a case had been submitted to counsel, whose opinion had been received just before the meeting, and that it was advisable for us to adjourn the meeting for a month. The Chairman moved the adjournment, and in seconding it I used the following words:—"As you have heard from our legal adviser, we have every reason to believe that the dividend we were to recommend to you to-day will this day month be proposed, and, if the shareholders agree to it, declared; but until we have gone thoroughly into this question of back dividends and seen whether or not our capital has been reduced, as has been suggested, I think it would be very unwise to come to any decision. I therefore ask you to adjourn the meeting. But do not go away in the smallest degree despondent; we have had a very favourable year." My prediction as to the declaration of the dividend to-day has thus been fulfilled. I can only say that the Board very much appreciated the ready way in which the shareholders acceded to our request to adjourn the meeting, and I can only regret if anybody either here or outside, was led to take a despondent view of the affairs of the Company, because as I told you before, there was not the slightest reason for it; and I shall by-and-bye move, with your assent, that the dividend then proposed shall now be declared. You will see by the circular which has been sent out that since our last meeting the Directors have taken the opinion of their legal adviser—as well as that of the Company's auditor, and also that of an eminent accountant unconnected with the Company—and they are confirmed in their opinion that the assets are fully equal to the liabilities. We had gone over the question before, and you naturally will ask, as shareholders, why we had not altered the balance-sheet without being asked to do it from outside. There were several reasons that led us to desire to keep the balance-sheet as it was a little longer. To begin with, it is very undesirable to be frequently altering balance-sheets, and it was thought by the Board that there were certain circumstances likely to happen shortly that would form a very convenient time for making a thorough revision and alteration of the balance-sheet. Those points were the following:—First, we were anxious to get the Indian guarantees paid off before any alteration was made. Then we were also desirous of thoroughly determining, so far as we are able, whether the amounts which have been declared and paid as past dividends really were properly dividends or not, and that is a matter which is now receiving the very anxious consideration of the present Board. Then thirdly, there was the question of the vendors' shares. It seems to ordinary people who are not so much, perhaps, connected with these companies as those who are, if I may use the expression, professional directors, that it is very unfair that we should have in our balance-sheets to put down £75,000 of liabilities for vendors' shares, and that on the other side we should have to have assets from the first fully equal to that £75,000, and for this reason, that that £75,000 did not profess to carry dividends for many years to come, but only to receive dividends after 30 per cent. had been paid on the rest of the shares. Therefore, to ordinary minds, it would seem, provided you had on the opposite side made such provision that you had no reason to doubt that when the 30 per cent. had been paid on the other shares, then that the assets and liabilities would be equal to paying 20s. in the pound on the £75,000 of vendors' shares, that that would be a right and proper state of things. However, we are told there is no doubt whatever, and that there is no question as to legality or otherwise in this matter; the law says that you must have from the first the assets on the one side fully equal to your liabilities on the other side for vendors' shares. It is not my intention at the moment to say anything more about the vendors' shares, but later on, at the proper time, I desire to do so, in the hope that some plan may be found by which the present somewhat conflicting interest of vendors' and non-vendors' shares may be arranged amicably, so that in the future we may have an undivided interest, which would be very greatly for the benefit of the Company. I propose as shortly and as briefly as possible to go into the altered features of the balance-sheet. I may say at starting that the revenue and the profit and loss accounts are not altered. If any of you have the old balance-sheet which was sent out to the ordinary annual meeting, and will compare it with the present one you will find that the differences are as follows:—If you will take the first item on the asset side the first item as it stood before was £113,990. That has been written down by the sum of £42,990, now making £71,000. This old sum of £113,990 is the original sum, if I may so say, of the £115,000 which stood there from the commencement. If you remember, by the agreement made in the early history of the Company there was to have been a larger amount paid for different things—such as patent rights, goodwill, &c. That sum was, however, reduced to £115,000, and that, again, was written down by the sum of £1,010 taken out of the sale of the Hawaian Exchange. That exchange was sold out and out, and the amount was deducted, leaving £113,990, instead of £115,000. Besides that amount the late Board in no way reduced that sum, at which the goodwill and patent rights had stood from the first; and, as you have already heard, your present Board had not intended altering it until next year. However, it is now altered. You will find that the next item, that of expenditure on formation of exchanges in hand to date, is not altered. We believe that that sum fully represents our present property, and we have kept and are keeping in excellent repair and working order all the different exchanges. The total sum of those two items is, therefore, now £105,629 1s. 2d., instead of £148,619. 1s. 2d. If you go down a little further you see a very considerable change in the appearance of the balance-sheet. It was pointed out that it would be better to bring up the Deferred shares, and to value them altogether with the other shares in the subsidiary companies held by your Company, and not to put them down, as was done in previous balance-sheets, unvalued. It has also been suggested by the Company's auditor, who is appointed, as you know, by the Company, and not by the Board, that it would be well to have the value of the whole of these secureties brought out into one total instead of specifying the value of each item separately. That seemed to the Board a very wise suggestion, because in so many different subsidiary companies there may be ups and downs, and one of them may be more satisfactory this year and another more satisfactory next. It has, therefore, been thought better to make one total sum. Of course, we have the different amounts at which in the opinion of the Board these shares in subsidiary companies should be valued. The Deferred Indian shares have merged now that the guarantees have expired—that is to say, some have already merged, some are merging: and they will all have merged by the end of this year. There will, therefore, be no Deferred shares in connection with the Indian companies, and all the shares—the old Deferred shares and the Preferred—will rank for dividend. You will see, therefore, that

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this old item of £45,760. 15s. 9d. has been written up by the sum of £43,355. 4s. 1d., making a total of £89,115. 19s. 10d. If you go to the bottom of the balance-sheet you find a total of £209,432. 10s. 9d., against £209,067. 6s. 8d.; or, in other words, after these figures have been carefully not only valued, but re-arranged, it is seen that the assets are, as the Directors said they were, amply sufficient to meet all the liabilities, and there is a small profit over of £365. 4s. 1d. You will see that telephone patents, goodwill, &c., have been decreased by £42,990, whereas the portions of the patents and goodwill which have been sold to subsidiary companies have increased by £43,355. 4s. 1d., leaving this balance of £365. 4s. 1d. If you look at the other side, one item will finish the whole alterations. You see sundry credit balances stood before at £1,874. 13s., and we have added the £365. 4s. 1d., increasing that item to £2,239. 17s. 1d., that being the excess of assets over liabilities. I think you will say that that is a very satisfactory state of things so far as the thorough soundness of this Company goes, and that it proves that your present Board at any rate have been justified in recommending to you a dividend of 2½ per cent., which they proposed at the last meeting, and are again going to propose for your acceptance to-day. There are one or two other points that it would be, perhaps, as well I should make a few remarks upon. These are the following:—It may be asked, "How have you arrived at the conclusion that the assets are worth a certain sum?" Well, at the amount at which we have valued them they pay us in dividend at the present time 6 per cent., and we think that a 6 per cent. steady dividend-paying property is worth par to us at any rate. It also might be asked why we do not propose to pay a higher dividend at the present time. Well, to begin with, if you carefully look into the accounts you will see that we have not got the cash in hand to do it. It is true that the profit and loss shows a balance of over £6,000, but there is a debt from the Egyptian Company of £6,287. It is hoped that that amount may be paid off during the year, but I would rather leave that matter to the Directors of the Egyptian Company than go into it myself from this chair to-day. But even supposing it were paid off, it would be very doubtful policy to spend all our spare funds in hand for dividend. I am one of those who believe that when we meet next year, the dividend will be sensibly increased from what it is this year—sensibly. At the same time, I think it would be very unwise in the present condition of the Company to spend all your money in hand in dividends. We have no reserve fund. There is no way at present of obtaining any extra amounts for working capital except to call on the shareholders—a proceeding which I do not think would be, at any rate, generally acceptable. Then I will read to you from the Articles of Association one paragraph, which touches upon the question of dividends. It is as follows:—"The Directors may, before recommending any dividend, set aside out of the net profits of the Company such sum as they think proper as a reserve fund to meet contingencies, or for equalising dividends, or for repairing, or maintaining, or extending the buildings or plant connected with the business of the Company, or any part thereof, and subject to these regulations, may from time to time apply the whole or any part of such fund for any purposes of the Company." That shows that there is full power to treat this in such manner as may be thought best. Your Company at the present time is earning a dividend which I think if it were paid in full would be considered decidedly satisfactory by the shareholders; and my great object in the remarks which I am now going to make is, if possible, to see whether we are not able, having shareholders with different interests at the present time, so to manage, as I said before, that we may have one interest, and if we had that one interest I am sure we should soon pay very handsome dividends in this Company. I have already referred to the question of the vendors' shares. You are aware, gentlemen, that the vendors' shares are 75,000, for which I do not say for one moment that an equivalent was not received, but at any rate for which not one penny was paid. Now, all the rest of the share capital is capital which at any rate has been paid for in hard cash. As you know, the vendors' shares are at the present time nominally £1 paid. The other shares have 11s. out of the £1 paid on them. Well, I have already alluded to the very grave doubt whether the previously declared dividends were or were not dividends at all; and touching on this question of the vendors' shares it would be very desirable either by means of the Board and the shareholders generally, or by a committee, or by any other means that might be considered to be the best, to see whether or not some arrangement could not be made (of course, something must be given on either side) by which the vendors' shares should be reduced in amount, the liability on the other shares wiped out, and the vendors' shares rank very soon for dividend. At the present time they cannot get anything until 30 per cent. has been paid upon the other shares. Now, 30 per cent., even supposing the previous dividends were real dividends, will take some very considerable time before it can be obtained; but supposing—to take the other view, and a probable view—that the back dividends were not dividends at all, then it means that 30 per cent. has to be paid from the present moment before anything can be received by the holders of the vendors' shares. The present Board, as a Board—which I think very fairly represents both sides of the question—hold, I believe, over 30,000 non-vendors' shares, and over 15,000 of the vendors' shares. It would not be difficult to pay larger dividends provided we had a working capital. It would be possible to get that working capital if we had calls on the unpaid amount of these shares; but that was tried some time ago, with the result, I think, that the shareholders got a 5 per cent. dividend, speaking roughly, and had to pay 10 per cent. in calls. I do not think they will be very desirous of following that plan again, and there is this to be said, that it is not altogether for the benefit of the vendors themselves that calls should be made on the other shares, because if the whole pound of flesh were exacted, and if the 9s. a share now unpaid were called up, it would mean £99,000 extra ranking as dividend, being a larger sum a great deal than the whole of the vendors' interest in this Company. I will not detain you by going into further details. They are more suitable for a committee or between Directors and the holders of the two different sets of shares than an occasion such as the present; but I have said enough, I hope, to show that there is on the part of the present Board, at any rate, an earnest desire to meet and consider the claims of all the shareholders of both kinds, that we believe that an arrangement could be made by which the holders of the vendors' shares would benefit quite as much as the other shareholders, and that if such an arrangement were carried out, it would be very greatly indeed for the benefit of this Company, for we should be a united body. We should then have by such an arrangement working capital, and be able to pay all fairly-earned amounts out in honest dividends year by year. Before I sit down there is one other point I would like to touch upon. In the last report—the report for the previous year—it was stated that the question of the Company's patent rights in Australasia has again occupied much of the Board's attention. This does not fall into the year 1887, which we are really considering to-day; but I thought it might interest the shareholders present to know that that long and weary litigation, as it was at one time feared it would be, and that long and weary negotiation, as it has been up to the present time, has at last ended, and that if we have not got as much as we think we ought to have got, we have at any rate made an arrangement such as will prevent any action being taken on one side or the other, and by which the rights of the Company are recognised over the whole of Australia, New Zealand, and Tasmania, and by which the Company will receive an annual amount in royalties. The one reason why we have not obtained all we ought to have obtained is that the Melbourne Exchange has been purchased by the Colonial Government. One of our great interests lay in that exchange. The Government have laid their hands on it, and, that being so, we have been advised that it would be extremely difficult for a private Company to get back anything, or to obtain anything from a Government, especially from the Government of one of the Colonies, where the laws are very strict.

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I hope you will think that the Board have considered the interests of the Company in agreeing to an arrangement by which, subject to six months on either side, all ideas of litigation are to cease, by which our rights are acknowledged, and by which we receive a royalty in the different Colonies. I do not know that there is anything more to say, but if any shareholder wishes to ask any questions I shall be very glad to answer them. I now beg to move the adoption of this report and balance-sheet.

The Right Hon. G. CAVENDISH-BENTINCK, M.P.: I beg to second that.

Mr. W. S. CUFF said he did not take a despondent view of the Company's affairs, but a very hopeful one. He desired, however, to ask one question. They had learnt by the report that the dividend of the Egyptian Company had been brought into the accounts, that the revenues of the Indian companies were maintained, and that the exchanges worked by the Company all showed a profit. The question he wished to ask was, why, notwithstanding those three favourable facts, the profits were only £12 more than those of the previous year? He had no doubt that it could be explained. The idea of the Chairman as to a reorganisation of the capital was very desirable. He thought it would be very beneficial if they could get a small consultative committee of the shareholders representing both classes of the shareholders to act with the Board.

The CHAIRMAN: Perhaps if any other shareholder wishes to ask any question he will do so. I would like to reply altogether, as that would be the simpler way. No other shareholder rising to address the meeting, he continued: The answer to Mr. Cuff's remarks would seem to be that the progress is practically the same. There is only 1 per cent. more from the Egyptian Company than last year. We had 5 per cent. in the previous year, and we have now 6 per cent. I think we have had a fair return from India, but there has been rather a heavier loss on exchange last year. He then put the motion in the usual way, and declared it carried unanimously. Continuing, he said: The next resolution which I have the honour to propose is:—

"*That a dividend at the rate of 2½ per cent., free of income-tax, for the year ended 31st December, 1887, be declared on the paid-up capital of the Company, other than the vendors' shares.*"

Mr. G. B. FROST: Gentlemen, I have much pleasure in seconding this resolution. It is quite true that the dividend is a small one, but I am perfectly certain that it is the beginning of better things. I take a very hopeful view of the future of the Company, and when we come to remember that this day week will see the end of the Indian guarantees—that we have no such liability in the future—I am certain that it does not take a very profound prophet to predict the future prosperity of the Company. I have much pleasure in seconding the motion.

The CHAIRMAN put the resolution, and declared it carried unanimously.

On the motion of Mr. THOMAS LLOYD, seconded by Mr. HENRY GREWING, the Right Hon. G. A. F. Cavendish-Bentinck, M.P., was re-elected to his seat at the Board.

Mr. CAVENDISH-BENTINCK: I have to thank you for the honour you have done me in re electing me a Director of this Company. I was nominated to that post at the first almost without my consent being asked, but since I have been a member of the Board I have done my best to fulfil my duties, as I think the attendance book would show.

Mr. GREWING then proposed, and Mr. FROST seconded, the re-election of Mr. B. St. John Ackers; and the motion was unanimously agreed to.

The CHAIRMAN: I am much obliged to you for the honour you have done me in re-electing me. I have a very large stake in this Company, and it will be my very earnest endeavour, not only for my own interest but also for the interest of the shareholders, to bring it to a successful issue.

On the motion of Mr. CUFF, seconded by Mr. R. WRIGHT, Messrs. Deloitte, Dever, Griffiths and Co. were re-elected auditors to the Company for the current year.

Mr. CUFF then proposed a vote of thanks to the Chairman and Directors. The Chairman had placed the position of affairs before the shareholders in an excellent manner. He (Mr. Cuff) believed they had got prosperity before them, and he felt that it was due to the efforts of the Directors for the way in which they had managed the business.

The motion was seconded, and carried unanimously.

The CHAIRMAN: On behalf not only of the members of the Board present and myself, but also on behalf of our absent Chairman, who devotes a great deal of time to this Company, I beg to return you our hearty thanks. You have given us your confidence, and I hope that that confidence is not misplaced. I am sure that we have a bright future before this Company, and I hope that the next time we meet we may have a better dividend to propose.

The proceedings then terminated.

Hastings and St. Leonards-on-Sea Electric Light Company.

The following is the report of the Directors, submitted at the ordinary general meeting, held at Hastings on the 22nd May, 1888:—

The Directors present herewith their statement of accounts for the year ended 31st March, 1888.

The Company is now supplying 30 arc and 864 incandescent lamps, as against 30 arcs and 704 incandescent lamps last year, again showing an increasing business. The Directors have every reason to believe that by laying down mains in new directions and increasing the plant, the demand for supply of electric light will enormously increase. The principal hotels are now lighted by electricity, with very satisfactory results, and applications are now being made to substitute incandescent lighting for gas in places of worship and other business establishments.

On referring to the profit and loss account it will be seen that the gross profit for the year amounts to £558. 18s. 1d.; but from this must be deducted interest on overdraft at bankers and on debenture bonds issued to the amount of £1,000, thus leaving a balance of £314. 9s. 4d., out of which the Directors propose paying a dividend of £3 per cent. free of income-tax, amounting to £205. 10s., and carrying forward the balance to next year's account.

The suggestion of the Directors at the last annual meeting of the shareholders as to raising a sum of £5,000 by means of debenture bonds was not carried out, but a sufficient number of shareholders were found willing to take up bonds to the amount of £1,000, bearing interest at 5 per cent. per annum. The Company's bankers, Messrs. Beeching and Co., kindly agreed to reduce the rate of interest on overdraft to £5 per cent.

The revenue account shows that a sum of £166. 6s. 3d. has been charged to that account for repairs to boilers, including a new fire-box put in by Messrs. Robey and Co., of Lincoln.

Messrs. Reeves, Langham and Woodhams are the retiring Directors, and offer themselves for re-election.

The Auditors, Messrs. Hart Bros., Tibbets and Co., retire, and offer themselves for re-election.

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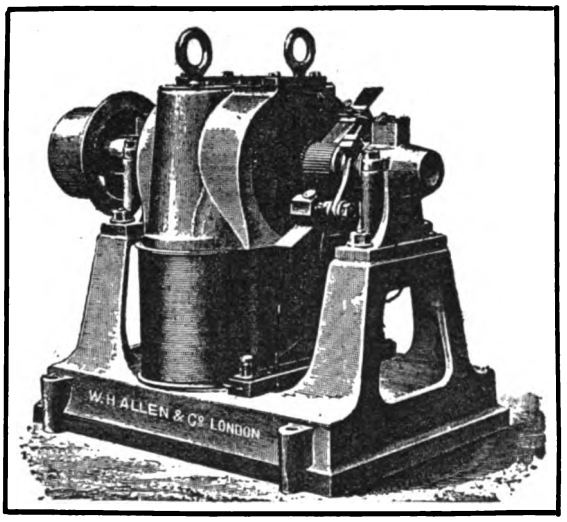

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, May 30, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending May 30, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American	37½ 38½	3 11 5	Jan., Apr., July, Oct.	...	...
2,614,820	Stock	20/0	Do. Preferred	63 64	4 5 11	,, ,,	64	63½
2,614,820	Stock	nil.	Do. Deferred	12½ 13	...	February	12⅝	12½
130,000	£10	3/0	Brazilian Submarine	12⅜ 12⅝	5 12 0	Mar., June, Oct., Dec.	12⅝	12⅛
16,000	10	8/0	Cuba Submarine	13 13½	6 1 0	February and August	13	...
6,000	10	10/0	Do. Preference	18½ 19½	4 2 1	,, ,,	...	..
12,931	5	2½%	Direct Spanish (£4 paid)	3½ 4	3 10 0	March & September	4	...
6,000	5	5/0	Do. Preference	8½ 9½	4 4 3	April and October	9⅜	...
60,710	20	2/0	Direct United States	8½ 8⅝	4 10 0	Jan., Apr., July, Oct.	8⅝	8½
380,000	10	2/6	Eastern	11⅝ 12	4 12 9	,, ,,	12	11⅞
70,000	10	3/0	Do. 6 per Cent. Preference	14⅝ 15½	3 19 0	,, ,,	15⅛	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅞ 13⅛	5 0 9	Jan., Apr., July, Oct.	13⅛	12⅞
22,050	10	5/9	German Union Telegraph and Trust	9 9½	7 7 4	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	5⅞ 6	5 1 0	Jan., Apr., July, Oct.	6	5⅞
178,992	10	3/0	Do. 6 per Cent. Preference	13⅞ 14⅛	4 5 0	,, ,,	14	13⅝
150,000	10	5%	Great Northern	13½ 14½	5 5 3	Jan., July, and April	14⅛	14
17,000	25	5/0	Indo-European	36 38	6 11 7	April and October	36⅛	...
38,348	10	3%	London Platino Brazilian xd	5⅞ 6½	...	May and November	6	...
9,000	8	4/0	Reuter's	7⅛ 8	5 0 0	April and October	...	...
338,225	Stock	12%	Submarine	140 150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America	5⅝ 6½	8 0 0	January and July	...	...
150,000	100	8%	Do. Debentures	112 117	6 16 2	June and December	...	...
88,321	10	nil.	West India and Panama	7/8 1⅛	...	...	1⅛	1
34,563	10	9/0	Do. 1st Preference xd	10⅛ 11	8 8 9	April and October	11⅛	11⅛
45,181	15	3/9	Western Brazilian	10⅛ 10⅝	6 4 6	March & September	10⅝	10⅝
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 10	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	⅜ ½	5 0 0	Yearly	...	...
220,000	£1	...	Oriental (11s. paid) xd	1/16 1/16	...	...	...	...
80,000	5	5/0	United	14⅜ 15	4 6 8	June and December	15	14⅜
50,000	5	2/6	United River Plate	5 5½	...	April and October	5⅛	5
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb. '86	Anglo-American Brush (£4 paid)	2½ 3	...	...	...	...
23,692	5	nil.	Do. (fully paid)	3½ 4	...	February & August	3/16	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2 2½	...	...	2⅛	2 1/16
312,000	½	5% '86	Maxim-Weston	1/16 1/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	39½ 40½	6 1 0	March and July	...	...
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 3	February & August	17½	17

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2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the duties of the family solicitor.

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For terms, &c., application should be made to the General Manager at the Company's Office.

GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 525.—Vol. XXI. FRIDAY, JUNE 8, 1888. Price 4d.

NOTES.

The discourse on "Influence Machines" delivered by Prof. Silvanus Thompson before the Society of Telegraph-Engineers and Electricians on Thursday evening is an admirable example of the employment of the methods of historical research in the field of science. The learned Doctor bids fair to make this field his own. The historical development of the Telephone, the Mercurial Air-Pump, and the Incandescent Lamp, have each been studied by Prof. Thompson in minute detail; but the subject of the present Paper will possess for many minds a still greater charm in that it lies remote from the province of commercial utilisation and the claims of rival patentees. Seeing, moreover, that the electricians of the last century, both in this country, in Germany, and in Italy, gave so much attention to the problem of accumulation, the Author may be considered fortunate in the selection of the present subject of his researches. But the richness of the mine must, of course, have added enormously to the labour of collecting and arranging the material—of which, indeed, only a very small portion was actually put before the Society on Thursday evening. Everyone must therefore feel the more gratified that Prof. Thompson has already met with a well-deserved reward—and, as he himself would no doubt say, an entirely adequate reward. The discovery of a hitherto unknown drawing of the influence machine devised in 1778 by Erasmus Darwin—a sketch, in all probability made by the inventor himself—is a success of which Prof. Thompson may feel justly proud. No treatise on static electricity ought henceforth to be considered complete without including this sketch and a reference to the recovery, after the oblivion of over a hundred years, of this the earliest attempt to design an influence machine. We trust that Prof. Thompson will continue to devote his leisure time to the history of scientific discovery, and that his researches will be as fruitful in the future as they have been in the past.

We commence this week the publication of a short series of Papers by Mr. G. de Tunzelmann on the so-called "Unipolar Induction" phenomena. We have arranged for these articles because we have good reason to believe that the questions involved will shortly assume a greater practical importance than is the case at present. The subject is one upon which a good deal of misapprehension—or at least difference of opinion—exists among practical men, as was evidenced by a prolonged discussion which took place in our columns last year. Since that date Prof. Edlund has added an elaborate theoretical Paper to his former investigations into these phenomena, and, though his theory is not generally accepted, his last Paper has given rise to a most interesting discussion of the whole subject among Continental physicists. Many of these phenomena are very little known or understood, and we imagine that several which will be discussed in Mr. de Tunzelmann's Papers will be new, and possibly even somewhat surprising, to the majority of our readers.

Lord Thurlow's Bill to amend the Electric Lighting Act of 1882 having now reached the Committee stage in the House of Commons, we may venture to anticipate that it will become law before the expiration of the present session. So far it has attracted very little attention in the Lower House, although its progress has been hampered by an inconsiderate proposal on the part of Sir George Campbell, and by the polite attention of the estimable Mr. Biggar, who took the earliest opportunity to move to report progress. Sir George Campbell's proposal practically amounted to the introduction of free competition in electric lighting. It is not necessary at the present juncture to discuss the general question thus raised, since it is sufficient to reply with Sir Michael Hicks-Beach that the amendment is opposed to the whole scope and purpose of the Bill. It is a great pity that private members should delay the progress of a measure which they evidently have not taken the trouble to understand by proposals of an impracticable character.

The only local inquiry under the existing Electric Lighting Act which the Local Government Board has yet had occasion to hold took place at Bradford last week, and is fully reported in our present issue. When the good people of Bradford learnt that nothing could be done without the official sanction of the Board, and that this would not be granted until an inquiry had been held, some rather strong language was indulged in. But the issue cannot be said to have justified these apprehensions, however well founded they may have been. The inquiry has been held within a very few weeks of the notice being given, and after hearing from the Town Clerk the history of the scheme, the inspector (Major Tulloch) promptly intimated that no objection would be raised on his part to the completion of the undertaking. The Corporation are now applying for powers to raise an additional sum of £5,000 (making £25,000 in all) to cover the cost of the preliminary installation. With Dr. Hopkinson as consulting electrician and Mr. Shoolbred as electrical engineer, the Corporation *ought* to experience

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no serious difficulty in carrying the undertaking to a completely successful issue.

It is, perhaps, a fortunate circumstance that a very excellent example of central station lighting is already in existence at Bradford (for full description of which see *The Electrician*, Jan. 6, 1888, p. 204). The efforts of Messrs. Schmidt, Douglas and Co., although on a much smaller scale than that now contemplated by the Corporation, have already educated the people of Bradford up to the idea of what central station lighting ought to be, and it will be impossible for the Corporation to offer them anything of a less satisfactory character. We thus possess an additional guarantee that no effort will be spared to secure the best possible results. It is only fair to add that Messrs. Schmidt, Douglas and Co. have carried out their work under exceptionally favourable circumstances as regards the area of distribution, and in particular that they have not had to face the problem of underground mains.

On the occasion of the *conversazione* given by the Royal Society on Wednesday evening last, it must be admitted that the devotees of botany, zoology and mineralogy were principally to the fore. Fresh water jelly fish, nests of living ants, and flies sucking sugar under miscroscopes attracted a large share of attention. But electricity cannot be altogether excluded from the field of zoology, a fact which was exemplified by the presence of a very fine specimen of the electric eel *(Gymnotus electricus)*. During the evening several of the guests were induced to test the electrical condition of the *Gymnotus*, with results of an amusing character to the onlookers. The General Post Office contributed a duplicate set of the Delany Sextuplex Telegraph, an instrument which has now been brought to great perfection. Robertson's Writing Telegraph was also again *en évidence*. Profs. Ayrton and Perry showed various novel applications of their magnifying springs, including a vacuum and pressure gauge, an apparatus for measuring the coefficient of expansion by heat, a micrometer, a thermometer, and a portable voltmeter. Perhaps the most interesting of these is the micrometer, which is capable of indicating the one twenty-thousandth of an inch. This instrument was made by Mr. C. Bourne (of the Central Institute). The spring itself has a diameter of only one or two thousandths of an inch, and in appearance it can scarcely be distinguished from a thread of cotton. By permission of Mr. D'Oyly Carte, the United Telephone Company laid on telephonic communication with the Savoy Theatre, and the music of the "Pirates of Penzance" was transmitted with much success. In another room Mr. C. V. Boys exhibited the remarkable experiments with soap bubbles which he has recently devised, and which so beautifully illustrate the laws of surface tension in liquids. The elementary laws of static electricity were also strikingly exemplified in the following way:—Two bubbles resting one against the other are shown to coalesce instantly when the most feebly electrified body is brought near, but when one bubble is blown inside another (a feat which Mr. Boys performs with the greatest ease and certainty) the inner bubble is completely protected by the outer, even from comparatively powerful electrical influence, and so the bubbles remain separate. On the ground floor a series of lantern demonstrations were given by Prof. Ray Lankester, Mr. W. Gardiner and Mr. J. Norman Lockyer, in which the electric lantern supplied by Messrs. Drake and Gorham was brought into use. We need scarcely add, in conclusion, that the *conversazione* was a brilliant success in every sense of the word.

The shareholders of the Swan United Electric Light Company seemed to be quite satisfied with the terms of the provisional agreement with the Paris Edison Company which were laid before them on Tuesday last. By this agreement it is provided that the share capital of the joint company is to be 2,000,000fr., of which 1,000,000fr. will represent in fully-paid shares the value of the combined businesses as going concerns. These shares will be divided between the Edison and Swan Companies in the proportion of three to two respectively. The remaining 1,000,000fr. is to be subscribed in cash by the two companies in the same proportion. The Swan Company has therefore to raise £16,000, and the Edison Company £24,000. The difficulty of arriving at a working arrangement was considerably enhanced by the fact that while the English Company are the sole owners of the Swan patents in Europe, the French Company are paying to Edison a royalty of 20 centimes for each lamp manufactured. Moreover, by the terms of their agreement the royalty was to continue so long as the company existed. A reasonable compromise has, however, been arrived at. The payment of the royalty will now terminate with the expiration of the patents in 1894, but meanwhile it will be paid upon the whole of the new company's manufacture. The agreement does not at present extend to Germany, where litigation has already been in progress between the two companies for some considerable time; but we take it that a compromise is certain to be arrived at in this quarter also, the situation having become too anomalous to last. Meanwhile, it is interesting to know that Messrs. Siemens and Halske are paying the Edison Company a royalty of 37½ centimes upon each lamp manufactured by them. It need hardly be said that the amalgamation is likely to bode no good to those makers of lamps upon the Continent who have hitherto refused to recognise the claims of either of the quondam rivals.

Owing to a sudden strike of the stokers at the Grosvenor Gallery on Sunday evening last a number of buildings in the West End were deprived of light. The Secretary of the Company states that the men left work because a gratuitous meal of roast beef, etc., was served to them cold instead of hot. Anything more insufferable can scarcely be imagined. We most sincerely trust that the London Electric Supply Corporation will find themselves in a position to prosecute the men, and that they may meet with exemplary punishment. When the stokers of the London Gas Company struck work not many years ago—or, at least, threatened to do so—the law was found to be powerful enough to prevent the carrying out of their mischievous designs. It would be an intolerable state of things if electric light enterprise were left at the mercy of men of the stamp of the ex-stokers of the Grosvenor Gallery

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The "Elektrotechnische Zeitschrift."—The *Elektrotechnische Zeitschrift*, which has hitherto appeared monthly, is now being published every fortnight.

Exeter.—The Exeter Electric Light Company have commenced operations at Trew's Weir, on the River Exe, where the central station will be established.

The Use of Electric Light for Sea Fishing.—Some German sea fishermen are making experiments with the electric light for night fishing. So far the results are said to have been highly satisfactory.

Elster's Bunsen Photometer.—The Imperial Technical Society of Russia have decided, on the report of the Expert Committee of the Petroleum and Lighting Exhibition, recently held in St. Petersburg, to award to Herr S. Elster, of Berlin, the Society's medal for his Bunsen photometer, which they have found to be specially valuable in practical working.

Spanish Tender for Telegraphic Cable.—The Madrid *Gazette* has published a notification from the Posts and Telegraphs Department, inviting tenders for the construction and laying of a submarine telegraph cable between Javéa and the Island of Iviza (one of the Balearic Isles). Tenders are invited for June 27th. The maximum estimate is 300,000 pesetas—say £12,000.

Telegraphy Gratis.—Guadalajara, the second town in Mexico, has just been celebrating the opening of the railway between it and the capital. The Local Telegraph Company to mark the event permitted the free use of its wires to all comers. Up to noon this had resulted in the despatch of 1,236 message. As a local paper says, this is certainly "doing the thing handsome."

Alexandria.—The Ministerial Council of Alexandria have approved of the project for lighting the city by the Edison Electric Lighting Company, but only on condition that the contractor will hold himself responsible for all damages that the Egyptian Government might be called upon to pay to the Gas Company, should the latter deem it advisable to take legal proceedings against them.

"Electrical Plant."—Commenting on its first anniversary, our contemporary *Electrical Plant* expresses itself entirely satisfied with the support it has received, which it regards as evidence of a rapidly increasing interest in electrical subjects treated from a popular standpoint, as well as of a growing demand for electrical plant. We trust that these anticipations may be realised.

The Copper Market.—According to Messrs. Merton and Co.'s copper statistics the deliveries in France and England had slightly increased this month, being 6,044 tons, compared with 5,877 tons in April and 4,489 tons in March. In the month of May, 1887, the deliveries were as much as 10,065 tons. On Wednesday there was a marked fall in copper shares, which continued yesterday, but prices of metal are still maintained.

The Van Rysselberghe System in Holland.—The *Journal de Gand* says that the trial of the Van Rysselberghe system, commenced some two years ago by the Dutch Government, has yielded unfavourable results. The authorities are going to abandon the system of simultaneous telegraphy and telephony, and have granted a concession to the Bell Company. Amsterdam and Rotterdam are to be united by a special telephone wire.

New Books.—Messrs. Macmillan and Co. will shortly publish a work on "The Theory and Practice of Absolute Measurements in Electricity and Magnetism," by Professor A. Gray, in two volumes. The first volume is just ready. It contains a sketch of the theory of electrostatics and flow of electricity, chapters on units, general physical measurements, electrometers comparison of capacities, &c. The second volume, dealing with magnetic theory, electric energy, etc, will follow soon.

Electricity in the Spanish Navy.—Major Cabanyes, of the Spanish army, is building a submarine torpedo boat, driven by electricity. The plant consists of a 60 horse-power motor, by Brown, of Oerlikon, and a battery of 60 accumulators. These accumulators are on a new pattern, and profound secrecy is maintained as to their construction. A very high capacity is claimed for them, and some trials recently made before the Spanish Government authorities gave great satisfaction.

Huddersfield.—At a meeting of the Huddersfield Chamber of Commerce, held a few days since, Mr. Crosland drew the attention of the council to the steps which are being taken in Bradford to light the town with electricity, and asked whether it would not be as well to suggest to the Town Council that they should take similar steps in Huddersfield.—Mr. Walker thought this matter was clearly beyond their province, and, after a desultory conversation, the subject was allowed to drop.

Bohemia.—For some little time the town of Neuhaus in Bohemia has possessed a central lighting station erected by Count Czernin, the chief landowner in the neighbourhood. The municipal authorities have signed a 20 years' contract for 85 16 candle-power incandescent lamps for street lighting purposes, while 365 lamps are used by private consumers, the demand in this direction being greatly on the increase. The plant comprises two dynamos driven by a turbine, and 1,000 accumulator cells.

The Lighting of the Prudential Assurance Company's Offices.—Messrs. Drake and Gorham have recently received instructions to put down a third engine and fourth boiler, as well as additional dynamo power, at the Prudential Assurance Company's offices in Holborn. The dynamos will be of Messrs. Crompton's make, as are the machines already in use. The accumulator arrangements are being modified throughout, in accordance with recent practice, and 264 of Messrs. Drake and Gorham's cells will be used in conjunction with the new plant. The total number of lamps will amount to 2,300.

Telegraphs in the Highlands.—The Telegraphs of the Highland Railway Company are being rapidly put in very substantial order on the inverted V principle. A fine specimen of a telegraph line, says *Engineering*, has recently been constructed between Inverness and Culloden, under the superintendence of Mr. Gilbert. The system is an excellent one, and the mode of construction appears to be specially suited for the country through which the Highland line passes. It has successfully withstood the severe gales and snowstorms of the past winter at such exposed points as Dava and Dalnaspidal—communication on either the Government or railway wires having in no way been interrupted.

The Electrification of Vapour.—Prof. J. L. Soret, of Geneva, has devised a pretty experiment showing the effect of electricity on collected dust and condensing vapours. He places in a darkened room a platinum crucible containing water, which is supported on a metallic stand connected with one pole of an induction machine. Above the crucible is placed a platinum point connected with the other pole. The water is caused to boil by the use of a Bunsen burner, and the whole is strongly illuminated by the beam of a powerful electric lamp. When the induction machine is not being worked the water vapour rises and is condensed in the ordi-

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nary way, but on setting the machine at work and lowering the point near the surface of the liquid no vapour appears, though the water may be boiling briskly.

The Schmelzer Carbon Factory.—A correspondent writes as follows:—One of the most important carbon factories is Mr. Ch. Schmelzer's at Nuremburg, established in 1884. Since its commencement the undertaking has been remarkably prosperous, and at present about 75 workpeople are employed. After many costly experiments, Mr. Schmelzer has succeeded in constructing most efficient pressing machines, especially hydraulic pressing machines, working with a normal pressure of 600 atmospheres, and the machines now in operation are capable of producing 25,000 meters of carbon-rods per day. Two generators furnish the gas for two furnaces, which comprise about 30 cubic metres available space in 40 compartments. The factory is lighted by 20 arc lamps, fed by a Schuckert dynamo.

Long-Distance Telephony in Sweden.—A correspondent writes as follows:—"The Swedish Government has commissioned the State Telegraphs to build a telephone line between Stockholm and Gothenburg, *vid* Orebro and Mariestad. The cost of the present line is put at 420kr. per kilometre, and as the line is 530 kilometres long, the total cost will be 222,600kr. This calculation is based upon a double line of copper wire of at least 3 millimetres diameter, and a single copper line will also be erected on the same poles, principally for use between intermediate stations. The fact of the Swedish Government going in for the Stockholm-Gothenburg line itself is of course synonymous with a refusal of the Stockholm General Telegraph Company's application for permission to erect a similar line, although the decree in question does not say so."

The Phonozenograph.—The Duc de Feltre has designed an instrument, which he calls a phonozenograph, intended to indicate the direction of any distant sound. A microphonic plate of peculiar construction is fixed in a vertical plane, and is in circuit with a battery and a telephone receiver, or a Deprez-D'Arsonval galvanometer and a Wheatstone bridge. The microphone is more or less affected by a distant sound, according to the angle that it makes with the source. By moving the plate about until the maximum effect is obtained the observer is enabled to exactly locate the direction of the sound. The indications of the telephone receiver are absolutely accurate, but those afforded by the galvanometer are less so, and this latter arrangement will require great modification of the microphonic plate before it can be said to be of a practical nature. This instrument may possibly prove of use at sea in preventing collisions in foggy weather.

The Telephone Market.—The monthly circular of a firm of stockbrokers which devotes special attention to the telephones says:—"Telephones have been a quiet market, and prices close flat. The negotiations for the amalgamation of the various interests hang fire. The radical vice which has characterised all the operations of the United Telephone Company since its formation, namely, endless procrastination and discussion in place of action, is no doubt the cause. The shareholders of this company having received good dividends seem quite content to remain ignorant of, or to ignore, the shortcomings of their directors. But for the happy accident that subsidiary companies were formed, whereby the management in certain districts was transferred to abler hands, the United Company's dividends would have been small. The company, in fact, is to-day successful, not owing to the exertions of its management, but really in spite of the fact that its best interests have been neglected, and its most important field of operations left practically unworked."

Electric Traction in Australia.—A recent number of the *Melbourne Age* contains the following telegram:—"It is considered likely that the Sandhurst and Eaglehawk councils will very shortly decide upon the construction of tramways upon the electric-motor principle. The councils, as a result of their inquiries, seem pretty well convinced as to the advantages of this system. A letter has been received from Messrs. Booth, Ellson and Co., the agents for an electric system, offering to form a syndicate to construct and work the tramways. They make a preliminary offer of £100 per annum for the right, and one-third of the profits over 8 per cent. A conference on the subject with the firm will be held on Monday." Sandhurst is one of the most important towns in the immediate neighbourhood of Melbourne, and any successful scheme introduced there is likely to meet with rapid extension. The same paper contains a leading article in which the advantages of electric traction are spoken of with the greatest enthusiasm. We trust that Messrs. Booth, Ellson and Co. will succeed in their efforts.

Capital Punishment by Electricity.—The Governor of the State of New York has signed the Bill presented by the Legislature, which substitutes death by electricity for hanging as the mode of capital punishment. The new law originated with the following recommendation by the Governor in 1885:—"The present mode of executing criminals, by hanging, has come down to us from the dark ages, and it may well be questioned whether the science of the present day cannot provide means for taking the lives of such as are condemned to die in a less barbarous manner. I commend this suggestion to the consideration of the Legislature." In 1886 a Commission was appointed by the Legislature to investigate and report upon the most humane and practical method of carrying into effect the sentence of death in capital cases, and the present change is the final outcome of the report of this Commission. The new law will come into operation in January, 1889. We have already expressed our own views on the subject, and trust it will be a very long time before electricity is called upon to do the hangman's work in this country.

Safety Signal Apparatus by Siemens and Halske.—An interesting description has lately been given by Herr Frischen, at the Polytechnic Society in Berlin, of a signalling and stop-motion apparatus for preventing accidents with steam machinery in large factories, constructed by Messrs. Siemens and Halske. Since in Germany the law has insisted that arrangements are to be made in factories for stopping machinery as quickly as possible at will, and that a clear signal is to be given every time before applying the steam power, considerable attention has been devoted by engineers to ascertaining how these requirements may best be fulfilled. Messrs. Siemens and Halske have introduced an electrical apparatus which is entirely automatic. The arrangement is extremely simple. An electric bell circuit is taken through all the rooms in the factory, including the engine room. The bells are rung by clockwork mechanism, which is held in check by a current which is kept continuously in the circuit. Every room is provided with a switch for breaking the circuit, which, of course, sets all the bells ringing. The starting or stopping of the engine is also made to do the same thing automatically.

The Vagaries of Lightning.—In *The Times* of Saturday last Mr. C. Tomlinson offers the following explanation of one of the many vagaries of lightning. He says:—"If it be granted that animals are more liable to the attacks of lightning than human

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beings, have we any explanation of the fact, if fact it be? When Snow Harris was planning his system of lightning conductors for the then recently completed Houses of Parliament, he explained to me the necessity of strongly protecting the ventilating shaft of the House of Commons. As a coke fire is usually kept burning in this shaft for the purpose of maintaining a ventilating force, a column of warm rarefied air ascends from this shaft to a considerable height, and would probably act as a line of least resistance, and so determine the course of a stroke of lightning. So, also, a flock of sheep huddled together during a storm would produce a similar column of warm rarefied air. Thus to mention one case out of a thousand, on the 17th of August, 1858, at Sacco, in the kingdom of Naples, out of a flock of 140 sheep the lightning killed 120; but the shepherd was not touched, and the shepherd boy escaped; but this puzzling fact is added—a kid which the boy held in his arms was killed. But for this, I should be disposed, to explain the recent case mentioned by Mr. Dudgeon on the above ground; the horses just taken from the plough were very warm, and sent up a steamy, rarefied air which acted as a line of least resistance to the disruptive discharge. The man probably did not share in this rarefied air, and so escaped from the lightning, only to be injured by the fall of the horse."

Fatal Accidents to Electric Light Linemen in Halifax, N.S.—The papers on this subject kindly sent us by Captain H E. Rawson, R.E., but which failed to come to hand, have been supplied us by Mr. Stepney Rawson, and we are now able to supplement our account of last week. From Captain Rawson's exhaustive evidence before the coroner's jury, which was fully corroborated by independent witnesses, it seems plain that the two fatal accidents which took place within forty-eight hours were entirely due to preventible causes. The lamps in use are Ball arc lamps, one terminal of which is insulated from the frame, while the other is part and parcel of it. The leads were of the wretched "underwriter's" type, and only 9in. apart. The pole at which the accident took place was the third from the dynamo, and owing to its position the whole of the wires leading to and from it are stretched parallel to one another. The circuit contained 75 lamps in series. On examining the lamp, Captain Rawson found that the + pole was in connection with the frame through the charred coils of the lifting magnet, and also (if they were at all damp) through the four strands of small manila rope fixing the carbon frame to the standards on either side. The wires were bare in several places, and in addition Captain Rawson found that a very small amount of moisture destroyed their insulation. In order to get at the lamp, the man must have sat upon the return wire, and on touching the lamp frame, got the full current through his body. The jury returned a verdict to the effect that Crocker's death was the result of accident, censuring the Chandler Electric Light Company for not taking precautions to prevent further fatalities on the lamp on which Webber had lost his life the day before, and making a number of recommendations.

The Electric Lighting of Spanish Theatres.—It appears that difficulties have arisen in carrying out the recent Royal decree issued by the Minister of the Interior, ordering the compulsory lighting of Spanish theatres by electricity. The Comedy Theatre of Madrid recently put up an installation and introduced the electric light, but objection was taken by an inhabitant living in the vicinity on the ground, it is asserted, that the noise caused by the motor was a public nuisance. The various accounts in the different Spanish papers are somewhat contradictory; but it would appear that on the objection being made the matter was laid before the civil authorities, and before the Theatrical Board in Madrid, both of which bodies, after examining the matter, reported the installation to have been erected in complete conformity with the regulations laid down in the Royal decree referred to, and this decision was given after the installation had been inspected by the municipal architect. It would appear, however, that the aggrieved ratepayer has taken the matter into the courts, and that the judge has forbidden the Comedy Theatre to use the electric light, and has placed a man in charge of the motor to see that his instructions are carried out. The lighting of the theatre with the electric light has therefore been suspended, and, as the theatre is not supplied with gas, the managers have had to resort to candles. The Madrid paper, *El Imparcial*, in calling attention to the subject, refuses to question the right of the judicial decision, but asks how can the exigencies of the Government authorities be harmonised with the decision of the Courts? And further, in what position will the companies be in September next, by which date the use of the electric light in theatres will be compulsory. It is to be hoped, in the interests of the electric companies and theatre goers alike in Madrid that the views of the authorities in interpreting the conditions of the Royal decree and the decisions of the Court should be settled without delay, especially in view of the compulsory nature of the Government requirements in this matter.

The Australian Association for the Advancement of Science. In November, 1886, chiefly owing to the exertions of Prof. Liversidge, a preliminary meeting of delegates representing nearly all the scientific and learned societies throughout the Australasian colonies took place in Sydney, the object of the meeting being the formation of an association on the same lines as the British Association for the Advancement of Science. The outcome was the formation of the Australasian Association for the Advancement of Science. It was also decided that the election of officers should be held in Sydney, in March, 1888, and that the first general meeting of the association should take place in Sydney during the first week in September, 1888, it being considered fitting that the association should be publicly inaugurated during the centennial year. A meeting of the local council was held on the 7th of March, and the following gentlemen were appointed:—Mr. H. C. Russell, B.A., F.R.S., president; Prof. Liversidge, M.A., F.R.S., and Dr. George Bennett, F.L.S., honorary secretaries; Sir Edward Strickland, K.C.B., honorary treasurer. The objects of the association are:—To give a stronger impulse and a more systematic direction to scientific inquiry; to promote the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers; to obtain a more general attention to the objects of science, and a removal of any disadvantages of a public kind which impede its progress. The rules of the association are practically the same as those of the British Association. As in the case of the British Association, a local committee is to be appointed in the place of meeting, to make arrangements for the reception and entertainment of the visitors, and to make preparations for the business of the general meetings. Sectional committees are to be appointed for the following subjects:—Section A, astronomy, mathematics, physics, and mechanics; section B, chemistry and mineralogy; section C, geology and palæontology; section D, biology; section E, geography; section F, economic and social science and statistics; section G, anthropology; section H, medical and sanitary science; section I, literature and the fine arts; section J, architecture and

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engineering. It will be seen that the Australasian Association proposes to cover a rather wider ground than its prototype, as it will embrace literature and art as well as science.

The Institution of Civil Engineers.—The annual general meeting—to receive and deliberate upon the report of the Council on the state of the institution, with the annual statement of the accounts, and to elect the council and officers for the ensuing year—was held on Tuesday, the 29th of May, Mr. George B. Bruce, president, in the chair. The report stated that during the twelve months ended the 31st of March, 1888, there had been an addition to the roll of 49 members and of 183 associate members, the number of non-corporate associates being reduced by 23. The increase had been 4·6 per cent. per annum, as compared with 4·19 per cent. for the previous twelve months. The students had increased by 25. At the date named there were on the books 1,617 members, 2,458 associate members, 461 associates, 20 honorary members, and 974 students—together 5,530. The receipts on account of income during the twelve months under review were £16,071. 12s. 2d.; on account of capital, £4,248. 11s. 2d.; and from trust funds, £433. 15s. 1d. The general expenditure had amounted to £13,956. 10s. 10d., of which more than one moiety constituted the cost of the publications. A sum of £6,476. 18s. 9d. had been invested in the purchase of £5,000 London and North-Western Railway Four per Cent. Debenture Stock, and the outlay on account of trust funds amounted to £476. 6s. 11d. These figures constituted the ordinary receipts and disbursements. Owing, however, to the purchase of No. 24, Great George-street, it had been necessary to sell railway debenture stocks of the nominal value of £9,000, and to transfer from the yearly receipts a sum of £4,617. 11s. 3d., to meet this outlay. The Papers read at the ordinary meetings had been of more than usual interest, and had given rise to animated discussions and to much correspondence. For some of the Papers the Council had awarded Medals and Premiums to Messrs. R. A. Hadfield, P. W. Willans, Dr. Edward Hopkinson, Messrs. E. B. Ellington, Josiah Pierce, jun., Sir Bradford Leslie, K.C.I.E.; and the Manby Premium to the late Mr. Hamilton Goodall. For Papers printed in the *Proceedings* without being discussed a Watt Medal and a Telford Premium had been awarded to Prof. Dwelshauvers-Déry, and Telford Premiums to Messrs. W. M. Thompson, J. W. Wyatt, and D. Drummond. Advantage had been taken of the increased accommodation to hold exhibitions of models, appliances, instruments, and specimens in connection with some of the subjects which came under discussion, viz.:—"Accidents in Mines," "Manganese Steel," and the "Use of the Plane-Table in Topographical Surveying." The success of these exhibitions had formed a most acceptable feature of the Tuesday evening meetings of last session, and it was hoped that they might be repeated and further developed as opportunity occurred. The ballot for council resulted in the election of Mr. G. B. Bruce as president; of Sir John Coode, Mr. G. Berkley, Mr. H. Hayter, and Mr. A. Giles, M.P., as vice-presidents; and of Mr. W. Anderson, Mr. B. Baker, Mr. J. W. Barry, Sir Henry Bessemer, F.R.S.; Mr. E. A. Cowper, Sir James N. Douglass, F.R.S.; Sir Douglas Fox, Mr. C. Hawksley, Mr. J. Mansergh, Mr. W. H. Preece, F.R.S.; Sir Robert Rawlinson, K.C.B.; Sir E. J. Reed, K.C.B., F.R.S., M.P.; Mr. W. Shelford, Mr. F. C. Stileman, and Sir William Thomson, F.R.S., as other members of the council. The session was then adjourned until the second Tuesday in November, at 8 p.m.

The Eastbourne Central Station: Visit of the Cheltenham Town Council.—A few days ago the members of the Electric Lighting Committee of the Cheltenham Town Council paid a visit to Eastbourne to see the electric light in operation there, and to inspect the plant laid down for its supply. The following report from the *Cheltenham Mercury* will be of interest: "The consideration which chiefly guided the committee to the selection of Eastbourne was that the installation in that town had been established under conditions as dissimilar from those existing at Taunton as any they could find, and offered an opportunity of comparing two fairly successful examples of different systems of lighting. The installation at Eastbourne was originally made about six years ago by the Anglo-American Brush Electric Light Corporation, but it has for some time passed into the hands of the Eastbourne Electric Lighting Company, and by this company extensive alterations and improvements have been carried out. The works are in the centre of the town, and are located in premises much more commodious than those at Taunton. The machinery also is more powerful, the dynamos being driven by a fine engine of 200 horse-power. In addition to the Brush dynamos originally used, three of newer construction have lately been laid down, and the machinery appears to now be equal to any demands likely to be made upon it for some time to come. Both arc and incandescent lights are maintained, the former for street lighting and the latter for internal illumination. Of public arc lamps there are 21, confined to the sea-front or parades, and extending about 2,000 yards. Of incandescent lights about 1,500 are supplied, and the public buildings lighted include the Town Hall, market, and two churches. In contrast to the plan at Taunton, all wires are conveyed underground in 3in. iron pipes, and some unsightliness is thereby avoided, though at an increase in the original cost. The underground service appears to be carried on with perfect efficiency, and certainly with none of the drawbacks experienced at Leamington, and there often attributed to the difficulty of underground insulation. The arc lamps are still run from the Brush dynamos, but the incandescent lamps are fed from the dynamos on the alternating current system, with transformers, for which it is claimed that unvarying steadiness and perfect control are thereby secured. The current is governed by an automatic regulator, delicate and beautiful in its operation, and a peculiarity of the Lowrie-Hall system. The quality of the light produced, so far as the incandescent lamp is concerned, can be spoken of with unqualified praise. The arc lights, though more powerful than those at Taunton, do not at present compare favourably with them, the carbons being apparently of lower quality, and the lanterns comparatively ill-cared for. This is avowedly due to the low cost at which they are supplied. The present charge is £20 per lamp per annum, but the Corporation are about to increase the payment to £30 per lamp in return for an increase of power and efficiency which there will be no difficulty in ensuring with the improved appliances of the Lighting Company. The cost of lighting the area over which the lamps extend is necessarily larger than formerly by gas, but the amount of light given is about twenty times that of the former illuminant. The light is supplied to the private consumers by meter, at the rate of 1s. per standard, and each light being equal to 16 c-p. The present manager of the Eastbourne works is Mr. H. J. Harris, by whom the visitors from Cheltenham were received with the greatest courtesy. Before returning to Cheltenham, one portion of the deputation took the opportunity of visiting Hastings to see the electric light in operation there, and had reason to be pleased with the inspection, while a second party accepted an invitation to inspect the extensive works of the Brush Company at Lambeth."

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UNIPOLAR INDUCTION.—I.

BY G. W. DE TUNZELMANN, B.SC.

If a magnetic pole in the neighbourhood of a conductor is made to vary in intensity, or if its position relative to the conductor is changed, then it is well known that an E.M.F. is produced in the conductor. Electric currents arising in this way are said to be due to magneto-electric induction; but, as was first observed by Faraday, electric currents may be produced in a conductor by means of a magnetic pole without either variation in its strength or in its position relative to the

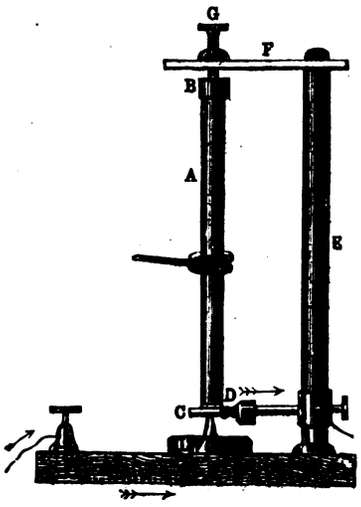

FIG. 1.

A, magnet; B, cap containing mercury; C, copper disc; D, tinfoil pad for rubbing contact; E, metallic pillar; F, horizontal metallic arm; G, metal pivot in electrical contact with F; L, metal pivot.

conductor. The name of unipolar induction is generally used to denote the production of electric currents under these circumstances. The term is a misleading one; but it has unfortunately come into general use.

In his second series of "Experimental Researches in Electricity," No. 217, Faraday points out that several of his experiments on terrestrial magneto-electric induction show that it is

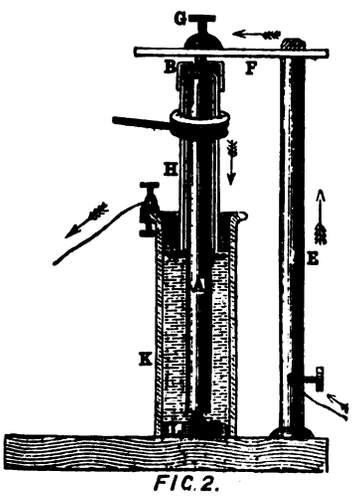

FIG. 2.

A, magnet; B, cap containing mercury; C, copper disc; D, tinfoil pad for rubbing contact; E, metallic pillar; F, horizontal metallic arm; G, metal pivot in electrical contact with F; L, metal pivot; H, copper cylinder separated from magnet by intervening paper; K, metallic vessel containing mercury.

not necessary for the production of a current that the moving conductor should, in cutting the lines of force of the terrestrial magnetic field, pass into positions of greater or less magnetic force; for example, the currents produced in a copper plate or sphere rotating in the earth's magnetic field, or in a wire moving across the earth's lines of force ("Experimental Researches," Ser. II., Nos. 149, 161, 171), were all produced in a practically uniform field.

These considerations led Faraday to attempt to obtain similar phenomena by means of an ordinary magnet, and the details of his experiments, made in 1832, are described in his second series of "Experimental Researches," Nos. 218 to 230: his later researches in the same subject, in 1851, are given in the twenty-eighth series, Nos. 3,084 to 3,122. The discovery of what is now known as Unipolar Induction was due, then, to Faraday, and though he did not give any special name to the group of phenomena, his researches form the basis of all subsequent work. We shall therefore begin by following pretty closely his series of experiments, though using somewhat more convenient arrangements.

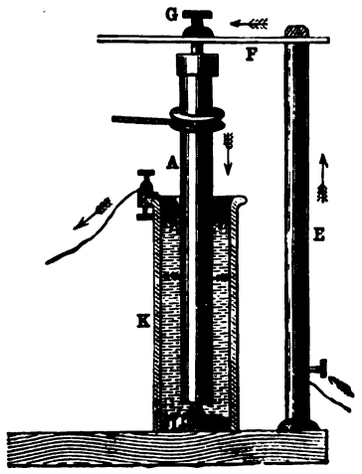

FIG. 3.

A, magnet; B, cap containing mercury; C, copper disc; D, tinfoil pad for rubbing contact; E, metallic pillar; F, horizontal metallic arm; G, metal pivot in electrical contact with F; L, metal pivot; H, copper cylinder separated from magnet by intervening paper; K, metallic vessel containing mercury.

A copper disc is cemented to the end of a cylindrical bar magnet, being insulated from it by an intervening sheet of paper. The magnet is then inserted tightly into a grooved wooden pulley, and its free end is provided with an open cylindrical cap to hold mercury for the purpose of making better contact.

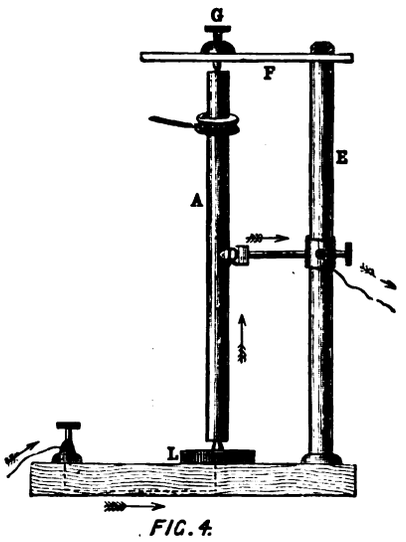

FIG. 4.

A, magnet; B, cap containing mercury; C, copper disc; D, tinfoil pad for rubbing contact; E, metallic pillar; F, horizontal metallic arm; G, metal pivot in electrical contact with F; L, metal pivot; H, copper cylinder separated from magnet by intervening paper; K, metallic vessel containing mercury.

Small holes are then made in the centres of the free end and of the copper disc, and the magnet is then pivoted, as shown in Fig. 1, to allow of its being set in rotation. A collector, consisting of a pad of tin foil, is made to press against the periphery of the disc, and wires are led from the rubber and from the lower pivot to a galvanometer. When the magnet is made to rotate a continuous current is produced through the galvanometer, which increases in strength with the speed of

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rotation, and changes its direction when the direction of rotation is reversed. The current is also reversed when the polarity of the end in contact with the disc is reversed.

These phenomena are exactly similar to those which would be observed if the magnet were fixed and the disc alone were made to rotate, and show that, as in this case, a radial E.M.F. is produced in the disc. If the disc is fixed and the magnet made to rotate no current is observed.

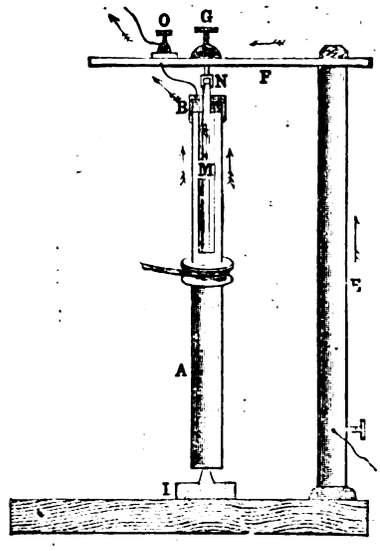

FIG. 5.

A, magnet; B, cap containing mercury; C, copper disc; D, tinfoil pad for rubbing contact; E, metallic pillar; F, horizontal metallic arm; G, metal pivot in electrical contact with F; L, metal pivot; H, copper cylinder separated from magnet by intervening paper; K, metallic vessel containing mercury; M, copper rod; N, cap containing mercury; O, binding screw insulated from the arm F.

An arrangement giving somewhat stronger currents, owing to there being better contact, is shown in Fig. 2. The lower pivot is here surrounded by a hollow cylinder, open at both ends, which fits tightly over the cylindrical base of the pivot, and the upper half of the magnet is enclosed in a copper

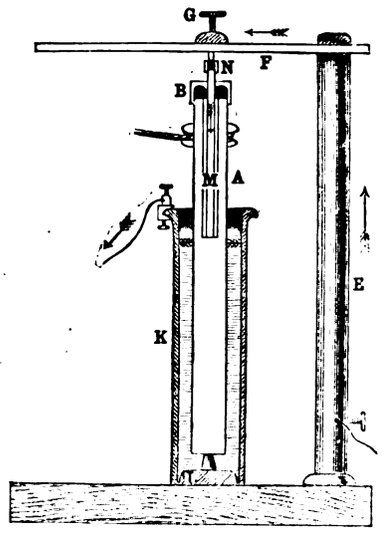

FIG. 6.

A, magnet; B, cap containing mercury; C, copper disc; D, tinfoil pad for rubbing contact; E, metallic pillar; F, horizontal metallic arm; G, metal pivot in electrical contact with F; L, metal pivot; H, copper cylinder separated from magnet by intervening paper; K, metallic vessel containing mercury; M, copper rod; N, cap containing mercury; O, binding screw insulated from the arm F.

cylinder closed at one end, and insulated from it by means of paper. The closed end of the cylinder is provided with an open cap containing mercury.

These experiments naturally suggest that the same phenomena would be observed with the magnet alone without the intervention of either cylinder or disc, and this is found to be the case. Fig. 3 shows the arrangement adopted. In the two latter forms of the experiments it is found that with a given speed of rotation the current is strongest when the surface of the mercury is at the centre of the length of the magnet, and falls almost to zero when the mercury only just covers the end of the magnet, or when the magnet is almost completely immersed.

Exactly similar phenomena may be observed without the use of mercury with the arrangement shown in Fig. 4, where a rubbing contact is used, as in the first experiments.

Here again we find, as we should expect from the preceding experiment, that the strongest currents are obtained when the rubber is in contact with the central portion of the magnet.

In order to show that the E.M.F. is entirely radial and not such as to produce a current down the axis of the magnet and up the external portions, or *vice versâ*, Faraday devised a most ingenious arrangement, shown in Fig. 5.

The central portion of one end of the magnet is bored out, the hollow extending nearly to its centre. A copper rod is then inserted into the hole thus formed and allowed to project beyond the magnet, from which it is insulated by a layer of paper. The free end of this rod and the hollow end of the magnet are both provided with caps to hold mercury. The magnet may conveniently be mounted as shown in Fig. 5. The axial contact is made by means of the upper pivot, and the other one by means of the bent wire shown in the figure, dipping

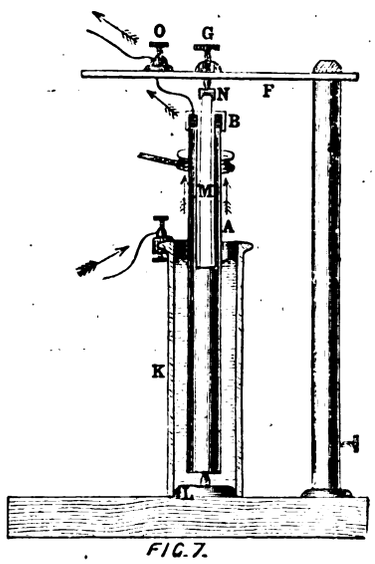

FIG. 7.

A, magnet; B, cap containing mercury; C, copper disc; D, tinfoil pad for rubbing contact; E, metallic pillar; F, horizontal metallic arm; G, metal pivot in electrical contact with F; L, metal pivot; H, copper cylinder separated from magnet by intervening paper; K, metallic vessel containing mercury; M, copper rod; N, cap containing mercury; O, binding screw insulated from the arm F

into the mercury contained in the cap attached to the magnet. This wire and the binding screw to which it is attached must, of course, be insulated from the portion of the metallic framework which supports it. When the magnet is rotated the current must pass down the copper rod and up the outer portions of the magnet, as indicated by the arrows.

The bent wire is now removed, and the lower half of the magnet is immersed in mercury, as shown in Fig. 6. If the magnet is now rotated in the same direction as before, a current is produced which is also in the same direction, but stronger, though the upper half of the magnet is entirely out of the circuit.

The bent wire is now replaced in its former position, but the other contact is made by means of mercury surrounding the lower half of the magnet, as shown in Fig. 7, so that the copper rod is now entirely out of the circuit. The current is still found to be in the same direction, and as strong as in the last experiment. We see, therefore, that the E.M.F. is entirely in a direction perpendicular to the axis of the magnet.

In the experiments hitherto described a cylindrical magnet has one end of its axis and the equatorial portion of its curved surface respectively in contact with the ends of a

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fixed metallic circuit. Fig. 8 shows a form of apparatus in which the magnet may be made to revolve, while the metallic circuit remains fixed as before, or the circuit may be made to revolve while the magnet remains fixed, or the magnet and circuit may be fixed relatively to each other, and be made to revolve together.

A copper disc, g, is rigidly attached to a metallic axis mounted in such a way as to allow of its being made to rotate. Two equal magnets, N S, are fixed with similar poles in the same direction, parallel to this axis, equidistant from it, and on the same diameter. The axis of rotation may therefore be considered as the axis of the compound magnet so formed.

The axis passes through a collar, h, of hard wood covered with brass, and also carries a pulley rigidly fixed to the collar. The collar can be rigidly attached to the axis by means of the screw f, which does not place the collar and the axis in metallic connection. Rubbing contact can be made at l, m, n, and h, by tinfoil pads carried on brass strips, and a similar pad can be attached to the collar by the screw e, and make rubbing contact at g, as shown in the figure. We will, in the first place, remove the strip $e\,g$, screw up the collar to the axis and the pulley, and set the apparatus in rotation. If the terminals of a galvanometer are now attached either to b and c or to b and a, a current will be observed, increasing in strength with the speed of rotation, and its direction will be reversed if the direction of rotation is reversed, or if this remains the same and the two magnets are reversed. If the galvanometer terminals are attached to a and c no current will be observed. Now remove the rubbers m and n, unscrew the collar from the axis and screw on the brass strip $e\,g$, connect a and d with the terminals of a galvanometer, and fix the axis to the bearings (by means of a screw not seen in the figure) so that it cannot revolve with the collar. If the collar is now made to revolve a current will be produced the same in direction and strength as if the axis carrying the magnets had been made to revolve with the same speed in the opposite direction. If we now loosen the screw which fixes the axis, and screw the collar to the axis, so that the strip $e\,g$ and the magnets rotate together without any change in their relative positions, we shall not be able to obtain any current on connecting the galvanometer terminals with a and d as before.

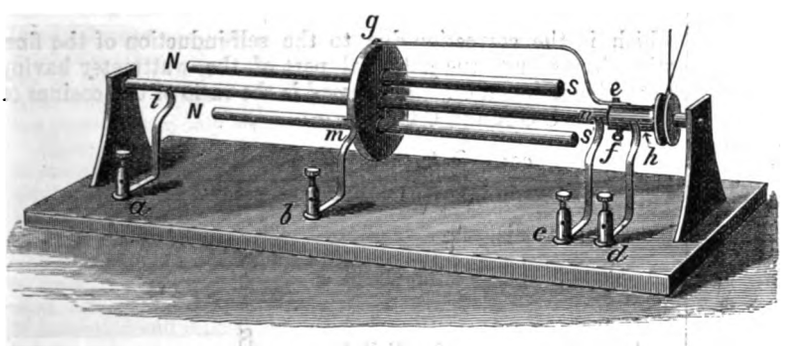

FIG. 8.

The results of these last three experiments confirm the conclusion previously arrived at, that the E.M.F. is entirely at right angles to the axis of the magnet, and in addition they appear to prove decisively that the current is due entirely to the motion of the magnet relatively to the rest of the conducting circuit, so that the lines of force due to the magnet must be considered to be rotating with it.

(To be continued.)

Bank of England.—Owing to the successful working of the 500-light extension at the Bank of England, the directors have decided to adopt the electric light for the new branch bank which is being built at the Law Courts. Messrs. Drake and Gorham are fixing a nine horse-power gas engine, and a twelve-unit Elwell-Parker dynamo of the latest type for this work.

NOTES ON ALTERNATE CURRENTS.

BY J. A. FLEMING, M.A., D.SC.

(Continued from page 75.)

The action of these two causes of error may be illustrated and explained best by the geometric method.

Describe a circle with centre O (Fig. 39), and take any line O A to represent the maximum value of the potential difference between the two points M M′ of the divided circuit, of which R is the resistance of the inductive circuit consisting

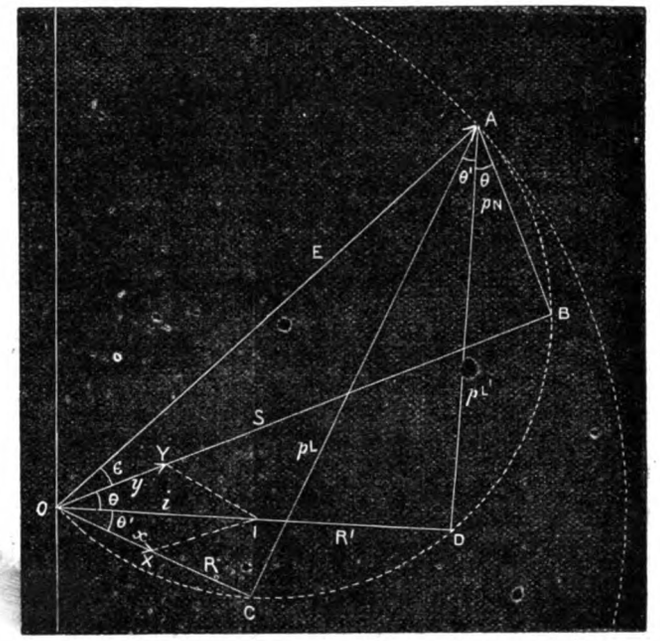

FIG. 39.

of the thick wire of the watmetter in series with the circuit in which the *power* is being measured, and S that of the fine wire of the wattmeter. Then, as before, the vertical projections of O A as it revolves represent the periodic variation of this potential difference. On O A describe a semi-circle, and set off on O A as a base two right angle triangles O C A, O B A, of which the sides O B, B A, and O C, C A are in the ratio respectively of the ohmic to the inductive resistances of these circuits. Otherwise the angle A O B is one whose tangent is p times the time-constant of the S circuit, and A O C is one whose tangent is p times the time constant of the R circuit. Take one Sth portion of O B, and set off O Y equal to it, then, as on p. 504, Vol. XX., O Y represents the maximum value of the current in the S circuit.

Similarly, set off O X equal to one Rth part of O C, and O X represents the maximum current in R. On O X, O Y, describe a parallelogram O Y I, and draw the diagonal O I, and produce it to O D. Then O I represents the maximum current just before division on the main currents. Join A D, A D and O D will represent the compound or equivalent inductive and ohmic resistance of the two circuits R and S in parallel.

To prove this last proposition, we must refer again to the paper by Lord Rayleigh on "Forced Harmonic Oscillation of Various Periods" (*Phil. Mag.*, 1886).

If R′ represents the equivalent resistance of a number of resistances joined in parallel between two points, and L′ represent the equivalent inductance of the system, then it is shown in this paper that

$$R' = \frac{A}{A^2 + p^2 B^2} \text{ and } L' = \frac{B}{A^2 + p^2 B^2},$$

where

$$A = \Sigma \frac{R}{R^2 + p^2 L^2},$$

and

$$B = \Sigma \frac{L}{R^2 + p^2 L^2}$$

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R and L being the resistance and inductance of any branch, and mutual inductance being zero.

Apply this theorem to the case under consideration of the two inductive resistances (R, L) (S, N) in parallel, we have

$$A = \frac{R}{R^2 + p^2 L^2} + \frac{S}{S^2 + p^2 N^2}$$

$$B = \frac{L}{R^2 + p^2 L^2} + \frac{N}{S^2 + p^2 N^2}.$$

Effecting the multiplication we have

$$A = \frac{R(S^2 + p^2 N^2) + S(R^2 + p^2 N^2)}{(S^2 + p^2 N^2)(R^2 + p^2 L^2)}$$

$$B = \frac{L(S^2 + p^2 N^2) + N(R^2 + p^2 L^2)}{(S^2 + p^2 N^2)(R^2 + p^2 L^2}$$

and $$R' = \frac{A}{A^2 + p^2 B^2} = \frac{R(S^2 + p^2 N^2) + S(R^2 + p^2 L^2)}{(R+S)^2 + p^2 (L+N)^2}$$

$$L' = \frac{B}{A^2 + p^2 B^2} = \frac{L(S^2 + p^2 N^2) + N(R^2 + p^2 L^2)}{(R+S)^2 + p^2 (L+N)^2}.$$

Turning back to Fig. 39 we see from the geometry of it that if the angle B O D is as before called θ that B O D = D A B.

Hence $$\frac{OD}{\cos\theta} = S - p N \tan\theta,$$

since A B = p N and O B = S by construction,

therefore $$OD = S\cos\theta - p N \sin\theta,$$

On page 736, Vol. XX., we have found the value of tan θ to be

$$\tan\theta = \frac{(SL - RN)p}{R(R+S) + L(L+N)p^2};$$

hence substituting we have

$$OD = \frac{S\{R(R+S) + L(L+N)p^2\} - p^2 N(SL - RN)}{(R+S)^2 + (L+N)^2 p^2};$$

or $$OD = \frac{RS(R+S) + p^2(SL^2 + RN^2)}{(R+S)^2 + (L+N)^2 p^2}.$$

On comparing this value for O D with the value above calculated for R′ we see they are equal, and hence O D = R′.

So that on the same scale on which O B and O C represent S and R the individual resistances O D represent the equivalent resistance for the periodicity employed. Similarly, it may be shown that A D = p L′ for the angle C O D = θ' = angle C A D, and

$$\frac{AD}{\cos\theta'} = pL - R\tan\theta',$$

or $$AD = pL\cos\theta' - R\sin\theta';$$

and since $$\tan\theta' = \frac{(RN - SL)p}{S(R+S) + N(L+N)p^2},$$

a similar substitution enables us to see that

$$AD = \frac{pL(S^2 + p^2 N^2) + pN(R^2 + p^2 L^2)}{(R+S)^2 + (L+N)^2 p^2},$$

and this is equal to the value found by analysis for p L′.

The diagram also shows us many other things besides this construction for the equivalent resistance and inductance.

It shows us for instance precisely what is the effect of the inductance of the wattmeter fine-wire circuit, and what must be the correction applied to the readings to get the real power expended in the induction circuit.

The actual reading of the wattmeter is proportional to the true mean value of the product of x or the current in the inductive circuit R, and y or the current in the fine-wire circuit S; and this as previously shown is equal to half the product of their maximum values, and the cosine of the difference of phase.

From Fig. 39 this mean value is therefore

$$\frac{OX \cdot OY}{2}\text{cosine BOC}.$$

This, however, is *not* the measure of the power expended in the R circuit. The true watts are proportional to the mean product of x and a current equal to one Sth part of e having a phase difference equal to the angle C O A, viz, that of the angle of lag of the current in R and the potential difference O A of its ends; hence the real power or watts are proportional to

$$\tfrac{1}{2}\frac{E}{S} \cdot OX \cdot \text{cosine COA},$$

since E is the maximum of e, viz., the instantaneous potential difference between the extremities of the branch circuits.

Now O Y is taken as one Sth part of the effective electromotive force in the S circuit; and on the same scale, on which O A represents the impressed E.M.F., O B represents the effective E.M.F. in that circuit. Hence, in taking the reading of the wattmeter, which is proportional to

the quantity $$\frac{OX \cdot OY}{2}\text{ cosine BOC}$$

as the watts, we are making an error, for the quantity really required is the value of

$$\frac{1}{2}\frac{E}{S}OX\text{ cosine AOC},$$

which is numerically equal to the real power. Hence two errors come in—one due to the maximum current in the fine-wire circuit being O Y or $\frac{OB}{S}$ instead of $\frac{E}{S}$ or $\frac{OA}{S}$, and the other due to the phase difference being taken as the angle C O B instead of C A O.

To correct the instrumental reading or observed watts to true value or real watts, we have to multiply the observed readings by two factors,

first, the ratio of $$\frac{OA}{OB}\text{ or }\frac{\sqrt{S^2 + p^2 N^2}}{S},$$

which is the correction due to the self-induction of the fine-wire circuit or to the potential part of the wattmeter having a sensible inductance. The *second* is the ratio of the cosines of the angles C O A and C O B or

$$\frac{\cos COA}{\cos COB} = \frac{\cos COA}{\cos(COA - BOA)} = k,$$

but from the diagram

$$\text{cosine COA} = \frac{R}{\sqrt{R^2 + p^2 L^2}},$$

and $$\text{cosine BOA} = \frac{S}{\sqrt{S^2 + p^2 N^2}}$$

$$\therefore k = \frac{\dfrac{R}{\sqrt{R^2 + p^2 L^2}}}{\dfrac{R}{\sqrt{R^2 + p^2 L^2}} \cdot \dfrac{S}{\sqrt{R^2 + p^2 L^2}} + \dfrac{pL}{\sqrt{R^2 + p^2 + L^2}} \cdot \dfrac{pN}{\sqrt{S^2 + p^2 N^2}}}$$

Combining these two corrections into a single product, we get as the full correcting factor:—

$$\frac{\sqrt{S^2 + p^2 N^2}}{S} \cdot \frac{R\sqrt{S^2 + p^2 N^2}}{RS + p^2 LN}$$

or $$\frac{RS^2 + p^2 N^2 R}{RS^2 + p^2 LNS} = F.$$

If we put $T_s = \frac{N}{S}$ where T_s is the time-constant of the S circuit, or the fine wire circuit, and $T_R = \frac{L}{R}$ where T_R is the time-constant of the R circuit, we have

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$$F = \frac{1 + p^2 T_S^2}{1 + p^2 T_R T_S},$$ *

and the real watts or power taken up in the circuit R is real watts = observed watts × F. F becomes unity for two cases when L and N are both zero, and also when $T_S = T_R$.

Hence, the ordinary wattmeter, applied as usual to measure the *electrical power* in a circuit traversed by a simple periodic current, gives absolutely correct readings only in two cases. First, when the fine-wire circuit and the circuit being measured have no inductance; second, when the fine-wire circuit and the circuit being measured have equal time-constants.

But if T_R is greater than T_S, then F is a proper fraction. The wattmeter reads too high, and the real watts are less than the observed. If T_R is less than T_S, then the observed readings are too low. If $T_R = T_S$, then the observed readings are correct. Hence the wattmeter may read too high, too low, or correct. Generally speaking, it reads too high, since the time-constant of the measured circuit will be in excess of that of the fine wire circuit.

(To be continued.)

UNDERGROUND ELECTRICAL CONDUCTORS IN EUROPE AND AMERICA.†

BY PROF. G. W. PLYMPTON.

The problems of construction of underground systems of electrical conduction will have been solved when the telephone and the arc light systems are both buried under our streets without impairing the efficiency or durability of either.

By this I mean that all the difficulties encountered in burying conductors are involved in converting telephone and arc light from *aerial* to *underground* systems. Telegraph lines and systems of incandescent lighting present fewer difficulties in the process of burying, and none of a kind not met with in dealing with the systems first mentioned.

The telephone problem is substantially solved. Some details only remain to be settled, among which may be mentioned the best size of conductor, the most serviceable insulation, and the maximum distance of effective service for either grounded or metallic circuits.

In Brooklyn, the general plan adopted is that of a conduit divided into ducts through which cables containing from sixty to one hundred wires are drawn. The material of the conduit is for the most part creosoted wood. About ten miles of this is already in use in our city, and about four and a-half miles of the Dorsett concrete conduit. For the extensions of the underground systems for the present year only creosoted timber is to be used.

Among the lessons learned from our experience are:—1st. That in creosoted conduits the use of cables covered with kerite, or any similar rubber or gutta percha compound, must be avoided. 2nd. That in the so-called lead-covered cables, the use of pure lead is also to be avoided, as it is slowly converted into a porous and friable lead carbonate. An alloy of lead with five or six per cent. of tin seems to resist the destructive action. 3rd. That the conducting wire first used is too small for satisfactory telephone service. The difficulties of induction and retardation led to complaints as soon as 4,000 or 5,000ft. of underground wire was put in service. The cables that are now being put in are made up of wires whose cross-section is greater by one-third than that of the first wire, and they are protected by twice the thickness of insulation.

I mention the above conclusions as having been drawn from our own experience in Brooklyn.

In commencing our work we gathered such information as could be gleaned from localities where solutions of the problem had already been attempted. The impression so largely prevailed that in Europe all telephone and telegraph conductors were underground that our Board decided that a personal inspection of European systems should be made by one of our number. The duty devolved upon me. The result of my inquiry has been published in the scientific papers.

I will briefly refer to a few of the incidents. [Prof. Plympton here gave an epitome of the third annual report of Brooklyn Subway Commission, which embodied his observations.]

In regard to the burial of the arc light wires I can only say that no method yet tried seems certain of success. Most of them certainly ensure the destruction of the underground conductors in from one to three years. But I have no doubt that a solution of the problem will soon be reached, although the system will be kept apart from the telephone and telegraph subway.

It does not seem likely that arc light conductors will be allowed in the same conduit with telephone wires, nor will they be distributed from the same manholes.

In saying that, I believe that a solution of the problem will soon be found. I do not mean to assert that casualties like that recently recorded of a man in the Bowery, who lost his life by grasping the naked wire close to an arc lamp, can be prevented by any system of burying wires. To prevent such *accidents* (if that is the term to be used) the arc lights must be buried with the wires.

All past experience teaches us to proceed cautiously. Nothing can now permanently check the growth of the telephone, the telegraph, or the electric light. They have become necessities of our civilisation, and any hasty or ill-advised enforcement of the law to convert all aerial to underground systems which should result in serious injury to them, would prove the surest way to perpetuate the nuisances of overhead wires and poles in the streets.

* This expression for the ratio of the real watts to the observed watts was given by Prof. Ayrton in the discussion of Mr. Kapp's Paper on "Transformers," read at the Society of Telegraph-Engineers, Feb. 16th, 1888. (See *Journal* of the Society of Telegraph-Engineers, Vol. XVII., p. 173.) Prof. Ayrton did not, however, at that time give the reasoning by which he established it, and the above geometrical method occurred to the writer in subsequently considering it.

† Read before the American Institute of Electrical Engineers, May 16th, 1888.

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MEETINGS OF SCIENTIFIC SOCIETIES.

(TO-NIGHT) FRIDAY, June 8th.

ROYAL INSTITUTION.

9 p.m. Lecture on "Phosphorescence and Ozone." By Prof. DEWAR, M.A., F.R.S, M.R.I.

SATURDAY, June 9th.

ROYAL INSTITUTION.

3 p.m. Lecture, "Count Tolstoi as Novelist and Thinker" (2). By Prof. C. E. TURNER, of the University of St. Petersburg.

PHYSICAL SOCIETY (Normal School of Science, Exhibition-road, South Kensington).

3 p.m. "On the Analogy betweeen Gases and Substances in Dilute Solutions." By Prof. J. H. VAN 'T. HOFF. Communicated by Prof. W. RAMSAY. Exhibition of a Lantern by Mr. W. LANT CARPENTER.

TUESDAY, June 12th.

ENGINEERING SOCIETY (King's College, London, W.C.).

4 p.m. Business Meeting.

THURSDAY, June 14th.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

SATURDAY, June 16th.

ROYAL INSTITUTION.

3 p.m. Lecture, "Count Tolstoi as Novelist and Thinker" (3). By Prof. C. E. TURNER, of the University of St. Petersburg.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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The Electrician.

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ELECTRICAL INTERESTS IN AMERICA.

While the relations between Electrical Engineers on the one hand, and Fire Insurance Offices and their clients on the other, have been undergoing prolonged discussion in this country, a satisfactory adjustment of their differences remaining as far off as ever, the States of New England appear to have settled these matters for themselves in a way which is at once surprising and instructive. In another portion of our present issue will be found the leading features of an association which bids fair to become a model for similar organisations throughout the United States, and which at the present juncture deserves the careful attention of electrical engineers in this country. The scheme of the "New England Electric Exchange" originated in much the same condition of affairs as that which has so long occupied the attention of the Society of Telegraph-Engineers and Electricians. In America the operations of electrical business have, of course, been more extensive, and possibly the work has not been so well done as, on the whole, it has been with us. But the difference is only in degree, the same defects being conspicuous in both countries, and leading to the same evil consequences. Installations of electric lighting and electrical power supply have fallen not infrequently into incompetent hands; customers have been disappointed with the results; insurance offices have declined to accept responsibility, and generally a feeling of insecurity has arisen, which, if allowed to go on uncorrected, may permanently prejudice the electrical industries. Such, at all events, is admitted to be the case in America; and in order to re establish public confidence by more stringent control over their profession, this association of electrical engineers has been instituted in New England.

Its leading objects, as set forth in Article II. of the proposed "Electric Exchange," are the promotion of electrical business, and "especially in the direction of securing perfection in electric light and electric power installations, and in har-

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monising and adjusting as far as possible all differences which may arise between various electrical interests." With regard to the latter part of the clause, the necessity for it is more pressing in the States than it is here, where the Government owns the greater part of the telegraph wires, and is amply protected against any injurious conflict of interests. But in the main, it will be seen, the New England scheme resembles very closely and will occupy a similar position to that which the "Association of Electrical Engineers" would have now occupied in this country had its conception been realised last year. As regards that abortive project we need only remark that the Society which was foremost in opposing it has since had an experience which ought to satisfy it that the functions of a trade society cannot be performed with efficiency or dignity by a scientific body whatever may be its title. Among the American electrical engineers there are no delusions of this kind. They mean business, and set about it with more directness and boldness than has ever been openly advocated even in these pages.

From a circular which accompanies the Articles of Association, and for the advanced proofs of which we are indebted to our Boston contemporary, *Modern Light and Heat*, we learn that the formation of the New England Electric Exchange has been the result of various conferences held between gentlemen interested in insurance matters and others engaged in electrical business. At these conferences the subject of "diminishing risks to property and life by a more thorough installation of electric light and power plants, and the employment of the most competent men, were discussed." One result of these discussions was the adoption of a "plan of licensing" competent men for the work they propose to undertake. We are not informed as to the details of the discussion; but we can easily imagine the course it would take. First of all there must be established an authoritative and trustworthy body of men associated and empowered to issue these licenses. Apparently no difficulties were experienced in that direction; and having settled this point, the next thing to be considered was to enforce the "plan of licensing" as an imperative condition of employment. The license would always be of some value; but unless the man who held no license could be prevented working, the credit of the profession would still be at his mercy. Happily the good relations which subsist between the insurance offices and the leading electrical engineers have enabled them to overcome this difficulty in a manner which to us seems almost sublime. The circular from which we have already quoted proceeds to announce that "After October 1st, 1888, the fire underwriters will not insure any property where electric light or electric power is used, nor pass any new installations, unless the party operating the plant or making the installation has obtained from this exchange a certificate of license."

If both sides to this bargain hold to the terms of it—or, more exactly, if the insurance offices, as well as their agents, are satisfied with the character of the licenses issued by the Electric Exchange, the effect must certainly be precisely what the latter desire, namely, the exclusion of incompetent workmen. The attainment of that object whenever hinted at in this country has been contemptuously rejected as in the nature of boycotting. In reality it no more deserves that reproachful designation than does the diploma of a medical man, or the barrier which hedges the profession of the law. The one and only thing needful in all such cases is that the examination shall answer its purpose—the purpose, namely, of excluding unauthorised and incompetent pretenders. Whether the examination proposed by the New England Electric Exchange will answer this description is a matter we need not stay to discuss. According to our ideas the mode of procedure is, perhaps, a little uncertain and liable to error. But experience will correct shortcomings of that description; and in the meanwhile an ingenious plan has been hit upon for lessening the burden of the examination, and rendering it available for all grades of knowledge and skill. Not every electrical workman or engineer is expected to be able to perform every kind of electrical work; but every holder of the Association's license is certified, after examination, as being able to do the class of work which he professes to do, and will be entitled to do no other. There are, in fact, five different classes of licenses, ranging from the first, which certifies the person "fully competent to install any electric light or power plant," to the fourth and fifth, which are issued respectively to persons competent to "operate electrical machinery," and "to do electric wiring." The examinations, therefore, are to cover not only the high-class electrician and electrical engineer, but the workpeople whom they employ; and it is obvious, if the tests are conducted with rigour and prudence, a general improvement in electrical workmanship all round may be anticipated. It would be idle to recommend this scheme for adoption here, where public feeling is against it, and where the conditions are not wholly identical. But we may watch the progress of it in the New England States with much interest, and probably with some profit.

REVIEWS.

Researches on Diamagnetism and Magne-Crystalline Action, including the Question of Diamagnetic Polarity. By JOHN TYNDALL, D.C.L., LL.D., F.R.S. New Edition. (London: Longmans, Green and Co. 1888.)

The phenomenon of diamagnetism was chosen by Tyndall as the subject of the first lecture delivered by him before the Royal Institution. This was in February, 1853, and a few months later (at the instance of Faraday) he was elected by the Institution to the Chair of Natural Philosophy. Tyndall continued for some years to devote himself to the study of diamagnetism, and contributed numerous Papers on the subject both to the Royal Society and to the *Philosophical Magazine*. In their collected form, these Papers were the first work of Tyndall's to issue from the press, and as a record of patient and laborious endeavour directed to the disentanglement of singularly complex and exceedingly delicate phenomena they will always occupy an important place in the history of experimental science. The electrician who values his acquaintance with the science solely for utilitarian ends may safely be recommended to neglect "the question of diamagnetic polarity"; but for those who cultivate the love of science for its own sake this will always be a delightful book.

It is, nevertheless, necessary to warn the student who reads the book for the first time in the new edition that he should be careful to discriminate between the *theory* and the *facts* therein set forth. The validity of the latter has been impeached by no experiment of subsequent date; but, on the other hand, it is necessary to say that the views of diamagnetic polarity adopted by Tyndall are by no means unreservedly accepted by later writers. The theory in question (which was also warmly advocated by Weber) supposes that the polarity acquired by a diamagnetic body in a given field of force is the reverse of that which would be acquired by a paramagnetic body under the same conditions. Faraday, on the other hand, denied that diamagnetism was a polar force at all; holding that the observed phenomena were simply due to a tendency in diamagnetic bodies to move from stronger to weaker parts of the magnetic-field. Faraday arrived at this view from a study of the behaviour of crystals in the magnetic field, which behaviour Plücker endeavoured to connect with the position of the optic axis. Tyndall, however, proved conclusively that the action, whether para- or dia-magnetic, is directed along the line of maximum density of the substance,

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and is only incidentally connected with the direction of the optic axis in crystals. The essentially polar character of diamagnetism must be held, even in opposition to Faraday, to have been conclusively proved by the famous *experimentum crucis* of Tyndall. In this experiment a bar of bismuth was placed within a solenoid traversed by a powerful current; it was then found to be attracted by one pole of a magnet and repelled by the other, which is usually accepted as the test of "polarity." But it is, perhaps, still a little doubtful whether the controversy between Tyndall and Faraday arose from anything more than differences of definition and phraseology. Writing to Matteucci in November, 1855, Faraday himself said, "I differ from Tyndall a good deal in phrases, but when I talk with him I do not find that we differ in facts. *The phrase polarity in its present undefined state is a great mystifier.*"

At the present time, however, while we accept our facts unreservedly both from Tyndall and from Faraday, there is a strong tendency to adopt an hypothesis which consorts with the theory (or at least the phraseology) neither of the one nor of the other, but is that originally due to the elder Becquerel. Accustomed as we are to treat all magnetic problems by the Faradaic method of lines of force, an electrician of to-day simply stands aghast at such a diagram as that of Fig. 1,

Fig. 1.

taken from page 248 of the present edition of Tyndall's book. In fact, this mode of regarding diamagnetic phenomena is entirely inconsistent with the fundamental properties of lines of force. Faraday, on the other hand ("Experimental Researches," § 2,821), exhibits the different action of a paramagnetic and a diamagnetic body in a field of force by the following diagram (Fig. 2), in which the left-hand body is

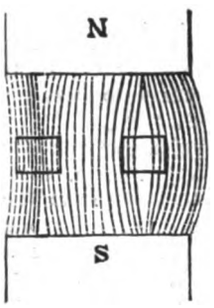

Fig. 2.

supposed to be paramagnetic and that on the right to be diamagnetic. This diagram is, so far as it goes, in accord with the hypothesis of Becquerel, which is simply that the magnetic permeability of paramagnetic bodies is greater than that of space (or of the ether), while for diamagnetic bodies the permeability is less than that of space; that diamagnetism is, therefore, a purely relative phenomenon, a substance appearing to be either paramagnetic or diamagnetic according as its permeability is greater or less than that of the medium in which it is placed. This explanation renders a satisfactory account, on the one hand, of Faraday's characteristic, namely, that diamagnetic bodies tend to move in the magnetic-fields from stronger to weaker places; and, on the other hand, it is quite in accord with the *experimentum crucis* of Tyndall. It will be found a most interesting exercise for the student to endeavour to apply this explanation to the experiments which Tyndall adduces in support of the theory of Weber, or in opposition to the views of Faraday. It is interesting also to note in passing how Tyndall, not having accustomed himself at that time to the delineation of magnetic fields, found it necessary to plot out some very simple cases by means of laborious experiment—cases in which the general character of the field would now be understood at a glance (*see* p. 103).

But, however much the simplicity and homogeneity of Becquerel's theory may tend to prejudice one in its favour, it cannot be said that the question has even yet been finally set at rest. Even if the whole of Tyndall's experiments are accounted for, there remains the fact that with diamagnetic substances the plane of polarisation is rotated in the opposite direction to that of paramagnetics. There is, however, no doubt that the more recondite problems of magnetism cannot be properly handled without a fuller recognition than is usually made of the distinction between the *inducing* and the *induced* fields. Becquerel's theory ought, probably, to be re-stated in a form in which it would be shown that the induced field of a paramagnetic body is stronger (or contains more lines per unit area) than the inducing field; while in diamagnetics the induced field is relatively weaker. On this assumption we believe that Prof. Ewing has been able to explain the difference in the direction of rotation of the planes of polarisation, without assuming an intrinsic difference in the sign of magnetisation. Meanwhile, we may at this point quote the following words of Tyndall, written in November, 1855, but which seem to us to convey a lesson which very many of us need to learn to-day:—"The cause of science is more truly served, even by the denial of what may be a truth, than by the indolent acceptance of it on insufficient grounds. Such denials drive us to deeper communion with Nature, and compel us through severe and laborious enquiry to strive after certainty, instead of resting satisfied, as we are prone to do, with mere probable conjecture."

In conclusion, one word may be said about that term which Faraday justly accused of being "a great mystifier." The Faradaic conception of the magnetic field has nowadays been so thoroughly absorbed and assimilated, and we have so many continuously recurring opportunities of verifying our deductions therefrom, that in spite, perhaps, of the warning just quoted, we are tempted to rest satisfied with any explanation or definition which can be harmonised with it. There is only one possible definition of polarity in terms of lines of force. Since lines of force are always closed curves every line which enters a body from without must also leave it again; the points of ingress and egress of the lines are points of opposite "polarity," and the essentially dual nature of the phenomenon is thus conformed to. In this sense Faraday was wrong in denying polarity to diamagnetics, but we think that Tyndall is wrong also if he still maintains that diamagnetic polarity is (in the same sense) opposite to that of paramagnetics.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

Chapter IX.—*Magnetic Fields (Continued).*

(Continued from page 48.)

110. *The Magnetic Meridian.*—At any given place on the earth's surface the magnetic meridian is the vertical plane (through that place) in which the total intensity of the earth's magnetic field is a maximum. Of the two component intensities, the horizontal and the vertical, into which, as before shown, the earth's field may be resolved, the former is necessarily a maximum in the same vertical plane as the total intensity, viz, in the magnetic meridian; hence the direction of this meridian may be seen by the direction in which a horizontally-pivoted magnetic needle sets itself, while the latter component, viz., the vertical, is the same in intensity in all vertical planes at one place. If, for example, we take a vertically-pivoted magnetic needle, whose horizontal axis of motion is through its centre of gravity, and move it round bodily, so that the vertical plane in which the needle moves is gradually altered until a vertical plane is found, in which the needle comes to rest in an absolutely vertical position, we know that the plane so found is at right angles to that of the magnetic meridian, because it is only in this plane that the horizontal intensity could be *nil*, and the vertical alone act.

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Having found this plane in the foregoing manner, we know that the magnetic meridian is in a plane 90 degrees removed from it. This method of determining the plane of the magnetic meridian is employed at Kew Observatory, in order to place the "dipping needle" correctly in that plane before taking readings of the angle of "dip" or "inclination." Full descriptions of the instruments employed, and the methods of measuring the horizontal intensity, and the angles of inclination and declination, with the corrections to be taken into account, will be found in Gordon's "Physical Treatise on Electricity and Magnetism," Vol. I., and in Stewart and Gee's "Elementary Practical Physics," Vol. II. The plane of the magnetic meridian does not always coincide with that of the geographical meridian as determined astronomically. From data accumulated since 1576 it is found that in London the magnetic and geographical meridians coincide about every 320 years. Since their coincidence 231 years ago the magnetic meridian became more and more west of the true meridian, until, after a period of 160 years, a maximum was reached, and it then commenced to return. The angle between the two meridians is called the angle of *declination*, and is now in London 17° 40′ west. It will also be understood that the intensity of the horizontal magnetic field varies according to the latitude; for instance, on the magnetic equator, or line of no dip, the horizontal intensity is equal to the total intensity, and the further north or south we go the weaker does the horizontal intensity become, the difference in its value being noticeable even in Great Britain, where, for instance, its value in the town of Inverness is ·15 C.-G.-S. units, while in London it is ·18, the difference of latitude being about 6 degrees.

111. *Uniform Magnetic Field.*—A Magnetic Field is said to be "*uniform*" when the force exerted on a magnetic pole of given strength is the same at all points in that field. Throughout the space described by the movement of any given magnetic needle suspended or pivoted horizontally, as in galvanometers and indicators, we may regard the earth's horizontal field H as absolutely constant in value, in other words, such a needle is suspended in a "uniform" field, and the force exerted on its two poles would be the same for all positions it could possibly take up. The number of lines of force per square centimetre would also, by definition, be constant at all points in a uniform field, and therefore the lines of force would necessarily be parallel lines.

112. *Comparison of the Intensities of Magnetic Fields.*—The relative intensities of two or more magnetic fields, or the relative strengths of field at two or more different points in a magnetic field which is not uniform, may be determined by the method of vibrations. A small magnetic needle, horizontally suspended or pivoted, is placed successively at the points where the magnetic fields are to be compared, and after having been set oscillating the number of oscillations made in a given time are counted. The cause of the oscillations is evidently the magnetic force (equal to the product of the strength of one pole of the needle and the strength of the field) acting at both ends of the needle, and tending to bring it to rest in a line parallel to the lines of force of the field. If there were no force there would be no oscillation. We can observe this by annihilating the force acting on the needle.

FIG. 70.

An ordinary compass needle, if turned round out of the magnetic meridian and then allowed to swing, will continue to oscillate about the meridian till it finally comes to rest in it. The force causing these oscillations can be weakened or annihilated by destroying *either* of the two factors composing it. That is, we may do away with the force by destroying either the magnetic field or the strength of the needle poles. If the needle *n s* (Fig. 70) is lying in the magnetic meridian, the earth's field H (shown by the straight arrows) may be neutralised by approaching a magnet, N S, which sets up in the neighbourhood lines of force (shown by the curved arrows) opposite in direction to those of the earth. As the magnet is approached, if the needle is turned round its centre and then allowed to oscillate back, it will be found that the oscillations become more and more sluggish, and a point will at length be reached when the needle will not oscillate at all, but remain in any position it is turned to. This principle of weakening the earth's directive force on a needle by means of a magnet placed, as shown, in the neighbourhood is employed sometimes with galvanometers, where it is required to render the instrument more sensitive, and increase the amplitude of the deflections with weak currents.

Or, again, we may destroy the force by demagnetising the needle—that is, doing away with the other factor on which the force depends. If the needle is demagnetised completely, as may be done by placing it within a helix, or coil of insulated wire, through which an alternating current is passing, or what is the same thing if, instead of the magnetised needle, we substitute a piece of hard steel unmagnetised, we find that it will remain still in any position in which it may be placed; in other words, there is no force acting on it, and therefore the needle does not oscillate or take up a definite position. We have a mechanical example of this when a body is suspended vertically at the end of a length of fine thread. The top end of the thread being fastened to some fixed point, if the body is raised a little with the thread taut and then let go we have a pendulum action, and oscillations take place till the pendulum finally comes to rest in the vertical line of the earth's gravitation field of force.

In a similar manner to the magnetic needle above, we have here a force acting on the body, causing its oscillations, and composed of two factors, viz., the mass of the body and the acceleration of gravity. If we could destroy either factor, oscillation would cease, in consequence of the absence of any force. The mass of the body could only be dispensed with by removing the body altogether from the thread, which would then do away with the force and the resulting oscillations. We could not, however, neutralise the effect of the acceleration of gravity by a counter field of force in the same manner as a magnetic field.

Incidentally, here, attention may be drawn to the analogy between a mechanical and a magnetic field of force. Mass in the one is analogous to strength of pole in the other, and acceleration in the one (force divided by mass) is analogous to intensity of field in the other (force divided by pole strength). If there could be such a thing as a separate pole it would move along a line of force in a uniform magnetic field at a constantly increasing velocity or acceleration.

We now come to the well-established law of compound pendulums, viz., that the value of a force causing such oscillations (when these are of small angle) is proportional to the square of the number of complete oscillations in a given time, or inversely proportional to the square of the time during which a given number of complete oscillations are made. The time of a complete oscillation or "period" is taken from the instant the needle passes a given point to the instant it reaches the same point again, moving in the same direction.

Suppose the intensities at two points, A and B, in a magnetic field are to be compared. If at A a magnetic needle makes, say, 60 oscillations per minute, and at B the same needle makes 20 per minute, the fields at those points are respectively in the proportion of $60^2 : 20^2$—that is, as 9 to 1.

113. *Comparison of the Strengths of Poles of Magnets.*—By the same method we may compare the strength of pole of two or more magnets. Let a small horizontal compass needle be placed with its centre on a line drawn in the magnetic meridian. Turn it round its centre away from the meridian, and then let it swing. Count the number of oscillations, say 4 in 12 seconds—that is, 20 per minute in the earth's field alone. Now, suppose we have two long bar magnets, A and B, of equal length, whose pole strengths are to be compared. Place A on the line marked out, with its north pole pointing towards the south pole of the

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needle; this increases the strength of field in the region of the needle, and it oscillates quicker, say 40 per minute. We have here two fields superposed in the region of the needle, each field being proportional to the square of the oscillations in a given time. The earth's field is then proportional to 20^2, and the two fields together proportional to 40^2; therefore the field produced by the pole of the bar magnet in the region of the needle is proportional to the difference of these squares $= 40^2 - 20^2$. Now remove A altogether, place B in exactly the same position, and count the oscillations, say 30 per minute. In a similar manner the field in the region of the needle due to the nearer pole of B is proportional to $30^2 - 20^2$. Now we have seen that the intensity of field at a point due to the pole of a magnet is equal to the strength of this pole divided by the square of the distance of the point from the pole. But the distance of the centre of the needle from the pole of each magnet in this case is the same, therefore the strengths of the respective poles are proportional to the respective intensities of field produced by each. We have therefore

$$\frac{\text{pole strength of A}}{\text{pole strength of B}} = \frac{40^2 - 20^2}{30^2 - 20^2} = \frac{1200}{500} = \frac{2\,4}{1};$$

or, making the calculation by the inverse ratio of the square of the time during which a given number of oscillations are made, we should have—

20 oscillations due to earth in 60 seconds
20 " " " A " 30 "
20 " " " B " 40 "

whence $$\frac{\text{field due to A and earth}}{\text{field due to earth}} = \frac{60^2}{30^2} = \frac{4}{1};$$

and therefore $$\frac{\text{field due to A}}{\text{field due to earth}} = 4 - 1 = 3.$$

Similarly $$\frac{\text{field due to B}}{\text{field due to earth}} = \frac{60^2}{40^2} - 1 = \frac{5}{4};$$

and, finally, the distance of the magnet poles of A and B from the needle being the same, the fields produced are proportional to their pole strengths. Hence—

$$\frac{\text{pole strength of A}}{\text{pole strength of B}} = \frac{3}{\frac{5}{4}} = \frac{2{\cdot}4}{1} \text{ as before.}$$

The kind of magnetic needle best suited for oscillation experiments is a short thick one—a piece of thick steel knitting needle not more than two centimetres long does very well—which can be magnetised in the ordinary way by stroking it over the pole of a permanent magnet, or by wrapping a layer of insulated wire round it and passing a current through the same, tapping the needle during the operation. If it is suspended, a convenient stirrup for it may be cut from a visiting card in the shape shown in Fig. 71, bending the ends over at

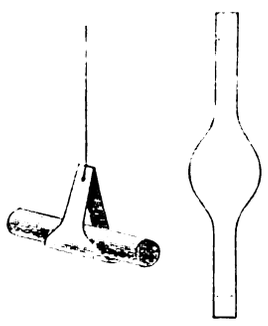

Fig. 71.

the dotted line, then piercing a hole through the four thicknesses of card and tying to it a fibre of unspun silk. Before the needle is put in the stirrup a somewhat heavier rod of non-magnetic metal, such as brass, should be hung and left for some time until all torsion is removed from the fibre. This will be the case when the weight comes to rest and remains so. The fibre should then be turned slightly till the length of the stirrup lies in the magnetic meridian and the magnetic needle inserted in it with its poles the right way. The needle is then lowered till it is just above a flat horizontal surface, such as a table or flat board, on which a card is placed with a black line drawn in the direction of the magnetic meridian. It is quite easy then to count oscillations every time the needle passes the black line going in a given direction. For greater delicacy a small circular mirror may be attached by beeswax to the fibre just above the stirrup, and a ray of light projected on to it from a lamp placed about two feet away, the lamp being surrounded by an opaque enclosure in which a narrow vertical slit is cut opposite the flame to emit the beam on to the mirror. The reflected ray thrown on to a white screen then shows the oscillations of the needle, and since these can be seen by this means when of very small angle, the arrangement is very sensitive, the meridian line for counting the oscillations being then marked vertically on the screen.

(To be continued.)

EDISON AND SWAN ELECTRIC LIGHT COMPANY v. HOLLAND AND OTHERS.

On Friday, in Mr. Justice Kay's court, the Attorney-General informed his Lordship that the final decision of the parties as to who should act as the umpires was not yet arrived at, but he handed in a list of suggested names for his Lordship to select from. His Lordship selected and ticked the names of the gentlemen who were to be asked to act in that capacity, but they were not made public at this stage of the proceedings; and as it was desired that experiments should still be made, which would occupy at least ten days, it was agreed that the case should stand adjourned until Monday, June 11th.

It was mentioned that the report would be drawn up by the gentleman hereafter to be appointed "moderator."

THE SEEL INCANDESCENT LAMP FILAMENT.

From further information recently to hand we are able to give the following details of the manufacture of the Seel filament. The characteristic peculiarity seems to be that the incandescent threads are formed of three annular layers, of which the innermost is the real carbon thread. This thread is saturated with a solution of certain mineral salts and a gum, and is thus provided with a non-conducting coating of salt which melts during the carbonisation. This coating not only protects the carbon thread from burning during the carbonisation and excludes the air, but it also gives the carbon thread a smooth surface, on which the third layer, which is necessary for the adjustment of the resistance of the filament, is deposited in a uniform manner. The third layer is composed of carbon, precipitated by a certain process, in which a paraffin bath is used.

The method of preparing the threads is as follows:—Wood, silk, cotton, or any other vegetable fibre is steeped in a solution of mineral salts and a gum, consisting of a mixture of a silicate or salt, gum-senegal, and caustic soda, and then rolled firmly between warmed grooved rollers. It is rolled in the shape of angle-iron, in order to obtain a many-edged material of small diameter, so as to increase the illuminating effect.

When this operation is finished the thread is carbonised in the usual way. The carbonised thread is then placed in an insulated vessel and connected to the terminals of a source of current, in the circuit of which is placed a regulating resistance. The vessel containing the thread is then completely filled with paraffin or naphthalene, so that the thread is completely immersed and the paraffin allowed to harden. Current is then passed through the filament, which becomes hot, and the paraffin close to it becomes liquid, while that in immediate contact is even vaporised. In consequence of the heating, particles of carbon are deposited on the thread, and the resistance of the latter gradually decreases. The paraffin farthest removed from the charcoal threads remains solid and forms an envelope for those parts of the paraffin that are liquid, and thus limits the liquefying of the material as well as excluding the air. When the carbon thread has been lowered to the right degree of resistance the current is cut off and the thread is ready for use. The paraffin is then entirely liquefied by heat, so that the carbon thread can be drawn out. It is cleaned of the paraffin particles attached to it by means of benzine, and is then ready to be inserted

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in the lamp. Hence the actual adjustment of the resistance of the carbon thread takes place in the bath, only the very smallest part of which is melted.

The advantage claimed for this method of treatment is that, owing to the presence of the gum-senegal, the pores of the thread are completely filled, and an exceedingly tough filament is obtained. The silicate and the caustic soda encompass the thread entirely, and when the latter is subjected to the rolling process they encircle it closely and uniformly on all sides. After being carbonised and prepared as described, the thread, therefore, consists of three layers, namely, the inner carbon layer, the annular silicate layer, and the uppermost precipitated, so-called "regulating layer," formed by the deposition of carbon.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

The last meeting of this Society for the present Session was held on Thursday last, at the Institute of Civil Engineers, the President, Mr. Graves, C.E., being in the chair.

After the usual formal business had been transacted, Prof. SILVANUS THOMPSON delivered the following address upon

"Influence Machines, from 1788 to 1888."

Prof. THOMPSON: Mr. President and Gentlemen—On the 5th June, 1788, a letter was read at the Royal Society addressed by William Nicholson to Sir Joseph Banks, the then president. In that letter he announced his discovery, or, rather, invention, of an instrument which, by the turning of a winch, produces, in indefinite quantity, the two states of electricity, without friction and without communication with earth. The 5th June, 1888, will be next Tuesday; and, surely, we British electricians can hardly allow the 100th anniversary of the introduction of the influence machine to go by without at least recalling to our minds what has been done in that 100 years (hear, hear), and how from the simple beginnings of William Nicholson we have now the very perfect influence machines of to-day. But I may be allowed to go back a little earlier than 1788, because not only the influence machine, but the very fact that there is electrical influence at all, was discovered in England in 1753 by John Canton, of Stroud, in Gloucestershire, and we have, therefore, a double right to claim the invention of the influence machine, because of the discovery of the principle upon which it is based. John Canton's writings, which were mostly printed in the *Philosophical Transactions* of the Royal Society, are, to be sure, not altogether clear; he was an extremely clever man, and lived amongst his apparatus, working with it, becoming familiar with it, even as in a later time Faraday did, and his ideas grew up from the experiments he made, and took form in his own mind and were expressed in language that is not perhaps exactly that either of his own time or of the present time. One thing that Canton observed was that every electrified body was apparently surrounded with a sort of electrical atmosphere; and he gave a great deal of attention to this electric atmosphere, which he declared to surround all electrified bodies. Further experiments, really on the same point, though not expressed in the same language, were made by various experimenters. Franklin touched the subject very briefly. Wilcke, of Rostock, and Prof. Æpinus, then in Berlin, touched the subject from a somewhat different point of view. Æpinus in particular explained all the things that he observed, not by thinking of an atmosphere at all, but by introducing the mathematical notion of action at a distance, and he gave a certain mathematical theory to account for the facts that he observed. In Italy Jacopo Beccari, working on almost exactly the same problems, viewed them from a third standpoint, and discovered that a charge of electricity on a body behaves quite differently according to that which may be near it; that if you have a charged body—say, a glass plate rubbed on one side—and you bring something against the back of that plate, the charge on the front of the plate behaves differently, as though it were a large charge or a small charge, according to circumstances. To this peculiar action he gave the Latin name "*Vindex*." I do not know how we are to translate it. The "vindication" of electricity would not convey any intelligible meaning, I suppose, to our minds. That which Canton was referring to as an electrical atmosphere, that which Æpinus was referring to as an action at a distance, is that which Beccari was referring to by talking about electricity having a "vindicating" power, and it amounted simply to this—that in the neighbourhood of a charged body actions take place which are all explainable, which are all consistent with themselves, provided you will understand that the body which is brought into the neighbourhood of the charged body is acted upon in such a way as to tend to drive out of it electricity if the charged body has a positive charge, or to draw electricity from outside into it if the charged body is negatively charged. In fact, the action which we now call *influence*, and which for long was called *induction*, is nothing else than the action which all these various experimenters referred to. And, for my own part, I think that John Canton's notion of atmospheres was at least as useful as any of the other notions; it at least suggested that the intervening medium took an essential part in the phenomenon. Wilcke, in particular, made numerous researches, and in one of those he discovered the real, the true, principle of what we now call the electrophorus. Wilcke had a horizontal glass table. There is a drawing given in the *Proceedings* of the Swedish Academy relating to this; below that on an insulating stand there was a flat plate of paper covered with metal. Above the glass table there was another conducting plate suspended by insulating cords and a mechanism of pulleys to let it up and down. He discovered if the plate under the glass sheet were charged that the plate over the glass sheet separated from it by the glass could receive a charge, if it were lowered down on the table and were touched whilst it was there and then lifted up again. That discovery of Wilcke's was made in 1762, and some twelve years later Volta, in Italy, working again at the same kind of problem, investigating the apparent action at a distance, discovered the instrument which we all associate with his name, the so-called perpetual electrophorus. This in its modern form every one knows to consist of a cake of some electric substance which can be excited by rubbing it. He called it the cake, and a lid which Volta called the shield (*scudo*) which you place upon the cake so that it is under the influence of the charge. You touch it, then you take it up, and you find that it has a small charge upon it—a small charge, as a matter of fact, of the opposite sign. If your cake is of such a nature that its charge is negative when rubbed with the rubber, everyone knows as a most elementary fact that the charge which the metal acquires by being touched in its neighbourhood is a positive change. Volta further devised a condensing arrangement, which he used quite separately, but also in connection with his electrophorus. From that time there was great attention paid to this obscure fact of the existence of phenomena of influence. Probably if it had not been for the discovery of this simple and useful apparatus of Volta, not one-tenth part of the persons who immediately occupied themselves with experimenting on inductive action would have ever troubled their heads about it; but here was so simple an instrument that everyone could make it. I have put the names of those who followed in this list [Table I.]. The date, by the way, of Volta is given in the table as 1776; he really discovered the electrophorus a year or two before, about 1775; but he did not publish the discovery until some time after he had made it, and he went on experimenting, and his combination of an electrophorus with a condenser was used in 1778. One of those who followed after Volta, and who introduced a somewhat novel principle, was Lichtemberg, the same who discovered that peculiar kind of pattern or figure that can be obtained by sprinkling mixed powders, such as red lead and sulphur upon an electrified surface. Now Lichtemberg devised a double sort of electrophorus, and it is interesting, because it introduces the principle of reciprocal action. The electrophorus which Lichtemberg employed was made of wood, about 2ft. long and 1ft. broad, with a wooden rim nailed on, and a composition of resin, pitch, and turpentine cast into it. The way he employed it was this—he rubbed the plate near one end to excite it; having excited it, he placed the lid upon it, then he touched the lid, so that it acquired an opposite kind of charge, then having got it charged he made this communicate a portion of its charge to another part of the surface, either by putting the thing down edgeways, or by having a special discharging tool pointed at one end with a knob at the top, by means of which the charge could be "let off" on to the surface of the cake. Suppose you have a negative charge at the rubbed end of the plate; the charge obtained by touching the lid under influence would be a positive charge, and you now impart this charge to a spot at the other end. Now, then, having got a spot slightly positively charged, discharge your lid, put it down over the positive charge, touch it while under influence, and it comes up negatively charged.

TABLE I.

Canton	1753	Goodman	1841
Wilcke	1762	Svanberg	1846
Volta	1776–1782	Billet	1851
Darwin	1778	Varley	1860
Lichtemberg	1780	Holtz	1865–1867–1883
Bennet	1787	Toepler	1865–1880
Cavallo	1788	Morton	1866
Nicholson	1788–1797	Thomson	1867–1868
Read	1794	Carré	1868
Bohnenberger	1798	Kundt	1858
Hachette and Desormes	1804	Schwedoff	1871
Ronalds	1823	Voss	1880
Belli	1831	Atkinson	1883–1885

Wimshurst, 1881–1888.

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Then discharge its negative charge on to the other end, discharge this, and repeat, and so carry from one end a positive charge to the other, and then use that positive charge to obtain a negative one. In fact, you will see that it is, to use the familiar language of the text-books, a kind of process in which you obtain charges by putting out your original charges at interest. You begin with a certain charge as your principal, you put that out to interest by the operation of touching the conductor whilst under influence, and every time you choose to perform this operation you carry away a fresh quantity of interest. But the curious point about this is, that when you have a surplus—when you have a positive charge as your principal, the interest is a negative quantity; and when you have a negative charge as your principal, the interest is positive—which is contrary to the ordinary way of the world (laughter).

However, that curious fact enables you to work reciprocally by having a sort of double electrophorus, and, taking the interest on the one, adding it to the principal of the other, and taking the interest on that and adding it to the principal at the other end. That reciprocal accumulative action is at the basis of all the modern influence machines. Almost at the same time Prof. Klinkoch, of Prague, invented an almost identical thing. The only difference from Lichtemberg was that he employed two separate cakes instead of one long cake. Then, from Lichtemberg, we come to another name,

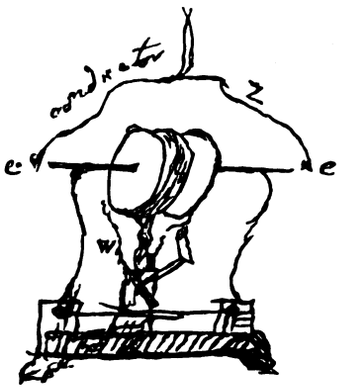

FIG. 1.—Facsimile of the sketch of the first Influence Machine by Erasmus Darwin, Esq., 1778,—recently recovered by Prof. Silvanus Thompson.

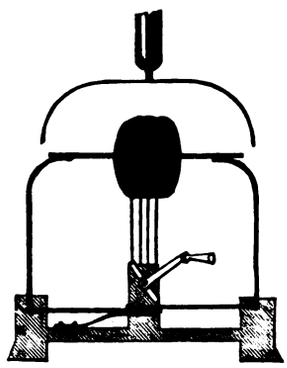

FIG. 2.—Probable appearance of Erasmus Darwin's Influence Machine.

a name which you will find mentioned in all the older cyclopædia articles in the history of electricity—I mean the name of Erasmus Darwin, the author of the "Botanic Garden," and the grandfather of the great Darwin (applause)—might I say the grandfather of the greater Darwin? Now Erasmus Darwin devised an apparatus for performing mechanically these operations of the electrophorus, by placing an insulated conductor under influence, touching it while under influence, and then carrying it away and making it give up its charge to something else. I searched vainly through all the literature of that time to try and find a picture or even an exact description of Erasmus Darwin's apparatus. It appeared to be a kind of *ignis fatuus*. The further one searched for Darwin's apparatus the more visionary did it become; and I was about giving it up in despair when I bethought me that there might remain possibly some unpublished literature on the subject. I had better read you first what is published. Darwin himself was greatly interested in the accounts of Volta's electrophorus, and in 1778, as we now know from unpublished manuscripts, he attempted to devise an arrangement for mechanically performing these manipulations. Bennet, one of the later experimenters, writing in a little book, "New Experiments in Electricity," published at Derby in 1789, says:—"Dr. Darwin, at the desire of Lord G. A. Cavendish, made the first attempts at such a mechanical arrangement with two plates moving between two others by a lever, so as to bring them to exactly the same position in each operation. This contrivance he soon improved by another instrument, in which the plates stood vertically and moved by rack-work in a direction exactly parallel to each other. This instrument was sent to Mr. Partington." I hunted in vain for Mr. Partington in all the cyclopædias and dictionaries. I then found a further reference in "Nicholson's Journal," dated 1797. It runs as follows:—"In the month of December, 1787, Mr. Partington lent me an instrument by Dr. Darwin, consisting of four metal plates, two of which were movable by wheel-work into positions which required them to be touched by the hand in order to produce these effects." That was the sum and substance of all that the cyclopædias could tell me. However, on applying to Mr. Horace Darwin, of Cambridge, he very kindly communicated with Mr. Reginald Darwin, of Buxton, and Mr. Reginald Darwin hunted up for me some old manuscripts of Erasmus Darwin's, and was successful in finding in a notebook of 1778 a page which has the drawing of this peculiar machine (applause). There is a rough facsimile upon the screen of this pencil sketch in Mr. Darwin's pages, and, below, a more polite version of the same apparatus (Figs. 1 and 2). In the middle there is a disc, which is electrified by rubbing, or has been electrified in some other way. In one case he used a metal sheet between two pieces of glass—the glass was to keep the metal sheet from sparking on to the other parts. Right and left of that there are two metal plates on insulating stands, worked by crank levers, and these crank levers move the plates towards the metal plate, and then move them away again. It is little more, you will see, than a mere mechanical translation of the action of placing a plate under the influence of a charged plate, and touching it while it is there. The more complex description of rack-work does not suit anything in this particular pencil sketch. However, the interest which Darwin took in this excited other persons; and Nicholson, having received from Mr. Partington this instrument, was incited to go further. In the

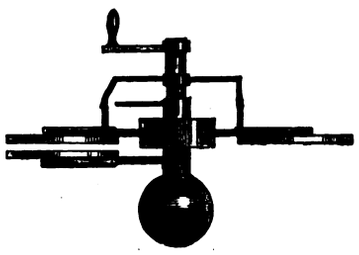

FIG. 3.—Nicholson's Doubler (plan view).

meantime, however, another small but very important piece of progress had been made. The Rev. Abraham Bennet was at that time curate of Wirksworth, and he communicated to the Royal Society, in 1787, a Paper under the following title, "An Account of a Doubler of Electricity, or a Machine by which the Least Conceivable Quantity of Positive or Negative Electricity may be Continually Doubled till it becomes Perceptible by Common Electrometers or Visible in Sparks." Now, Bennet's doubler was a very ingenious thing, though we can hardly call it an influence machine. It merely consists of three metal discs mounted with handles. I do not possess an actual specimen, but I have a rough model here lent me by Mr. Wimshurst, by which I may illustrate to you what is meant exactly by this doubler. Suppose this to be a metal plate, which I place on an insulating stand, and that it has a small charge of electricity somehow or other imparted to it. Call it 1. Now take a second metal plate and lay it close over it. The second one was varnished on both sides to prevent contact. Touch it while it is there by stretching out the forefinger. That plate will receive a charge which will not quite amount to 1, and will be of negative sign. If the first was plus 1, then the second will be minus 1. Then take the third plate, and place it over the second and touch it under influence. This charge will be not quite 1, but it will be 1 plus (nearly). Next take your plate into the plus 1 charge, lay it on the top of the third plate, whose charge is already plus 1, so that you obtain plus 2. From this you can immediately get minus 2 on your second plate. Now, then, over minus 2 lay the first plate, touch it, and you get plus 2, and having got plus 2, and put *that* down on the first plate, you get plus 3; and so you go on adding to the charge each time by these successive operations. Mathematically it is not exactly doubling, supposing the action to be perfect, but the meaning is sufficiently conveyed by the name "doubler." Now, Bennet's doubler at once invited the mechanical genius to step in and make it up into a working instrument, and that is exactly what was done within the next twelve months in two entirely different ways. The first way in which it was done was by Tiberius Cavallo, an Italian

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physician, resident for many years in London. I have here an actual specimen of Cavallo's doubler. I may say that this is, to a certain extent, historical, for it is kindly lent to me from the collection of apparatus in the possession of the London Institution in Finsbury-circus. Cavallo's multiplier consists of four metal plates, three of which stand on insulating pillars, but the fourth, which is not insulated, is connected with the earth. Call them 1, 2, 3, and 4; 1 is fixed, 2 is movable, 3 is fixed, and 4 is close to it. No. 2 stands upon a lever, so that it can be moved horizontally from a position close to No. 1, into a position touching No. 3, and then back again. A small gap exists between 3 and 4 that can be increased, but should be as small as possible at starting. This acts as an air condenser. Now, supposing a small charge is given to plate No. 1; you bring plate No. 2 near to it, but not touching, but while it is there touch it. But Tiberius Cavallo gives you an apparatus for doing this. A wire comes down and touches an earth contact, so that it actually is touched while under influence. So it receives a negative charge, and goes on negatively charged until it gives up its charge to the plate on the other side, and as often as you shift this lever backwards and forwards the electrophorus action goes on; and in this way you multiply any very small charge. In fact, you perform mechanically a somewhat similar operation to that which Bennet proposed to use with the doubler (applause). There is, however, no accretion to the original small charge—the original small charge merely gives up interest every time. Cavallo made many experiments with multipliers and doublers. The thing, however, that bothered both him and Bennet was that, even though you imparted

Fig. 4.—Nicholson's Revolving Doubler (from an actual machine).

no charge whatever to the first plate to begin with, if your instrument was properly made and dry you always ended by getting a charge. Their difficulty was, not that the thing would not work, but that it would work when you began with nothing, or apparently nothing; and Cavallo made lots of experiments to find out how it was that these apparatuses appeared to work spontaneously, and he came to the conclusion that you could not possibly put two metal plates near to one another without their somehow or other acquiring different electric states. Further than that, I am afraid, he did not go; and his researches may be said to bring us to the end of the first period. Then, in 1788, as mentioned in my opening sentence, Wm. Nicholson devised the revolving or rotating doubler which we now associate with his name. I have here upon the wall a large drawing of Nicholson's revolving doubler (Fig. 3), and I have also here, lent me from the historical collection of the London Institution, a Nicholson doubler of ancient date (Fig. 4) I know not whether it be an actual century old, probably not, because it looks like an instrument maker's apparatus. Nicholson himself says that he only made one doubler, and that this was presented to Prof. Martinus Van Marum, who wrote a beautiful book on electricity, and who at that time was in charge of the Teylerian Museum at Haarlem. It might be worth while writing over to the authorities at Haarlem to know if that historic doubler is there. But here is the doubler lent us from the London Institution. It consists of two metal plates on the ends of insulating arms, and a third metal plate which goes first past one and then past the other. Supposing a small charge were imparted to either of these two plates, then the third plate, while it is opposite this, is touched—there is a spring that touches it. If, therefore, the first plate have any charge upon it, the moving one would receive a charge—an opposite one. Then that comes round, and will pass opposite the second fixed plate; this plate is touched by a wire that connects it to the ball, so that if that were positive the interest on it is negative. That comes round to the other side, and the interest of that will be positive, and will be communicated to the ball, which will be slightly positive. But when it comes round again to the other side another action also takes place. When the third plate comes opposite the first one, not only is it touched while under influence, but at that moment, by means of a rod, plate No. 1 and plate No. 3 are connected, so that any charge that remains in this, after having given up some to the ball, is joined at that moment to the charge in No. 1, and they act doubly upon the movable plate, and the movable plate is under the influence of a stronger electric charge than before; so that it receives a bigger interest, which is carried round to the other side. Thus, every turn of the doubler increases the charge on the original plate, so that turn after turn excites the machine more and more highly, until it has attained a certain state of excitation. I may say that I have a copy of the original Paper here, with a drawing of the doubler upon it. This instrument does not work very well, probably

Fig. 5.—Lecture Table Electroscope.

because the glass used at that time was not so good a glass as we nowadays employ.

[An experiment was then shown by means of a model of the apparatus which had been constructed by Mr. Wimshurst. This consisted of a large Nicholson doubler, one of the fixed plates of which was connected to a simple electroscope made of two lightly balanced leaves of thin wood, with paper discs at their upper ends (Fig. 5). This doubler produced, with about a dozen revolutions, a charge sufficient to cause the leaves to fly apart to a distance of four or five inches.]

Now, there is a very interesting effect I can show you. At the moment when the movable disc comes opposite the one to which this is connected it will of course exercise an action like that of a condenser while the interest is being taken, so to speak, by influence from the principal. If the charge on the fixed disc is positive, then when the movable plate comes opposite it, and is touched, it will be left negatively charged, and so the two charges being of opposite sign they attract one another across the space between: and, consequently, the free charge, part of which was upon the electroscope, is condensed back into the fixed plate of the doubler, causing the leaves of the electroscope to close together. But as soon as I bring the charged disc round to the other side the action is reversed, and the electroscope leaves open out again. Then we have here, in Nicholson's apparatus, an influence machine which can excite itself and which can increase its

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own charges. The earliest criticism passed upon this machine by Prof. Robison was that, because the discs approached one another edgeways, you would have such a tendency to large surface-density at the edges that you would inevitably get a spark between the one and the other. That criticism is perfectly just, and in modern machines we find that—in general, at any rate—where you want to get any very high potentials, you do not have two surfaces of metal brought past one another without some kind of mechanical device, such as the introduction of a sheet of glass to prevent the possibility of a spark passing from one to the other. In fact, you must have at least *two* thicknesses of glass—one thickness is not enough—between the rotating part and the fixed part. One is not enough, for the simple reason that if you merely have one fixed or one moving sheet of glass, you have sparking or discharging in the air from the exposed metal part against the back of that glass, and the glass gets charged on its other surface with a charge which neutralises the effect of the charge on the metal conductor attached to it. You must have two thicknesses of glass. Now, from this point we enter upon the real history of the machine. In 1797 Nicholson devised what he called a *spinning condenser*. It is not quite clear from his account of it whether he devised it on his own notion or whether it was suggested to him by Bennet; at any rate, he says it was made after he had been talking to Bennet on the subject. In it there was a disc with two pieces of tinfoil attached to it, and this passed over a second disc which also had two pieces of tinfoil, one of which only was charged, and there were certain springs to touch so as to bring the charges round. In a very few years other forms had been devised. There was a Mr. John Read, who read a Paper at the Royal Society in 1794. His apparatus was like Nicholson's, but he called it a "spectacle doubler," because he made the discs of glass! You may judge of the strange sort of thing that Mr. Read brought

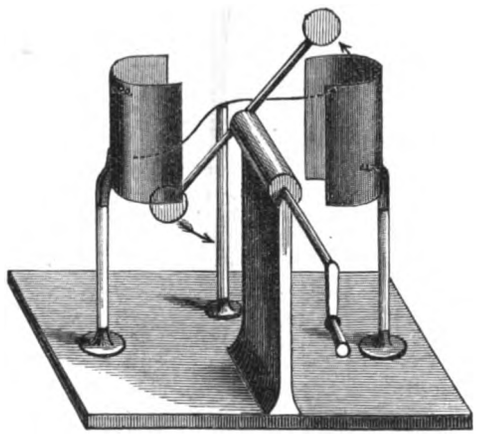

Fig. 6.—Belli's Doubler.

out with his doubler from this :—"Knightsbridge Charity School fills up a piece of ground between the north end of the chapel and Hyde Park wall, and the main sewer at that neighbourhood runs at no great depth under it. The number of children educated in this school is thought by some to be too great for the size of the school. On this account it becomes infected with a very disagreeable stench, especially when the doors and windows are shut up. I have sometimes found the noxious effluvium so very strong in this school that I have hastened out to breathe a purer air. I have often examined the electrical state of the air in this school with a doubler, and have always found it strongly negative" —and he made a number of unsavoury experiments in order to discover whether there was any real connection between the electrification which he could get out of a doubler and the atmosphere in which that doubler was worked. Then, to go on with my list, we come to a curious book, published in 1798 by a German pastor, Bohnenberger, which book is absolutely full of influence machines. Many of them are most curious machines. Some are made with mechanically sliding parts, some, like Cavallo's, with levers, some with rotating parts; in fact, there is one which is extremely like the Nicholson doubler set up on end. Doublers of various sorts grew and multiplied. In France Hachette and Desormes revived the Nicholson doubler, merely making an addition to the number of rotating parts. Then, about 1820 (the thing was not published till 1823, so I do not know the exact dates) the late Sir Francis Ronalds devised a form of doubler in which the movable plate was swung backwards and forwards at the end of a pendulum opposite the two fixed plates. In the case of Ronalds' doubler, as in Nicholson's, these two fixed plates were both to be charged with the same kind of electrification. If you began with positive electrification at one side the carrier became negative, but the plate at the other side became positive, and then these two were put together for an instant, so that any charge upon it might be used along with that in the further multiplying. But from the time of Ronalds onward, although we have two fixed parts and a rotating part, they are used not exactly in the same way; they are not both electrified with the same sign, but in the reciprocal manner devised by Lichtemberg in his long electrophorus. Henceforth, from this point onwards, when you have two fixed parts at the two sides, one is used as a positive and the other as a negative plate. As in the ordinary pattern of dynamo you have a rotating part between two fixed poles, so in the ordinary influence machine you have a rotating part between two fixed plates which I propose to call, and have for some time called, the "field-plates." Some people call them the armatures, some people call them the inductors; there are various names for these two fixed plates, but "field-plate" seems to me the name that is most comfortable to employ. As in the dynamo machine, we call that part which provides the magnetic field the "field-magnet," so in the influence machine I call by the name of "field-plate" that part which provides the electric field. Now, in 1831 Belli described a form of doubler which has this peculiar arrangement of two fixed field-plates, one of which has become positive at the same time that another one becomes negative (Fig. 6). In this case the field-plates are made of metal folded round on themselves, one at each side, and the two rotating parts are metal discs of about 1½in. diameter, carried at the ends of a glass stem. As these go round they are touched while under influence. You will see here at the back, standing also on an insulating stem, though it need not be insulated, a conductor. This has spring ends and extends down to the lower side of the field-plate on the one hand and to the upper part of the field-plate on the other hand. A little way down from the top of one field-plate and a little way up from the bottom of the other plate there are a couple of small springs soldered on inside, so that they touch these rotating carriers as they go round. Suppose, then, we start with a small charge, and one field-plate be slightly positive (the rotation is supposed to be left-handed in Belli's drawing), this little disc will go between the folds of the field-plate and be touched by the diagonal conductor

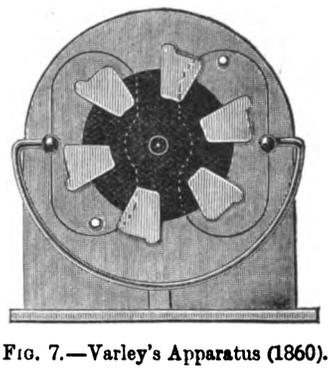

Fig. 7.—Varley's Apparatus (1860).

just the last thing before it comes out. It is then negatively charged while it passes round underneath; as it goes up on this side the first thing it does is touch the internal spring and give up its negative charge to the plate on this side. Then as it goes up the last thing that happens before it comes away from the negative field-plate is that it is touched by the contact spring on the other end of the diagonal conductor, and goes off positively charged, giving up its positive charge to the little spring on the inside of the other field-plates. Now that is absolutely typical of what happens in all the modern influence machines. Some time ago—in fact, long before I knew this particular apparatus of Belli's—for the purpose of illustrating lectures on this subject I devised an almost identical piece of apparatus, which I also have here, the only essential addition being the pair of discharging combs to receive any superfluity of charge remaining over. Curiously enough, almost an identical thing, though different in form, is the little replenisher which we have in Sir William Thomson's electrometers. All the essential features are present. There are two field-plates, right and left; there are two insulated pieces of metal on the ends of arms, which go round. I would like to call this rotating part with the two sectors on it an "armature." In the dynamo the part that rotates with the various sections or coils of wire upon it is the analogue of the part which in the influence machine rotates and carries around the metallic sectors or charged conductors. Each one of these metallic conductors being touched, while under influence, by a little brush goes off charged, gives up its charge to the other side, and so this thing charges itself up. Beside this doubler Belli devised another machine having a rotating plate of glass with metal plate affixed to it. To this machine he gave the name of *macchina ad attuazione*. I thought this must be a misprint for *attrazioni*—the *attraction* machine; but no, it is *attuazione*

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in two places, and as the Italian dictionaries do not give that word I conclude that he made it up, and that it meant an actuation machine, a machine which works not by friction but by *actuating*, by being *actuated* or something of that kind; that is the nearest translation I can get for it. From the time of Belli there is a great gap; very little was done. There was a certain Mr. Goodman, of Birmingham, who made up a large machine which is supposed to work on the influence principle, though I am not at all sure that it does. Then Svanberg in 1846 devised another arrangement of a double electrophorus, where a disc had to be carried over the top from one electrophorus to the other. Then there comes a blank, and the science of the construction of influence machines absolutely died out, to be revived again by Varley. This brings us to the third period. In 1860 Cromwell Fleetwood Varley described an influence machine which had in it almost everything that we have in the modern ones, and, indeed, it is a machine of a very advanced type. In Varley's apparatus (Fig. 7) you have, as before, two field-plates; they were pieces of tin-foil stuck against glass—a large sheet of glass. They are those two oval patches in the figure. In front of them (or rather between them, for there are two sets one in front and one behind connected together) rotated an armature—a disc in fact—having carriers of metal upon it, which as they rotated were touched while opposite to one field-plate, and then went round to give up the charge so acquired to the other field-plate. Those two knobs which are joined together by a connecting arc are the parts which correspond to the neutralising brushes which touch the carriers as they go round. The knobs were used in some of Varley's actual machines, though he himself suggests that for certain purposes it would be better to use spring contacts. The rotations are in this figure supposed to be right handed.

(To be continued.)

THE ELECTRIC-LIGHTING SCHEME IN BRADFORD.

LOCAL GOVERNMENT INQUIRY.

On Thursday, May 31st, Major Tulloch, R.E., one of the inspectors of the Local Government Board, held an inquiry at the Town Hall, Bradford, in respect to the application of the Corporation for sanction to borrow £20,000 for the purposes of the proposed electric-lighting installation in the borough. There were only about half a dozen persons present in addition to the inspector. Alderman Frederick Priestman, chairman of the Gas Committee, and the Town Clerk (Mr. M'Gowen) represented the Corporation; and Mr. J. N. Shoolbred, electrical engineer to the Corporation, was also present.

The Town Clerk, in laying the case of the Corporation before the inspector, stated that some time since the Corporation obtained a confirmatory Act of Parliament which empowered them to supply electricity for lighting purposes and for motive power By that Act two years' grace was given to the Corporation, within which time they were to do something towards putting into operation the powers granted, subject to the condition that if the Corporation did not move within that period and any company wished to take up the project, the powers granted to the Corporation should not stand in the way. Before the two years expired, however, the Corporation introduced a Bill into Parliament containing clauses seeking to make their electric lighting powers permanent. The Board of Trade, after considering that portion of the Bill, came to the conclusion that it would be undesirable to give to the Corporation such powers in a permanent form, but gave them an assurance that if any other persons came to the borough with any project the Corporation should be duly considered, and the powers granted to them should remain in their hands unless there had been unreasonable and wilful default on their part. About that time, as the inspector would be aware, the subject of electric lighting was not so far advanced as it had since become, and it was thought best to let the matter remain in abeyance for awhile, pending such improvements as might be made. Some time afterwards a company came to the Corporation and asked for permission to carry cables over the streets. This seemed to the Corporation a most objectionable mode of procedure, considering the weight of the cables and consequent danger to the public; and as other persons, including the Post Office authorities, were required to carry wires underground in the busy part of the town, the Corporation refused the application. To some people it might have seemed ungracious on the part of the Corporation to refuse liberty to the company to use their electric powers while at the same time the Corporation had similar powers but neglected to carry them into effect. The Gas Committee thought it well to bring the subject up for discussion in the Council, and, it being found that there was likley to be a considerable demand for the electric light, it was, after full inquiry and consideration of the subject in all its bearings, determined that the Corporation should make a start. No one, however, yet knew sufficient of electric lighting to justify the setting up of a complete system for the whole borough, and it was thought that the most judicious mode of proceeding would be for the Corporation to select a central portion of the town, and to have a limited installation put down until it was seen how far the project was successful. Plans were therefore prepared by Mr. Shoolbred, acting for the Corporation, and it was resolved to seek powers to borrow the necessary money; and the Council having made application to the Local Government Board for that purpose, as directed by the Act of 1883, the result was the inquiry now being held. As the inspector well knew, the Corporation was required to give the utmost publicity to everything they did, and such had been the case in the present instance. So far as could be ascertained, the scheme seemed to meet with very general approval, and the absence of opposition was a strong testimony in favour of this view. It should be stated that the trade of the town was of a peculiar character, and the Corporation were told by the merchants that the electric light would be a great convenience to them, as facilitating the matching of tissues of the various textile fabrics produced in the town, as also in showing off the various shades of colour. It remained for the inspector to say whether he felt justified in recommending that sanction be given for the Corporation to borrow the amount for which application had been made. It was at first thought that £20,000 would be sufficient to meet the demands; but when tenders had been received for the necessary works it was found that nearly the whole of that sum would be absorbed, and the Corporation requested to be allowed to amend their application so as to include an additional £5,000. In the year 1871 the Corporation bought up the undertaking of an old gas company, and it might perhaps be thought that in seeking now to supply electricity they were cutting their own throats; but being satisfied that there was a demand for the electric light they wished to be able to supply it themselves, and so maintain the exclusive control of the streets, as they were apprehensive that if any trading company were to get a foothold in the town the difficulties of the Corporation would be very much enhanced. It was most desirable that only one authority should deal with the streets, and every arrangement would be made to secure economy in carrying out the project.

Alderman F. Priestman added his confirmation to the Town Clerk's statement, and explained the desirablility of having the works proceeded with as soon as practicable. Considering the substantial character of the plant to be laid down, he urged that the term of the loan should be as long as possible.

The Town Clerk proposed to call Mr. Shoolbred, the Corporation's electrical engineer; but the inspector stated that the engineer had already supplied him with the fullest particulars, and that no further information was really needed on his part, adding that there was nothing in relation to the scheme generally, or arising out of the inquiry, to which he saw the least objection. The inspector remarked that the best course for the Corporation to adopt would be to address to the Local Government Board a supplementary application for the additional £5,000 required. It was highly desirable that an inquiry should have been held, as the subject was new both to the Corporation and the Department. Indeed, he believed the Bradford Corporation were the first municipal authority to take action in the manner they proposed.

On the motion of Alderman Priestman, seconded by Mr. Joseph Edmondson, a vote of thanks was passed to the inspector for his courtesy in conducting the inquiry, and Major Tulloch having responded, the proceedings closed.

THE CONSTITUTION AND PLAN OF LICENSING ADOPTED BY THE "NEW ENGLAND ELECTRIC EXCHANGE."

The New England Electric Exchange is the title of an association which has recently been established in the United States for purposes which are fully explained by the following extracts from the "Constitution" of the new organisation:—

Article I.—The name of this association shall be the New England Electric Exchange.

Article II.—The object of the exchange shall be the general promotion of electrical business and especially in the direction of securing perfection in electric light and electric power installations, and in harmonising and adjusting so far as possible all differences which may arise between various electrical interests.

Article III.—Every one residing and doing business in the New England States and actually engaged in manufacturing or installing electric light or electric power apparatus, or in operating commercially an electric light or power plant, is eligible to membership in

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the exchange, and may become members upon complying with the provisions of this constitution.

Article IV.—The officers of the exchange shall consist of a president, a secretary who shall also be treasurer, and a board of directors consisting of the above named officers and three other members, all of whom shall be elected by ballot at the annual meeting in April.

[After some formal clauses the articles proceed.]

Article V.—The directors shall be the governing body of the exchange; they shall meet from time to time, at the call of the president, or at the request of any two of their number, and shall adopt such measures for promoting the object of the exchange as they deem expedient, or as instructed by the exchange; they shall be the judges of the eligibility of all applicants for membership; they may fill until the next regular meeting of the exchange any vacancies occurring in their own body or in the offices of president, or secretary-treasurer.

Article VI.—Regular meetings of the exchange shall be held on the second Monday of April, July, October, and January, at such time and place as may be appointed by the president.

Article VII.—The annual dues shall be three dollars ($3.00) for each member, payable in advance, and shall cover the time between two annual meetings.

[The remaining articles are purely formal.]

PLAN OF LICENSING.

In order to promote ambition in excellence of workmanship and extent of knowledge among men practically engaged in installing or operating electric plants, and to thus make it an object for fire underwriters to recommend the introduction of electricity in preference to other means for producing artificial illumination and power, the New England Electric Exchange will issue licenses under the following general plan:—

Licenses shall be of five classes, each class representing a certain extent of qualification.

First class licenses shall be issued only to persons fully competent to instal and operate any electric light or electric power plant.

Second class licenses shall be issued only to persons fully competent to instal and operate any two of the following plants, viz., incandescent light, arc light, or power.

Third class licenses shall be issued only to persons fully competent to instal and operate any one of the following plants, viz., incandescent light, arc light, or power.

Fourth class licenses shall be issued only to persons fully competent to operate electric machinery, and who are not competent to do electric wiring.

Fifth class licenses shall be issued only to persons fully competent to do electric wiring and who are not competent to operate electric machinery.

Any person desiring a license shall make formal application to the secretary of the exchange specifying the class of license desired; these applications shall be referred by the secretary to the directors, who shall select three persons to examine the applicant and report upon his qualifications.

The examiners shall appoint, for the examination, such time and place as may be deemed by them advisable, and the applicant shall appear before them at such time and place for examination.

The examination shall be such as to satisfy the examiners as to the fitness of the applicant for either the license applied for or for one of another class.

All licenses shall be properly filled out with the class of the license, name and qualification of the licensee, certified to by the examiners, submitted to the New England Insurance Exchange or to the Boston Fire Underwriters' Union, as the case may be, bear in token of their approval the signature of one of their inspectors, and then be dated and issued under the seal of the exchange.

A license shall be valid for one year from its date, but the licensee may apply within that time for examination for a license of a higher class.

The directors of the exchange may, for cause, revoke any license granted by the exchange.

All applications for license must be accompanied by two dollars ($2.00) to help defray expenses, and must bear the signature of two members of the exchange.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *May 26th*, 1888.

We have just had given us in this city a remarkable evidence of the manner in which the march of improvement may be arrested by ignorance or corruption on the part of municipal authorities. The Harlem Railroad Company has been seeking for permission to change the Fourth and Maddison Avenue railroad into an electric road, using the Julien motor and storage system. Considerable preparations have been made for the work, of which I have already advised you, including the equipment of a very compact generating station, and the building of a number of remarkably fine cars. Public sentiment along the line is overwhelmingly in favour of the change, as shown by the fact that out of one thousand letters of inquiry on the subject addressed to residents on or near the avenue, 656 answers were received, and only five of those were against the scheme. All this had little weight with the aldermen, who by a vote of fourteen to ten this week have rejected the report of the railroad committee recommending the adoption of electricity. As may be imagined, some of the objections to the scheme were of an amusing nature, the chief opponent of the motor going so far as to assert that it would be dangerous for a passenger to have steel nails in his shoes. Another nineteenth century objection was that the introduction of electricity would throw thousands of workmen out of employment, just as though the total amount of labour to be done after all would not be the same; while the benefit and convenience to the public would be so great. The remarks made in the course of the discussion showed that however well informed the board might be about political machinery, it had plenty to learn in connection with that of an electrical kind. It is understood that the street railway company will run its cars as far down as 14th-street, and will await the development of public opinion to compel the aldermen to give it privileges below that line.

As a contrast to this, however, it is interesting and encouraging to note the reception given the Enos system at West St. Paul, Minn., operated by Thomson-Houston motors. In this system the car swings below the working mechanism, being carried practically on a one-legged structure, in which one rail stands above the other. The car runs about 14 feet from the ground, upon open and light truss work, and there is necessarily an absence of wooden guard timbers, cross tie-beams, sleepers, &c. The current is carried to the motor by the rails on the upper trestle, while the guide tracks or brake wheels follow the under trestle through the rail on which the return is made. A very successful demonstration of this system was made a few days ago, and was witnessed by the leading city authorities of the two great cities of St. Paul and Minneapolis, all of whom were greatly pleased with what they saw, and voted for electricity with both hands.

While on the subject of motors, I may mention that the Sprague Company, which has recently been paying special attention to mining apparatus, has brought out a mine hoist, which it has supplied to a corporation at Aspen College. This work is, as is well known, of a difficult character, and in the present case the electrical apparatus replaces a steam plant. There are to be two of these hoists put in, driven by 10 horse-power motors, while another motor of the same size is used for general miscellaneous service. The current is to be generated by water-power, and a circuit, a mile long, will be run from the turbines to the motors.

The Sawyer-Man Electric Company in this city is now rapidly settling down to work in its magnificent new quarters in West 23rd-street, where its floor space of 117,000 feet is ready for use. The Consolidated Company, using the Sawyer-Man system, has recently issued a broad-sheet circular, showing the number of installations and of lights under its patents. According to the grand totals given, there were on the 15th December, 1887, 308,302 lamps operating under the Sawyer-Man patents. On April 15th, 1888, there were 429,313, the increase in four months being 121,011 lights. The company proposes to give its factories combined a capacity of at least 10,000 incandescent lamps a day, a figure that furnishes some idea of its faith in the future of the business.

The prolonged telephone litigation seems now to have really reached its end in the refusal of the Supreme Court to grant a re-hearing of the Drawbaugh claims. I do not mean to say

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that there will be no more Perkin Warbecks—in fact, there are one or two in the field now—but Mr. Bell has been held by the Courts now to be entitled absolutely to everything that he was granted, and all efforts to lessen the meaning of the broad interpretation given his patents must be hopeless. Of course, we have a good deal of newspaper talk about the iniquity of all this thing, and about the evils of the monopoly thus set up and fortified; but nobody seems anxious to impeach the Supreme Court, and there is, after all, even among those who do not love the Bell Company any too well, a feeling of satisfaction in seeing the value of patents so thoroughly established.

Quite a discussion is going on just now as to the cause of death by the electric current. Mr. P. B. Delany read a Paper last week before the American Institute of Electrical Engineers discussing the subject, and making a suggestion that a thorough investigation was in order. Prof. E. J. Houston has just published a Paper read by him before the American Philosophical Society, in which he expressed the opinion that death is due to electrolytic action of the tissue: to use his own words, in the case of the direct current death sometimes results from shock, but generally from the electrolytic effect on the blood or other tissues of the body; while death by the alternating current probably results from shock only. He explains the more frequent cases of resuscitation after shock from the alternating current by the absence of electrolytic decomposition of the tissues. In one of the electrical papers this week, Dr. Robert Amory in turn takes up the question, and refuses to allow Prof. Houston's explanations to go unchallenged. He makes the assertion that medical men are of the opinion that most generally death by electricity is caused rather by asphyxia than by chemico-physical effects on the living tissue. According to him, the animal functions of muscular contraction are thrown into strong tonic spasms, which will prevent the free respiratory movements essential to life. Hence the movement of the blood in the capillary circulation is arrested, the tissues are paralysed, oxidation of the blood ceases, the heart is no longer stimulated to action, and death ensues.

I noted recently in this correspondence the favourable remarks of one gas association president with regard to the electric light. These have now been seconded by President M'Millin, of the Western Gas Association. He submitted some interesting statistics in his annual address with regard to the manner in which electric light and power affected the gas industry. Taking the figures furnished by a number of gas companies, he found that the gas production had increased 7 per cent. during the year, while the electric lights had displaced gas burners that would have averaged a consumption amounting to about 10 per cent. more. The responses of the companies show that there was a marked increase in the use of electric lights over the previous year. From the information obtained, Mr. M'Millin drew various conclusions. One was that there was to be a struggle for supremacy between the gas engine and the electric motor, the latter being shown to have gained considerably. He thought that the struggle would result in the discarding of the small steam engines. He believed it also to be policy for gas men to supply electric light when possible, thus recognising the legitimate and reasonable demands of the public for a first-class commodity. Of the electric light he said that the time was coming when the public would demand arc or other powerful lights on most public streets. As to incandescent gas lighting, he said:—"It is making equal progress with the electric light; it is the most convenient, the most cleanly and the least objectionable from a sanitary point of any light now in use. Its convenience is making it popular. It will not do for gas managers to longer expect to fight it off by proclaiming its unreliability." This is striking language from a prominent gas engineer, and it does much credit to the speaker's clear perception of facts. It is perhaps not undeserving of note that a motion was made to change the name of the body to the "Western Gas and Electric Light Association." This was promptly vetoed down, but the mere fact that it was offered is very significant.

CORRESPONDENCE.

FIRE TELEGRAPHY AND FALSE ALARMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the leading article which appeared in your journal of the 25th of May on the subject of electrical fire alarms, and which criticises my Paper on fire telegraphy read at the Society of Telegraph-Engineers and Electricians, I was exceedingly pleased to find that you so fully support my conclusions that the aggregate destruction of property has been greatly reduced, notwithstanding the large increase in the number of fires, by the adoption of electrical alarms, and that this reduction may be extended in the future by the general employment of good systems of fire telegraphs, combined with a large number of street call-points.

Your straightforward criticism of so important a subject of public interest is sure to contribute largely to the desired object, and I accept willingly every word you have expressed, even when you accuse me of being "an enthusiast for fire telegraphy;" although I may be permitted to entertain some doubts as to the accuracy of this opinion. None can know better than the editor of an electrical journal what enormous difficulties are placed in the way of promoters of new appliances, however good they may be; hence a little enthusiasm is, perhaps, more a virtue than a vice. When once conservative prejudices are overcome and the ball is set rolling there is no further need for enthusiasm, and people will then begin to wonder why things were allowed to remain for so many years in this unfortunate state of "*Dolce far niente.*"

However, be that as it may, at present I am chiefly interested in considering the remarks made by Capt. Shaw during the discussion on my Paper. I must, in the first place, fully endorse your opinion that "the most valuable result of the Paper was the speech made upon it by Capt. Shaw, the chief of the London Fire Brigade," and "that we ought to give the carefullest attention to Capt. Shaw's remarks." I think the entire public ought to be grateful to that officer for having participated in the discussion, and for having given us information, hitherto unknown, of the greatest public interest and importance.

Capt. Shaw assured the meeting that the street fire-call points of London answer admirably, but that they are subject to the serious inconvenience of encouraging false alarms. The electrical calls transmitted from the London street call-posts during last year amounted to 362 false and 833 good electrical calls, counting in the latter, for my purpose, such calls as were sent unnecessarily, but in good faith, on mere suspicion of fire. It is this information concerning the large number of false alarms, coming as it does from so high an authority, which is very liable to cause misleading conclusions. The subject requires, therefore, as suggested in your article of the 25th May, some further investigation, the more so as this unfortunate experience connected with the London fire telegraphs is sure to act as a serious obstacle to the development of fire telegraphy in England if it be not at once shown that the serious inconvenience which Capt. Shaw's figures indicate need not exist.

Fortunately for fire telegraphy, however, it can easily be shown that Capt. Shaw's unfavourable experience is not the rule, but the exception. This I fully anticipated when the statement was made at the meeting; but not being prepared at the time with evidence to prove my belief I could only leave it for reply at a later date. Therefore, after collecting the necessary data, I communicated with your contemporary, the *Electrical Review*, and an article appeared on the 20th of April, making a comparison between false alarms sent in Berlin and in London, which clearly showed how considerably the high percentage of the latter could and should be reduced. In accordance with my table showing the number of false and good alarms during the year 1887 in London and in Berlin, it appears that in London 14·2 per cent. of false alarms were sent maliciously, against 3·5 per cent. in Berlin. Then, again, in comparing the fire-telegraph systems in the two cities from a technical point of view, the official figures show that whilst in 1887 London had 16·1 per cent. of false calls, inherent, in

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FIRE CALLS RECEIVED FROM STREET ELECTRICAL CALL-POSTS.

TOWN.	Year.	False Calls.						Good Calls.			Grand total of calls.	Percentage of False Calls Sent from Street Call Posts.			
		Sent maliciously.	Due to unknown causes.	Due to apparatus or lines out of order.	Due to collisions of vehicles with alarm posts.	Due to accidental ringing during repairs of the line, and through accidental contacts.	Total false calls.	Sent unnecessarily, *i.e.*, for very slight fires or merely on a suspicion of fire	Good calls.	Total good calls.		Sent maliciously.	Due to defect in the system.	Total percentage of false calls.	
												%	%	%	
London	1887	170	74	91	14	13	362	13	820	833	1,195	14·2	16·1	30·3	The fire telegraphs in all these towns are on the Siemens system.
Berlin	1887	14	...	...	...	...	14	...	383	383	397	3·5	0·0	3·5	
Cologne.....	1885	5	...	...	...	...	5	31	206	237	242	2·1	0 0	2·1	
,, ...	1886	10	...	1	...	...	11	27	224	251	262	3·8	0·4	4·2	
,, ...	1887	8	...	2	...	...	10	14	227	241	251	3 2	0·8	4·0	
Frankfort-on-Main	1887-88	5	...	2	...	...	7	...	89	89	96	5·2	2·1	7·3	
Munich.....	1887	...	...	...	...	...	...	...	...	...	...	0·0	0·0	0 0	
Vienna	1887	7	...	...	...	7	14	116	416	532	546	1·3	1·3	2 6	
Magdeburg	1887-88	...	...	...	...	...	...	...	127	127	127	0·0	0·0	0·0	
Aix-la-Chapelle ...	1887	6	...	...	...	...	6	9	63	72	78	7·7	0·0	7·7	
Kœnigsberg	1887	...	...	...	...	...	...	...	72	72	72	0·0	0·0	0 0	
Stockholm	1887	6	...	...	...	...	6	2	61	63	69	7 7	0·0	7·7	
Dresden	1887	...	...	...	...	...	...	39	140	179	179	0·0	0·0	0·0	

one way or another, to the telegraph system in use, Berlin had not a single false alarm attributable to this cause.

The question of "false alarms" has thus, so to speak, a social and a technical side. The social question embraces the number of false alarms sent maliciously, whilst the technical question depends entirely upon the reliability of the telegraph system in use and of its careful installation. From what has been said already it is evident that the false alarms due to maliciousness are in London far too many, whilst those due to defects in the electrical system could, perhaps, be entirely eliminated by the adoption of a telegraph system which is intrinsically free from the defects which operate in causing the class of false alarms enumerated by Capt. Shaw.

In order to still further prove my views I have compiled the following table, which shows that the percentage of false calls sent from street call-posts in London is comparatively most unduly high, and that a considerable reduction is possible. I have been favoured with the statistics presented in this table by the chief officers of fire brigades in a number of towns on the Continent, chosen at random, but in all of which the Siemens fire-telegraph system is in use, a system with which I am personally acquainted.

It will be seen by a comparison between the results obtained in London and in these ten Continental towns that the technical question of false alarms can be satisfactorily solved, but with regard to the best means to reduce the present high rate in London of 14·2 per cent. of false calls sent maliciously, the only remedy is that suggested by Capt. Shaw, that the magistrates should punish severely anyone detected in interfering with the call-points. Similar annoyances by evil-disposed persons have been experienced in other services in their early days, but have almost entirely ceased in course of time. The former enormous malicious destruction of telegraph insulators is, for instance, still fresh in the memory of the older telegraph engineers, and the writer has a vivid recollection of a young man of fortune amusing himself persistently by shooting down in the morning the attractive glazed porcelain insulators, which had been erected the day before on one of the most important telegraph lines in the British Empire, specially constructed for the conveyance of news received from the seat of War in North America.

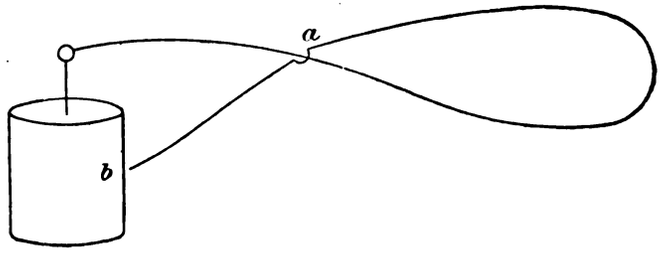
Lapse of time, the "properly administered" assistance of the magistrates and of the public in general, have acted so beneficially on the distorted minds of those few evil-disposed persons that, as our Post Office authorities could testify, a most desirable improvement has taken place in the preservation of the telegraph lines, and consequently of the service in general. I am therefore confident that with similar assistance on the part of the authorities the high percentage in London of 14·2 false calls sent maliciously will likewise in course of time become considerably reduced. Adding to this the adoption of fire-telegraph systems which are free from defects likely to cause false alarms there is no reason why false alarms should not become in London, if not entirely extinct, at least as rare as they are in many other large cities, which show an average of about 3 per cent. of false calls sent maliciously, and not more than about ½ per cent. due to defects in the telegraph system.—Yours, &c. R. von Fischer-Treuenfeld.

London, 2nd June, 1888.

ELECTRICAL OSCILLATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your last issue I read with interest Mr. F. Higgins' letter. Let me say here that the curve given in my paper to assist in conveying a notion of the electrical oscillations at the establishment and rupture of a circuit conveying a current was in no sense intended as an accurate representation of the form of the current curve, but simply as a graphic device to avoid longer verbal description. It would be very useful if Mr. Higgins could give us the whole of his current curve up to complete steady current. As given in his Fig. 1 it seems to me to be only that part of the current curve which extends from zero to about half way up to the steady value. Any such actual observations, with the means by which they were obtained, would be most instructive.



Mr. Higgins deserves our thanks for drawing attention to the simple experiment with the two binding screws. Might I add that I do not recollect to have seen this same idea brought home sufficiently as an explanation of the *modus operandi* of a lightning protector on a telegraph circuit? The simple device of Mr. C. F. Varley of twisting together the silk or cotton covered wires leading from the terminals of the old single-needle instrument depended for its success as a lightning protector on the all but perfect opacity of the inductive circuit of the coils to sudden discharges; and the same is, of course, true of every other such device, such as the usual double-comb protector. All these are only forms of Faraday's old experiment of the Leyden jar discharged by a loop of wire, with the loop crossed in the middle and wires nearly touching.

If the discharge wire is crossed at *a* and nearly touches, then

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on making contact at *b* the spark appears at *a*, even although there is a complete metallic circuit.

Following the nomenclature of dynamics, these brief electromotive forces producing electric discharges such as a spark, might be spoken of as *electromotive impulses*. The general result may be summed up by saying that if a network of conductors is submitted to an electromotive impulse, the course and sub-division of the discharge will be very different with very short discharges to that which it has when the discharges are relatively of much longer duration. Thus it would be highly probable (though I have never tried the experiment) that if a jar, as above shown, were discharged through a piece of wet string at *b*, that the dragging out of the discharge thereby caused would stop the spark at *a*, and make it take the course of the metallic loop.—Yours, &c.,

University College, London. J. A. FLEMING.

THE ELECTROLYSIS OF MERCURY BY THE ACTION OF AN ALTERNATING CURRENT OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Perhaps it will be of interest to some readers of your valuable paper to know of the peculiar behaviour of two mercury electrodes placed a short distance apart in dilute sulphuric acid when an alternating current of electricity is passed from one electrode to the other through the dilute sulphuric acid. As soon as a current is caused to flow, the mercury becomes agitated and presents a beautiful wavy appearance on its surface, which increases in its agitation as the current strength increases. The mercury at the same time being attacked by the acid forming an insoluble sulphate, this rises with the hydrogen which is liberated at the surface of the mercury in a cloudy form, and slowly falls to the bottom of the cell. This peculiar phenomenon is of great scientific interest, as this sulphate is formed in proportion to the current passing; consequently the mercury loses in weight in the same proportion. We made these discoveries in the course of an extended series of experiments to overcome the difficulty of metering alternating currents. Owing, however, to many mechanical difficulties in the use of mercury the idea to use this as a meter was abandoned. Further searches resulted in a successful issue, and we hope to shortly publish an account of the working of our meter.—Yours, &c. LOWRIE-HALL.

[Our correspondent has certainly made a very interesting discovery, and one which it would be extremely interesting to investigate further from the theoretical point of view. It can scarcely be correct, however, to speak of the "electrolysis" of an element.—ED. *E.*]

MR. HOWELL'S TESTS OF THE EFFICIENCY OF INCANDESCENT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of May 4, 1888, you make the criticism upon a Paper read by Mr. J. W. Howell on "The Maximum Efficiency of Incandescent Lamps," that the method adopted for measuring the current in the difference of potential is the most important. This statement is supplemented with the hope that the instruments used were not of the ordinary "commercial" type. Your remarks imply that there is a probability that Mr. Howell, who is the electrician of the company, has not been supplied with proper apparatus for making determinations. To this we have only to say that for eight years the question of E.M.F. resistances and candle-power have been a constant study on the part of Mr. Howell, and that he has availed himself of every opportunity offered him to make comparison with the standards of other laboratories and firms. If he were to give an adequate statement of the precautions used to insure the accuracy of his measurements it would take a separate and equally long Paper as the one read. This was not deemed advisable. The difference of 1 per cent. in the volts in the marking of a sixteen candle-power lamp would make a difference of one candle-power in the light given. This makes the question of E.M.F. one of great importance in our business, and it has compelled us to have it under investigation continuously ever since we started business.—Yours, &c.,

(For THE EDISON LAMP COMPANY)
FRANCIS R. UPTON, Treasurer.

Harrison, N.J., May 22, 1888.

THE INVENTION OF THE ELECTRIC LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. G. H. Staite's letter under the above heading in your last issue shows that he is labouring under a misapprehension as to well-known facts.

It is no doubt true that Mr. Edison's first patented invention relating to electric light by incandescence, though announced at the time as a great discovery, was, in fact, nothing more than Staite's invention adapted to the regulation of platinum incandescent lamps arranged in "series."

It may perhaps be of some satisfaction to Mr. G. H. Staite to learn that this invention, however ingenious in itself, is not the basis, nor indeed does it form any part of the system or systems of incandescent lighting at present in use, under whatever name they may be known.—Yours, &c.

June 5, 1888. ST. G. LANE-FOX.

PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

6,928. F. V. ANDERSON and J. F. TAFE. London. Improvements in electric switches. May 9, 1888.

6,953. W. SOUTHERN. Liverpool. Improvements in electric gas lighters. May 9, 1888.

6,961. G. A. NUSSBAUM. London. Improvements in automatic electric batteries. May 10, 1888.

6,985. M. IMMISCH. London. Improved switch for electrical tramcars. May 10, 1888.

6,988. M. R. WARD. London. Improvements in the method and means of supplying electrically worked vehicles with fresh sets of accumulators or equivalent sources of electricity. May 10, 1888.

7,035. W. E. LANGDON. Derby. An electrical coupling. May 11, 1888.

7,083. T. W. FORD. Clewer. Improvements in electro-medical batteries. May 12, 1888.

7,111. J. H. DAVIES. London. Improvements in electrical couplings partly applicable to other purposes. May 14, 1888.

7,131. Sir W. THOMSON. Glasgow. Improved apparatus for measuring and regulating electric potentials and currents. May 14, 1888.

7,256. F. ROWLING. Leeds. An improved combined holder-switch and cut-out for electric glow lamps. May 16, 1888.

7,301. Sir W. THOMSON. Glasgow. Improved apparatus for measuring and regulating electric potentials and currents. May 17, 1888.

7,308. C. A. RANDALL. London. Electric date and time printing stamp. May 17, 1888

7,321. J. KENT and F. J. BEAUMONT. London. An improvement connected with accumulator jars or other receptacles for holding plates of metal or the peroxide plates and negatives for electrical storage batteries. May 17, 1888.

7,332. H. EDMUNDS. London. Improvements in and connected with conductors of electricity. May 17, 1888.

7,333. R. MCKENZIE. London. Improved electrolytes for electric batteries (H. Weymersch, France). May 17, 1888

7,355. R. VON F. TREUENFELD. London. An improvement in field telegraph and other similar conductors. May 17, 1888.

4,673A. P. M. JUSTICE. London. Improvements relating to incandescent electric lamps (C. Heisler, United States). March 27, 1888. Note.—This application having been originally included in No. 4,673, dated March 27, 1888, takes, under Patents Rule 23, that date.

7,463. M. KOTYRA. London. Improved alternating commutator. May 19, 1888.

7,479. F. L. RAWSON and W. WHITE. London. Improvements in insulation in electrical machinery and apparatus. May 19, 1888.

7,480. F. L. RAWSON and W. WHITE. London. Improvements in insulation in electrical wire or in its supports or carriers. May 19, 1888.

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COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

May 19, 1888.

6,809. J. ESHELBY and E. ESHELBY. Dublin. Improvements in electric bell indicators. May 10, 1887.

6,918. W. E. GEDGE. London. Improvements in telegraphy (A. Claude, France). May 11, 1887.

7,042. F. G. CHAPMAN, F. M. DEARING and W. G. CHAPMAN. London. Improvements in electric arc lamps. May 13, 1887.

9,829. T. STANLEY. London. Improvements in dynamo-electric machines. July 13, 1887.

9,904. L. GRABAU. London. Improvements relating to the production of insulating coatings or linings in electrolytic apparatus. June 14, 1887.

10,195. J. P. HALL. Manchester. Improvements in dynamo-electric machines. July 21, 1887.

10,575. W. EMMOTT and J. H. RIDER. Halifax. Improvements in instruments for electric measurement. July 30, 1887.

15,717. C. A. RANDALL. London. Electrical date and time stamp. November 16, 1887.

May 26, 1888.

5,648. J. H. HOLMES. London. Improvements in apparatus for making and breaking electric circuits. April 18, 1887.

9,017. W. CROSS. London. An improved method of heating ores and other substances by an electric current for effecting metallurgical, chemical and other operations, and furnaces or apparatus therefor. June 24, 1887.

10,454. J. T. GENT and H. G. ELLERY. London. Improvements in and relating to electrical signalling apparatus for domestic and other purposes. July 27, 1887.

5,713. J. K. HALLOCK and G. C. BLICKENSDERFER. London. Improvements in electric elevators. April 17, 1888.

5,913. A. W. HEAVISIDE. Newcastle-on-Tyne. Improvements in electric telegraph, telephone and electric light insulators. April 20, 1888.

PATENTS SEALED.

May 18, 1888.

3,158. P. EVERITT. London. Improvements in machines for giving currents of electricity on the insertion of a coin, token, or the like. March 1, 1887.

4,369. P. JOLIN. Bristol. Improvements in instruments for detecting and measuring electric currents. March 23, 1887.

4,365. F. L. BAKER (Manchester) and F. BRYAN (Levenshulme). Improvements in and relating to telephonic and telegraphic call apparatus. March 29, 1887.

5,140. W. H. QUARTERMAN. London. Improvements in galvanic batteries. April 6, 1887.

5,193. G. A. GRINDLE. London. Improvements relating to a system of generation and distribution of electricity. April 7, 1887.

6,267. A. C. COCKBURN and E. THOMAS. London. Lock switches for use in electric circuits. April 29, 1887.

6,590. W. H. SCOTT and E. A. PARIS. Norwich. An improved magneto-electric cut-out. May 5, 1887.

6,621. J. D. F. ANDREWS. Glasgow. Improvements in electro-motors. May 5, 1887.

6,933. D. NICOLL. London. Improvements in the insulation and laying of electrical conductors and in apparatus for that purpose. May 11, 1887.

9,515. E. WORMS and J. BALE. Paris. Improved process and apparatus for tanning by aid of electricity. July 5, 1887.

13,148. F. ROSS and A. FRANZEN. Vienna, Austria. An improved method of and apparatus for producing rectilinear or rotary motion by the aid of electricity, chiefly applicable to the regulation of electric currents. September 28, 1887.

13,447. A. L. LINEFF, London, and E. H. BAYLEY, Eltham. Improvements in electric railways and tramways. October 4, 1887.

155. A. J. BOULT. London. Improvements in or relating to electrical turnstiles. (O. Ehrling, Germany.) January 4, 1888.

May 25, 1888.

16,273. E. DESROYIERS. Paris. Improvements in dynamo electric machinery. December 11, 1886.

4,545. C. D. ABEL. London. Improvements in electrical measuring and indicating apparatus (Siemens and Halske, Germany). March 26, 1887.

4,714. F. A. AMORIC. Ismailia, Egypt. Improved electrical signal-bell apparatus for stations communicating with a single-wire telegraphic circuit. March 29, 1887.

5,186. A. P. TROTTER and W. T. GOOLDEN. London. Improvements in brush holders for dynamo-electric machines. April 7, 1887.

5,210. A. SERRAILLIER. London. Improvements in automatic apparatus for subjecting the person to the action of electric currents. April 7, 1887.

6,409. R. E. B. CROMPTON and W. A. KYLE. Chelmsford. Improvements in dynamo-electric machines and motors. May 2, 1887.

6,681. R. E. B. CROMPTON. Chelmsford. J. C. HOWELL. Llanelly. Improvements in secondary batteries or electrical accumulators. May 6, 1887.

7,317. J. KYNOCH and W. HABGOOD. London. Improvements in secondary electric batteries. May 19, 1887.

8,262. W. M. MORDEY. London. Improvements in and pertaining to electric generators. June 8, 1887.

SPECIFICATIONS PUBLISHED.

10,963, 1887. FLEMING, J. A., and GIMINGHAM, C. H. Measuring electro-motive force and power. (Price 11d.)

13,970, 1887. NIGHTINGALE, M. Automatically administering medical electricity to the human frame, &c. (Price 8d.)

2,515, 1888. FEAVERYEAR, J. Dynamo-electric generators, &c. (Price 8d.)

3,835, 1888. COPELAND, H. P. Telegraphic apparatus. (Price 8d.)

3,995, 1888. LAKE, H. H. (Walter). Galvanic batteries. (Price 8d.)

4,274, 1888. THOMPSON, W. P. (Gibson). Storage batteries. (Price 6d.)

4,275, 1888. THOMPSON, W. P. (Gibson). Storage batteries. (Price 8d.)

1,333, 1887. WEBSTER, W. Oxydising and decomposing by electrical action organic matter, &c. (Price 8d.)

6,682, 1887. SWINBURNE, J. Electrical distribution, &c. (Price 11d.)

6,993, 1887. SLATER, H. H., and NEWMAN, A. S. Signalling by electricity. (Price 8d.)

ELECTRIC LIGHTING SCHEME AT EDINBURGH.

The Anglo-American Brush Electric Light Company have applied to the Town Council of Edinburgh for permission to equip a central lighting station, and draft conditions were adjusted by a sub-committee of the Council on the 30th ult. It is proposed to lay mains along Prince's-street, from Charlotte-street to the Register House. Several of the hotel keepers in Princes-street are desirous of introducing the light, and it is expected that about 2,000 incandescent lamps will be required. If the scheme is carried out the Callender-Webber system of underground electric conduits will be adopted, and the current will be charged for either by rental or meter rate. On Tuesday last the report of the Streets Committee came before the Town Council.

The TOWN CLERK proceeded to read the report as follows:—"Edinburgh, 30th May, 1888: At a meeting of the sub-committee of the Streets and Buildings Committee, on a letter from the secretary of the Anglo-American Brush Electric Light Corporation (Limited), asking permission to lay conductors in Rose-street-lane for distributing the electric current to hotels in Princes-street, the sub-committee, after consideration and examination of the plans submitted, agreed to recommend that the permission should be granted during the pleasure of the Council, and terminable on six months' notice by either party, on payment of 9d. per lineal yard per annum, payable quarterly, commencing the first payment on the —— day of September, 1888, when the said Electric Light Corporation shall pay 2¼d. per lineal yard for each lineal yard of street or ground broken or conductors laid, and so forth quarterly thereafter so long as this permission endures.

Bailie WALCOT said that the last clause about the 2¼d. was something he never heard of in committee.

The DEPUTY TOWN CLERK said it meant that the payment was to be made quarterly instead of yearly.

Bailie ROBERTS objected to the clause. He had never heard of it. They must keep by the committee's decision. He could not understand how the report had been altered.

The DEPUTY CLERK said the clause had been put in by Mr. Smith-Clark.

Bailie ROBERTS said that he did not think it was proper that the report should have been altered.

The clause was then struck out.

Bailie WALCOT said he had wished the report read, to show that they had not given the Brush Company any exclusive right.

Mr. MACPHERSON said there was no use talking about the Company laying the pipes in three months; three years was more like it. He agreed that the report should have come to the Council as it left the Committee.

Mr. MILLER DUNLOP objected to giving such powers to a private company. There was an understanding that they were to keep the electric lighting in their own hands.

Mr. KINLOCH ANDERSON said that was true, but this was only an experiment, and even if it succeeded the Council could take up the electric light if it was becoming general.

Bailie WALCOT moved the adoption of the report, and said there was a strong conviction in the committee that it would be an improper thing for them to throw any obstacles in the way of the progress of electricity. He believed there was a great future for both gas and electricity.

The DEAN OF GUILD said that was all right, but were they to allow this or any other company to tear up their streets?

Bailie WALCOT said that was included in the charge. Perhaps they had better hear the report as amended.

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The TOWN CLERK again commenced to read the report:—Agree to recommend that permission should be granted during the pleasure of the Council, and terminable on six months' notice by either party, on payment of 9d. per lineal yard per annum so long as this permission endures—

Bailie M'LACHLAN (breaking in): It ought to be added that 9d. per annum is the minimum charge.

The DEAN OF GUILD: That is not the point. It is the grammar of it (laughter).

The LORD PROVOST: Better re-commit it.

Bailie WALCOT: Perhaps you will hear it all read.

The TOWN CLERK then read the rest of the report, which was as follows:—

"The work to be executed to be carried out within six months from this date at the sight and to the satisfaction of the committee and of the city road surveyor, under plans and specifications to be submitted by the promoters; the portions of streets to be passed through to be lifted, relaid, and maintained by the promoters to the satisfaction of the city road surveyor, and restored in the same manner in the event of discontinuance of the permission by the Council, or of the promoters ceasing to exercise their rights under said permission; the arrangement being also on condition that said Electric Corporation shall in no way interfere with gas, water, or other pipes or drains. The sub-committee are treating this as merely an experiment, and to be understood as such, leaving it open to revise the foregoing conditions at pleasure. Further, the said Electric Corporation shall not on any occasion or for any purpose interfere with the pipe track, or with the streets or lanes through which it passes, without warrant by the Town Clerk." The report was signed George Roberts.

"1st June, 1883.—The Streets and Buildings Committee approved of their sub-committee's report, and begged to recommend the Magistrates and Council accordingly. (Signed) G. R.

Mr. MILLER DUNLOP said the Brush Company could go over the whole city on that agreement.

The TOWN CLERK said the plan showed what streets were meant.

Mr. MILLER DUNLOP said they ought to have been specified.

Bailie ROBERTS seconded Bailie Walcot's motion.

Bailie WALCOT said he did not think the report made it clear that the Brush Company had not got an exclusive right here. Let them understand that any other company could get the same right as themselves.

The DEPUTY CLERK: You could not give them an exclusive right if you tried.

The LORD PROVOST said it would be wiser to re-commit the matter. He must say that he did not think documents of that sort should be left to one member of the committee to revise. They ought to be completed before they left the committee's hands.

Bailie ROBERTS said the report was completed. But, of course, Mr. Smith Clark and Mr. Harris went to the window and talked the matter over there, and they seemed to have put in the few words which were objected to. But the words were deleted, and it was all right now.

It was then agreed that the matter should be re-committed.

AN EXPLANATION.—In reference to the electric light minute given above, Mr. Smith Clark, who had left the Council meeting before the matter came on, upon reading the report of what occurred in the evening paper, made the following explanation:—The draft minute which was submitted by the Deputy Town Clerk to the Committee on Friday last, 1st inst., was regarded as defective in several respects. It was, however, approved of, subject to such alterations as might be made upon it by Mr. Smith Clark, who was requested by the committee to revise it. Mr. Clark, upon revisal, found that, while the minute stipulated for an annual rent of 9d. per lineal yard, it contained no provisions as to when the rent should commence to be payable. He accordingly inserted a stipulation that it should be payable quarterly at the rate of 2¼d. per lineal yard. On the same day (1st inst.) Mr. Smith Clark sent the draft minute to the Deputy Town Clerk revised, accompanied by a letter requesting the clerk to show his alterations to the convener, Bailie Roberts, for his approval. He added that the provisions as to payment of rent were important, and had been inserted so as to avoid any future question; and that as these alterations were intended merely as suggestions, the Deputy Clerk might make any corrections upon them, subject to the approval of Bailie Roberts. Apparently neither Mr. Smith Clark's letter nor his alterations had been shown to the convener of committee.

PARLIAMENTARY INTELLIGENCE.

ELECTRIC LIGHTING ACT AMENDMENT BILL.

In the House of Commons on May 31st, on the Committee Stage of the Electric Lighting Act (1882) Amendment Bill,

Sir G. CAMPBELL moved the addition of the following words to the first clause:—"When a local authority duly applies for a license for an area within its jurisdiction such license shall be granted by the Board of Trade unless the Board of Trade are of opinion that special reasons exist why such license should not be granted, and in such case they shall make a special report stating the grounds of their refusal. The grant of a license to any company or person shall not in any way hinder or restrict the granting of a license to the local authority, or to any other company or person, with the consent of the local authority within the same area."

Sir M. H. BEACH said that he was willing, on behalf of the Government, to accept the Bill as it stood, but could not agree to the proposals in the amendment. If the amendment were pressed, he should feel bound to object to the matter going any further.

Mr. MUNDELLA condemned the amendment as being absolutely unnecessary and mischievous, and hoped that it would be withdrawn.

Sir G. CAMPBELL said that when he was told this clause was mischievous he began to think there was something in it (laughter). He declined to withdraw the amendment.

Mr. BIGGAR moved to report progress, and the motion was carried.

NEW COMPANIES REGISTERED.

THE "ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, LIMITED.—This Company is registered with a capital of £10,000, in £10 shares. The subscribers are:—

Sir John Pender, 18, Arlington-street, Piccadilly, K.C.M.G.
Sir James Anderson, 62, Queen's-gate, Knight.
Louis Floersheim, 4, Bank-buildings, E.C., Merchant.
John Denison Pender, 51, Hans-place, W., Gentleman.
Louis Schott, 4, Bank-buildings, E.C., Merchant.
James Pender, Thornby Hall, near Rugby, Gentleman.
K. L. M. Anderson, 10, Throgmorton-avenue, E.C., Stockbroker.

COMPANIES' MEETINGS & REPORTS.

The Consolidated Telephone Construction and Maintenance Company (Limited).

The seventh annual general meeting of this Company was held at the Cannon-street Hotel yesterday, Thursday, under the presidency of Mr. C. L. W. Fitzgerald.

The SECRETARY (Mr. Charles Curtoys) read the notice convening the meeting, and the report of the Directors (given below) was taken as read:—

The CHAIRMAN said that the amount available as the profit of the year was £10,788, which with the balance brought forward was increased to £12,484. They had already paid an interim dividend at the rate of 5 per cent. per annum, and they now proposed to write off the machinery, plant and furniture £541; and pursuing the policy which they had always carried out, of writing down the value of things, they proposed to write off the further sum of £2,000 from the item of investments in telephone companies—that was, from the investment in the Edison-Gower-Bell Telephone Company. That investment had now been written down from £25,000 to £18,000. The ordinary expenses of the year had been, in round figures, about £200 less than those of the previous year. In going through the accounts and balance-sheet he stated that the plant to-day was in a most efficient state, and they had gone on improving it, while they were reducing its value. The stock of instruments was about £1,000 more, which was caused by their taking over the stores of their late contractor. The sum on the debit side of the balance-sheet of sundry creditors and credit balances was now pretty well paid off. He believed they only had practically about £300. They now proposed to pay a further dividend of £2. 17s. per cent., which would make a total dividend for the year of £5 7s. per cent. Col. Gouraud's action against the Company for payment of his fees for the year 1883–4 had been decided in that gentleman's favour, and he had now, after nearly four years, commenced an action against the Committee of Investigation on the ground that the reports published to the shareholders were libels upon him. The Directors were advised by the solicitor that the reports were privileged reports, and all he could say as Chairman of the Committee was that nothing could have been further from their thoughts than the idea of libelling Colonel Gouraud. There was no object in doing so. What they did try to do was to show to the shareholders what they found from the minutes, and they put that in print. Whether Colonel Gouraud would proceed with his action he could not tell. The Edison-Gower-Bell business in Portugal had been sold to a company called the Anglo-Portuguese Telephone Company, which had already issued one report, which was decidedly favourable. Since they had taken the manufacture of telephones into their own hands, he had mastered their manufacture sufficiently to be able to say that he could undertake the management of the business. Since they had been working—since the contract was terminated—everything had gone on satisfactorily, and they ought to make more profit than if they employed a third party who contracted to make the instruments at a fixed price. He was sure that the shareholders would be glad to hear that all the telephone companies were working in harmony together, and no doubt, should the amalgamation scheme take place, of which he thought there was every probability, they would see a very considerable advancement in the number of telephones ordered; for this reason, that he thought every one could understand that provided they could talk from London to Manchester, Liverpool and Leeds, there would be many people who would take telephones who would not otherwise have them. He believed the fusion was extremely probable, and it would be a very good thing for all of them, and would make them much stronger in regard to their relations with the Government. One of the most satisfactory features in the whole report was the progress of the subsidiary companies. The Telephone Company of Austria increased by 245 subscribers, and in income £1,801; and the Anglo-Portuguese Company—the late Edison-Gower-Bell Company—had increased by 130 subscribers, with an income of £994. He had been looking over the figures of those companies from the year 1884, when he saw that the Telephone Company of Austria had 626 subscribers, and an income of £4,227, while the Edison-Gower-Bell subscribers

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numbered 603, with an income of £4,000, making a total of 1,239 subscribers, and an income of £8,227. Those totals were now as follows :—Subscribers in Austria and Portugal, 3,536 ; and income, £23,255. Further than that, they had at last made those companies absolute money paying concerns—in other words, he and his friends on the Board had found the money for those companies, so that they should have working capital, which they never had before, and they were now paying cheques to the Company for the goods made for them. Having referred with satisfaction to the acquisition of Mr. Buckingham on the Board, he concluded by moving

"That the statement of accounts and balance-sheet and the report of the Directors and auditors, as now submitted to the meeting, be received and adopted, and that a final dividend of £2. 17s. per cent. be paid, making, with the interim dividend previously paid, £5. 7s. per cent. for the year ended 31st March, 1888."

Sir ALEXANDER ARMSTRONG, K.C.B., seconded the motion, which, after a short discussion, was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. RICHARD VAN ZELLER, Sir Alexander Armstrong and Mr. Arthur Henry Baker were severally re-elected to their seats at the Board ; and subsequently the auditors, Mr. J. G. Griffiths and Mr. A. E. Green, were reappointed auditors.

An extraordinary general meeting of the Company was afterwards held, when, on the motion of the Chairman, seconded by Mr. Grëwing, a resolution was passed in effect terminating the management by the Company of the business carried on by it in Austria for the Telephone Company of Austria (Limited).

On the the motion of Mr. WARD, seconded by Mr. GERMAINE, a vote of thanks was passed to the Chairman and Directors, and the proceedings terminated.

[A full report of the meeting will be published next week.]

The accounts of the operations of the Consolidated Telephone Construction and Maintenance Company for the year ended 31st of March, 1888, show a net profit of £10,788. 7s. 4d., which, with the amount carried forward from last year, leaves a balance of £12,484. 5s. 9d. for disposal, after making provision for doubtful debts.

The Directors propose to deal with this amount as follows, viz. :—To pay a further dividend of £2. 17s. per cent., making with the interim dividend paid in November last £5. 7s. per cent. for the year, writing off the sum of £541. 6s. 3d. for depreciation of plant, machinery, and furniture, and the sum of £2,000 from the Edison Gower-Bell Telephone Company's securities, thus leaving a balance of £1,372. 9s. 11d. to carry forward.

The Directors have received a further sum of £4,427. 14s. 5d. on account of profit arising from the liquidation of the River Plate business, which is included in the above statement, and there is still a further considerable amount to be received under that head.

They have received an interim dividend at the rate of 5 per cent. on the shares of the United River Plate Telephone Company, which is also included in the foregoing.

The action brought against your Company by Colonel G. E. Gouraud for the payment of his fees for the year 1883-84, at the rate of £1,000 a year, was decided in his favour. He has now, after waiting four years, thought fit to commence an action for libel against the Committee of Investigation appointed by the shareholders in May, 1884, on the ground that the reports are personal libels.

Colonel Gouraud's action against your Directors for the course they have pursued in conjunction with the Edison Gower-Bell Telephone Company in prosecuting infringers of their patents in Belgium has been again postponed at his request. So far as the action in Belgium is concerned all has gone favourably, and the case has arrived at the stage when experts will be called to decide if an infringement has been committed.

The negotiations in Portugal alluded to in the last report have been satisfactorily terminated, and the result is that a very favourable concession for the working of the telephone business in the cities of Lisbon and Oporto has been granted to the Anglo-Portuguese Telephone Company, to whom the Edison Gower-Bell Telephone Company sold the Portuguese Exchange business for 37,500 fully paid £1 shares in the new undertaking.

Your Directors have deemed it necessary to terminate the contract which they had for the manufacture of telephones, &c., and to take the management of the factory entirely in their own hands. This was accomplished in February last, since which time all has been working smoothly and satisfactorily. Under the agreement with the contractor your Company had to purchase a certain amount of material and stores, which explains the increase of stock shown in the accounts.

The Directors have pleasure in stating that they are working in complete accord with the United Telephone Company, from whom they are expecting large orders, seeing that the development of that Company is progressing very favourably.

A fusion of all the Telephone Companies of the United Kingdom being in contemplation, your Directors are using their best endeavours to promote your interests in connection with the same.

The business of the subsidiary companies continues to make most satisfactory progress.

It is with extreme pleasure that your Directors have to announce that Mr. J. H. Buckingham has joined the Board.

In accordance with the Articles of Association the following Directors retire by rotation, and being eligible, offer themselves for re-election, viz. :—Sir Alexander Armstrong, K.C.B., &c., and Arthur Henry Baker, Esq.

The auditors, J. G. Griffiths, Esq., F.C.A. (Messrs. Deloitte, Dever, Griffiths and Co.), and A. E. Green, Esq., F.S.A.A., also retire, and offer themselves for re-election.

Swan United Electric Light Company (Limited).

An extraordinary general meeting was held on Tuesday at the Cannon-street Hotel for the purpose of considering and, if deemed desirable, of approving of an agreement dated May 5, 1888, made between this Company and the Compagnie Continentale Edison de Paris, and for authorising the Directors to do all acts necessary for carrying such agreement into effect.

Mr. JAMES STAATS FORBES occupied the chair and said :—Gentlemen, this is a very important meeting for the shareholders of this Company. I will try to be as brief as possible, but, in view of the great importance and perplexity of the matter, I am afraid I shall not be very short, because I think it necessary you should understand what you are about to do. What we are about to do is, in fact, to imitate abroad what we have done with great advantage to ourselves at home. You know the history of the United Company, in which you have a very large interest. You were in litigation with the Edison Company as to the respective patents of Mr. Swan and Mr. Edison in Great Britain and Ireland. We took very strong views of the priority and value of the Swan patents, they took the same views as to the priority and value of the Edison patents, and we were fast verging upon what might possibly have been ruin to both companies—litigation to the death to settle which was the governing patent and whether there was any patent at all. In that state of things, happily for us, prudent counsels prevailed ; the two companies were put together on the theory of making the best of what had been done, assuming *bona fides* on both sides, in building up the united business, which should have the advantage of preventing litigation, the raising of very delicate questions as to the value or priority of both sets of patents by uniting them both, for the purpose of defence against the common enemy, the infringer. Now, that is what we did in England ; it was rather more easy here, for the reason that the Edison Company had got the entire control of Edison's patents in Great Britain, and the Swan Company had got the entire control of the Swan patents. There were no other interests ; but abroad it is a little different. There, as here, Mr. Swan and Mr. Edison are face to face, as here the one accuses the other of infringement ; the Swan Company abroad are in the same position as they were here—that is to say, wherever patents have been registered they are the sole possessors. That it not quite the case with the Edison ; they seem to have been handed over originally to one or more parties by Mr. Edison, and as we have to deal with things as we find them, it is not much good going into their history. We find, however, that the Edison Company of Paris, with whom we are dealing, have not the same absolute power over the patents for the whole of Europe that the Swan Company has, or that the Edison Company had in Great Britain. You will see at once that led to rather more difficulty in negotiations. There have been more Richmonds in the field. The Swan Company for the last two years have been not indisposed, in view of the legal proceedings on patents, to come to an agreement with the Edison Company abroad ; but we were face to face with considerable internal difficulties, in fact to know who we were to negotiate with, and how one district was to be protected in which one set of people had the command, and another in which another set of people had the command. That has taken a great deal of time, and we have come to the conviction that it was wise to do abroad what it was wise to do here, for the very same reasons. While conflicts were going on, there was great uncertainty and cost in fighting. In the second place, the fact of there being litigation has a depressing effect on the spread of invention. People do not like to go into installations and run risks of being served with notices from time to time that they may be preparing for themselves the defence of an infringement suit. The object, therefore, was to put these companies together. The object and the reasons were generally what I have stated—for the purpose of mutual protection, advantage, and defence, because in every place in Europe there are lots of clever fellows who will make and sell lamps on the patents of Mr. Edison and Mr. Swan and pocket the benefits if we let them. Now we shall be much stronger and united against infringers by having both sets of patents under our control ; and, besides, in a place in which one patent may be weak, in another it may be strong. We then come to the delicate point in all such negotiations—the relative value. It is very difficult to find out and appreciate the relative value of what is partially unknown, because although we have heard of the Swan and the Edison lamps for a good many years the business is still, so to speak, in its infancy. It is a great undeveloped business, and the development of that business would depend very much, if we remained distinct companies, upon who won the suits. If the result of that litigation was to bar the Swan Company from manufacturing lamps all over Europe, and to give the Edison Company, so to speak, the monopoly of that manufacture, the relative portions or values would be greatly altered. Those questions have never been brought to issue. We have had to resort to the only known factor which influences men's minds in the circumstances—that is, having both gone on the theory that the patents were valid patents, we have each done a business, we have each a going concern, the businesses have been founded on different principles ; we for instance have paid cash for our patents, the other people have bound themselves to pay royalties on their patents. We have spent a great deal of money in these foreign countries in bringing our business to its present standard of expansion. Well, we have gone on the simple factor, how much work had we done, how many lamps had we manufactured and sold ? That seemed to be one reasonable factor. That had to be modified by some considerations ; for instance, if these suits which are pending in different countries, in Germany, in France, in Austria, and in Belgium, if they should go absolutely against one company or the other, that would be a very disturbing factor, or if the result was to throw these patents open to all the world we should both be in a bad state. Many people would hesitate to attack a united company, but none would if the result of the action of the two companies was to proclaim to the world that

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the patents were not binding, and were open to all. We have taken similar views on both sides of the relative value of that factor. Fortunately, the method of computing the proportion does not involve the necessity of dealing with the capital of either company. In going into the question of what it has cost A or B we have taken the factor of the business actually done as the basis of the future division of the profits of the business. The thing was to get rid of this litigation, and to proceed as a united company to extend the business. The administration costs will probably be somewhat diminished, the efficiency of the lamp will be greatly improved, the public mind will be set at rest, there will be no alarming forebodings that people may be challenged as infringers and subject to legal proceedings, the business will increase, with the increase of numbers the profit on lamps will greatly increase. This is one of those businesses where a comparatively small number of lamps means a profit inconsiderable in comparison with a much larger output. The charges are comparatively great on the small quantities, and are greatly diminished on the increased output. Supposing on an output of a quarter of a million you make 1s. a lamp, if you increase the ontput to half a million the profit may be 1s. 6d. What we think is that our plan of putting these companies together will effect a double object, not only increase the output, but it will reduce the cost of each individual lamp, so that the profit will be greater. In order to express in legal language what I have told you in so few words it has been necessary to enter into an agreement with this Continental Company of Paris, and I had better perhaps briefly, before submitting the agreement to you, for your information go through the different articles so that you can understand exactly what it is. It is to be a union of the two companies; it is to be called the Company General of Incandescent Lamps; the duration of the company is to be fixed by the statutes up to the 31st December, 1894, that being, in fact, about the day or a little beyond the day when the patents of both Edison and Swan lamps die; it is a few weeks in case of the necessity of winding up the companies. In that event there would be time to do it; but that term may be prolonged or reduced, if the necessity should arise, by the resolution of a special meeting called for the purpose, but only when such resolution is passed by a majority of three-fourths of the share capital of the Company. I cannot myself see any reason to believe that, during the term of the patents at all events, there will be any necessity to interfere with this as a going concern. I think it is exceedingly likely that if the business is managed with tolerable prudence, that at the end of the six years you will have a well-established going concern, not protected by patents, which then will be thrown open to all the world, but probably protected by improved processes, which in the interval may be patented; at all events, if not that, by a large connection all over Europe, and by a trade mark which I hope will have behind it the character of the most efficient and best incandescent lamp which can then be produced. If that be so, this Company would go on; it would go on, I suppose, on conditions which we need not even anticipate now, but I should think, possibly, very much on the conditions of this agreement. I must tell you that this is to be a French Company, that is to say, a Société Anonyme, which is equivalent to our limited liability. The seat of the Company will be in Paris, but may be transferred to any other place. What do the parties bring in? This is an arrangement based on bringing in a going concern, or rather two going concerns; we propose to bring in what we have got, and they propose to bring in what they have got. What they would bring in is France, Belgium, Austria, Hungary, and Spain, that is where the Edison patents are under the control of this Company; we bring in France, Belgium, Russia, Austria, Hungary, Italy, Sweden, Norway, and Portugal. There is one important area entirely left out, that is Germany. The gentlemen in Paris have not the power of controlling the Edison interest in Germany, and, as I have had occasion to tell you at some of our meetings, in Germany, amongst other places, we are in litigation. But it is not impossible, when this preliminary step has been taken, Germany may follow. However, Germany is excluded from this agreement, the reason being that they cannot bring in Germany. There is one point of importance which I should be very glad to make clear. I said that this business had been founded on different principles; whereas we out and out bought the Swan patents by shares and money, the foreign people submitted themselves to a tax or license—or royalty, I think, is the proper term—of twenty centimes a lamp. That has been one of our great bones of contention and difficulties—these twenty centimes. Well, it is the payment made to Mr. Edison for bringing in his brains and patents. In France he got a royalty of somewhat under twopence on all the lamps manufactured within the area of these patents. We have had to look at that, amongst other things, and we have seen fit—I do not know that I need enter too largely into the discussion of why, as a matter of prudence and after full consideration—to accept that twenty centimes as a charge on the old business, but only for the duration of the patents. Now, that is one of the points which made us insist so strongly upon each party bearing its own burden. The contract was that twenty centimes should be paid as long as the Company existed; we have agreed that it shall be paid till the end of the patents. I have told you what everybody brings in, and the consideration for bringing it in is the creation of a certain quantity of shares, representing what has been done heretofore—what I may call the cost of the affair up to date—and a further amount of shares representing the capital which it will be necessary to find to develop this business from time to time. Now, it is not a big thing; you need not be alarmed by supposing you have immediately to find more capital. The share capital of the Company is to be 2,000,000fr., which is £80,000, of which 1,000,000 is to represent in fully paid shares the values of the going concern as put into the common pot, and the other million is to be made up of cash contributed by the companies in the respective proportions in which the profits of the united concern are to be divided. The division of these profits was a very anxious matter, and I think you may give us credit for having been ourselves largely interested—not that I think the mere pocket influence is the full consideration which ought to bind honourable men acting in the control of others, but still it has a certain interest; but being, first of all, large shareholders, and, what is more, being the implicitly trusted Directors of this Company, we made the hardest possible fight about the proportion, and I think Mr. Leyland, who has taken an immense deal of pains over this matter, will agree with me that we have reason to be very well satisfied with the proportions brought out. We think that, looking at the relative work done by the two companies; looking at the risks of litigation in these different countries; looking at the position which these people have got into in France, Belgium, and Austria by combinations which they have made with important people, that they stood upon the very nature of the thing to do a bigger business than we did. That is to say that their chances, if we had gone on even in a friendly way, were of a character to give them a better business than ours. Then there was the great risk of our failing on these patents, and that was a very serious matter, so that altogether the Directors are quite satisfied and are prepared to take all the responsibility of recommending you to accept the proportions. I have told you what the respective proportions of the companies are to be in consideration for their contributions. There shall be allotted to the Continental Company 1,200 shares, and to the Swan Company 800, of 500fr. each, fully paid up. That represents the million of francs which I told you would be represented in shares of the going concern. The other 2,000 shares are to be subscribed, 1,000,000fr. in cash, in the same proportion as the above contributions, and we shall have to find £16,000, and those gentlemen will have to find the balance, £24,000; and the profits realised in the future will of course follow the shares. Of every £100 profit made they get 60 per cent. and we get 40 per cent., and we think, looking at the matter all round, it is a very satisfactory bargain, and the more one looks at it the more satisfied he becomes (hear, hear). By uniting these companies on these conditions, we get rid of the litigation, and shall be able to build up a trade mark and a business of great value by the time of the expiration of the patents. We think we have done very well indeed, looking at the outlay of the two companies, in arranging for that amount of the net profit, because, after all, the number of shares represents the concrete value, which works out at 60 per cent. and 40 per cent. respectively. Under the arrangement the two companies are put together as a going concern in those countries, and there is an end of all litigation, and each party withdraws from the litigation and pays its own costs. One very important matter is this—suppose in the interval there should arise some unforeseen, as far as the present goes, necessity for terminating this bargain, which could be done in general meeting recommended by the Directors, each company would return to the *status quo ante bellum*, or perhaps I should say *ante pacem*, with all its rights intact, but not with its right to litigation. Therefore, if at the end of two or three years we should dissolve the partnership—which I cannot foreshadow, it has been provided for—it would not mean a revival of litigation. Neither party can challenge the rights of the other in the future, and that seems to be a matter of some value, looking at the cost of this litigation (hear, hear). I have told you, I think, of the chief facts. Then, there is the capital. We get 1,000,000fr. as representing what we put in in fully paid up shares, and I may say in the presence of a couple of distinguishd lawyers, one English and the other French, that the recent division does not affect the rights of any company to do what we are doing—it represents so many thousands paid down to carry on the business. These are the general terms of the agreement, but there are some exceptional things I ought to call attention to. The only charge resting on the business, over and above the cost to the parties, is that 20 centimes, and we, for reasons which are satisfactory to our minds, thought it better to accept that for the term of the patents. But there are some other conditions. We were pretty free all over Europe. We had not committed ourselves very much; and they had. They had made bargains with a very important firm, well known in this country—Sir William Siemens and Co.—who are equally powerful people in Germany and elsewhere abroad. They were large manufacturers or installers of electricity abroad, and they had made contracts with the Edison Company, under which in Austria-Hungary and Russia they are entitled to manufacture lamps as lessees upon the terms of certain royalties to the parent company. We have had to face these different arrangements, and there is no getting rid of the bargain with Siemens; but what we have stipulated is that all benefits arising under that shall come into the common pot. Siemens pays 37½ centimes for the right to manufacture the lamps, and they manufacture on a considerable scale, though not so large as to interfere with the scope of our Company. They may like to take our lamps at the trade price, or make lamps themselves and pay the royalty, and the parent company undertake to hand those royalties over. They have similar arrangements with the Italian Society and with a large firm in Belgium, and whatever the benefits are they will come into our "pot"; they are not entitled to make any charge for doing the work, and we have the power of control to the extent of examining their books. We have reserved for our Company the right to manufacture lamps in Germany, and sell them as long as the law will allow us, and if anybody chooses to buy lamps in Hamburg and any of the German ports for export, not to Great Britain, but to any parts of the world where there are no patent laws, we shall be free to do that business. There is the general character of the bargain, though, of course there are a great many details. The French Company have other business besides lamp making, such as the manufacture of dynamos, but we shall not enter into these. The fusion, of course, involves Articles of Association and the appointment of the Direction. Therefore, it becomes a matter of confidence. We are very well satisfied with the outcrop of the discussion. Of course, we go in as the minor factor, and we were careful to consider how that minor factor was to be protected from being overridden and outvoted by the major factor. What we did was to get three Directors out of a Board of seven; that still leaves the governing

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power in the hands of our French friends, but we could not reasonably claim more. The Directors would be nominated for the whole term of the agreement, and it is for the shareholders to say whether they will run the risk of so nominating their Directors. The French Company have nominated Messieurs. Bernard, Chatard, Rau, and Porgés; while your interests will be represented, if you approve of this agreement, by Mr. Leyland, Mr. Simon, our agent in Paris since the formation of the Company, and who is a man of exceptional intelligence and straightforwardness, and myself. Article 12 decrees what is to be done with the net proceeds after deducting the working expenses. There is to be a reserve fund of five per cent., which is according to the common law of France; six per cent. interest on the shares; then from the balance shall be set apart ten per cent. for the Board of Directors, to be distributed amongst the members in equal parts—thus, if the shareholders do not get six per cent. the Directors will get nothing. I beg now to move

"*That the Agreement now submitted, dated the 5th May, 1888, and made between the Swan United Electric Light Company (Limited) of the one part and the Compagnie Continentale Edison de Paris of the other part be and the same is hereby approved, and that the Directors be empowered to do all acts necessary for carrying such Agreement into effect, and constituting the new company, and to enter into a further agreement to be made with such new company.*"

The Chairman explained that the further agreement referred to a bargain with the Edison and Swan Company not to make lamps for exportation to those countries protected by Swan's patents.

Mr. LEYLAND seconded the motion, and expressed an opinion that when the new arrangement was found to work well Germany would reconsider its position, and come to similar terms. He recommended entering into the agreements which had been described by the Chairman as the very best thing the Company could do (applause).

Mr. BERNSTINGL and Mr. B. T. THOMPSON put several questions in response to an invitation to do so, and they were duly answered by the Chairman.

The motion was then put, and carried unanimously.

The meeting then closed with a vote of thanks to the Chairman.

The Western Counties and South Wales Telephone Company.

The following report of the Directors of the above Company for the year ended 31st December, 1887, was presented to the shareholders at the third annual ordinary general meeting of the Company, held yesterday, the 7th instant.

Capital Expenditure.—The capital expenditure for the year ended the 31st December, 1887, has been £28,789. 15s. 11d., making a total of £85,290. 16s. 8d. to date.

Revenue.—The gross revenue of the Company for the year 1887 was £23,597. 10s. 5d., against £15,406. 11s. 1d., for the year ended 31st December, 1886.

Working Expenses. — The working expenses for the year 1887 have been £6,693. 8s. 3d., against £4,898. 17s. 10d. for the year ended 31st December, 1886.

Dividend.—Balance of net revenue account £5,397. 19s. 9d. Dividend of 6 per cent. on the paid up Preference share capital for the year ended 31st December, 1887, £4,310. 9s. 5d. For appropriation of balance, see statement at end of accounts, £1,087. 10s. 4d.

Ordinary Capital.—The Directors desire to state that although the progress of the Company has been such as would have justified them in recommending the payment of a dividend on these shares, they consider it best to defer doing so for this year. The opening of the Company's system of trunk wires has necessitated a large amount of capital expenditure (see paragraph relating to trunk wires), at present practically unproductive, and the general revenue of the year has therefore to bear the burden of the Preference dividend on the capital outlay.

Growth of Business.—It will be seen from the following figures that the growth of the business of the Company for the past year has been very rapid; the number of subscribers to the Company's exchange system having considerably increased, while there has been a satisfactory addition to the number of private line renters. The subscribers to the various exchanges and the private line renters on the 31st December, 1887, and on the 31st December, 1886 (including orders on hand), were as follows:—

	Exchange.	Private.	Total.
December 31st, 1887	1,572	462	2,034
December 31st, 1886	993	325	1,318
Increase in 1887	579	137	716

Mileage of Trunk and Renters' Wires.—Erected up to 31st December, 1887, 2,140 miles; erected up to 31st December, 1886, 1,163; increase in 1887, 977.

Trunk Wires.—The amount expended in extending trunk wires up to 31st December, 1887, has been £18,874. 3s. 8d., while the rentals applicable to that year are only £210. 1s. 10d., but the Directors look forward with confidence to the current year bringing in a substantial revenue from the trunk wire system.

Additional Capital.—To enable the Company to carry out the contemplated extensions of business it will be necessary to raise additional capital, and the Directors propose to create a further amount of £100,000 in 20,000 Preference shares of £5 each.

The following resolution was submitted for the consideration of the meeting:—

"*That the capital of the Company be increased £500,000 by the creation of twenty thousand new Preference shares of £5 each, which shares shall be entitled to receive out of the profits of the Company a cumulative preferential dividend of £6 per cent. per annum on the amount for the time being paid up on such new Preference shares respectively; and in case of any final distribution of assets, the amount paid up, or credited as paid up, on such new Preference shares shall be paid out of the assets of the Company in priority to the amount paid up, or credited as paid up, on the Ordinary shares, and the said new Preference shares shall be entitled to the same privileges, and shall be subject to the same conditions in other respects as the original Preference shares, so far as the same privileges and conditions are respectively applicable to the circumstances; and the said new Preference shares may be issued by the Directors either as and under the name of Second Preference shares, subject to the prior rights and privileges attaching to the original Preference shares, or with the consent of the holders of the original Preference shares in accordance with the provisions of Article 39, the said new Preference shares may be issued on an equality with the original Preference shares.*"

Borrowing Powers.—The following resolution was submitted for the consideration of the meeting:—That the following Article shall be substituted for Article No. 71, namely:—

"*They may borrow any sum or sums of money on such security and terms as to interest or otherwise as they may deem fit, and may secure the same by mortgage or other debentures, or by bonds or other securities, or by any mortgage or charge of or upon the whole or any part of any property, funds, assets, or effects of the Company or its uncalled capital, but so that not more than £20,000 be owing at any time without the consent of a general meeting, and provided that not more than £10,000 of the said money shall be borrowed without the consent, in writing, of the United Telephone Company (Limited), and no borrowed money shall, without the like consent, carry interest at a higher rate than 6 per cent. per annum.*"

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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The Post Office.—The Directors are pleased to state that the relations of the Company with the Post Office officials are satisfactory.

Retiring Directors.—The following Directors, Messrs. Charles Nash and Richard Cory, retire by ballot, but, being eligible, offer themselves for re-election.

Auditors.—Messrs. Tribe, Clarke and Co. retire in accordance with the Articles of Association.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended May 25th, 1888, are estimated at £4,125, and for the week ended June 21st, at £3,376.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of May was 4,437, estimated to produce £3,300, against 4,040 messages, producing £3,061 in the corresponding month of last year. The traffic receipts for the month of February, estimated at £3,600, realised £3,666.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this company for the month of May, 1888, amounted to £1,800, and to £1,568 in the corresponding period of 1887.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of May, 1888, amounted to £40,586, and to £36,495 in the corresponding period of 1887.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of May, 1888, amounted to £49,003, and to £48,057 in the corresponding period of 1887.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this company are as follows:—Receipts in May, 1888, £23,200; from January 1st to May 31st, 1888, £108,400; corresponding months, 1887 and 1886, £103,520 and £100,960 respectively.

STANDARD ELECTRIC LIGHT AND POWER COMPANY (in liquidation). A meeting of the creditors of this company will be held at the office of the company, 7, Westminster-chambers, Victoria-street, Westminster, S.W., at 11 a.m. on Wednesday, the 13th inst. "to consider the offer of a new company for the purchase of the whole of the assets of the above named company, for a sum that will enable the legal and other expenses to be paid and the creditors to receive 5s. in the £;" and "to pass such resolutions as the creditors may consider desirable."

UNITED TELEPHONE COMPANY.—The directors recommend a dividend for the second half-year ended 30th April, 1888, at the rate of 10s. per fully paid share and 5s. on the new shares, making, with the interim dividend paid on the 2nd December last, a total dividend for the twelve months of 15 per cent., as compared with 13 per cent. for the previous twelve months.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended May 25th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,366, and for the week ended June 1st, £2,675.

WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this company for the month ended 31st May amounted to £4,700.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month to May 31st, 1888, are £2,991, as compared with £3,438 in 1887. February receipts, estimated at £6,449, realised £6,625.

PERSONAL.—Mr. Frank Kitchell, representing the firm of Augustus Noll and Co., of New York, the agents of the Sawyer-Man Company, is at present in England, with a view to introduce the Sawyer-Man system of electric lighting into England and France.

SUBMARINE CABLE COMPANIES.

December, 1887.

(Compiled by LEWIS WELLS, F.S.S.)

Name of Company.	Capital.	Cable Mileage	Revenue including Subsidies	Reserve and Renewal Fund.	Dividends per cent. on Ordinary Capital.	Market price June 6, 1888.
	£		£	£		
African Direct	475,000	2,739	30,000	Nil.	Nil.	notquoted
Anglo-American....	7,000,000	10,437	195,493	948,662	1½ per cent.	63 ¼ dis.
American Telegraph and Cable.....	2,200,000	5,537	80,000	†	5 ,, ‡	notquoted
Black Sea	130,000	351	6,795	Nil.	3½ ,,	
Brazilian Submarine	1,489,000	7,326	203,470	138,721	7 ,,	25¾ pm.
Commercial Cable..	1,600,000	6,937	110,000	†	Nil.	notquoted
Télégraphe de Paris à New York.....	1,680,000	3,409	23,000	34,530	Nil.	83¾ dis.
Central and South American	1,000,000	3,178	†30,000	†	?	notquoted
Cuba Submarine....	220,000	940	39,642	74,000	8 per cent.	35¾ pm.
Direct Spanish	143,724	704	21,850	8,447	4 ,,	par.
Direct United States	1,214,200	2,983	46,573	325,749	2 ,,	57½ dis.
Eastern (Sept., 1887)	5,722,450	22,053	623,126	576,367	5½ ,,	20¾ pm.
Eastern and South African (Mar., '87)	818,300	4,554	152,845	149,440	10 ,,	notquoted
Eastern Extension..	3,329,400	13,022	451,865	620,095	6½ ,,	30¾ pm.
German Norwegian.	79,900	248	7,123	1,542	5 ,,	notquoted
German Union	330,000	1,119	50,615	97,304	10 ,,	10¾ dis.
Great Northern	1,825,000	6,108	279,216	522,541	7½ ,,	40¾ pm.
Hamburg Heligoland	10,500	40	940	528	5 ,,	notquoted
London Platino Brazilian	483,480	1,058	19,807	12,468	2½ ,,	37½ dis.
Mexican	200,000	709	†20,000	†	?	notquoted
Montevidean and Brazilian	105,270	200	2,512	5,850	½ per cent.	,,
River Plate	55,500	32	†10,000	†	?	,,
Spanish National ..	348,790	2,035	7,920	Nil.	Nil.	,,
Submarine	338,225	303	134,597	217,687	13¾ per cent.	50¾ pm.
West African	531,090	2,825	64,000	Nil.	Nil.	50¾ dis.
West India and Panama.....	1,325,530	4,119	91,948	124,050	Nil.	90¾ dis.
Western & Brazilian	1,498,650	2,543	159,789	154,194	4½ per cent.	32¾ dis.
West Coast of America.....	450,000	1,699	57,893	27,000	5 ,,	40¾ dis.
	35,202,909	107,708	2,971,019	—		

† No information published. Accounts not obtainable. Revenue estimated.
‡ 5 per cent. guaranteed by Western Union Company.

[The above table, for which we are indebted to the courtesy of the compiler, will be found valuable for purposes of comparison, and in any discussion of questions relating to cable work. We hope periodically to insert the table with the necessary alterations.—ED. *E.*]

FENN and CO., LD.

10, RAILWAY APPROACH, LONDON BRIDGE, S.E.

SPECIALITIES.

WIRE-CUTTING PLIERS. DRAW VICES.
SHIPS' LANYARDS.
PORTABLE VICE BENCHES. TOOL CHESTS.

ALL KINDS OF HAND AND BENCH TOOLS FOR RAILWAY, TELEGRAPH, AND TELEPHONE MECHANICS.

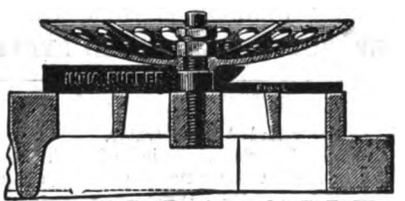
LATHES, SHAPING, DRILLING, AND PLANING MACHINES, SHAFTING, PULLEYS, BELTING, &c.

Contractors for most of the Government Departments.

ESTABLISHED IN 1665.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.
"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, June 6, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending June 6, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	37 38	3 11 6	Jan., Apr., July, Oct.	38	36⅞
2,614,320	Stock	10/0	Do. Preferred	62 63	4 9 2	,, ,,	63⅛	62
2,614,320	Stock	nil.	Do. Deferred	12 12½	...	February	12⅞	...
130,000	£10	3/0	Brazilian Submarine	12⅜ 12⅝	4 15 0	Mar., June, Oct., Dec.	12¼	12 7/16
16,000	10	8/0	Cuba Submarine	13 13½	5 18 9	February and August	...	...
6,000	10	10/0	Do. Preference	18½ 19½	5 2 6	,, ,,	...	...
12,931	5	2½%	Direct Spanish (£4 paid)	3½ 4	3 10 0	March & September	...	...
6,000	5	5/0	Do. Preference	8½ 9½	5 5 3	April and October	9	...
60,710	20	2/0	Direct United States	8⅜ 8⅝	4 11 6	Jan., Apr., July, Oct.	8 1/16	8⅜
380,000	10	2/6	Eastern	11⅝ 12	4 11 9	,, ,,	12	11⅝
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜ 15⅛	3 19 0	,, ,,	...	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	110⅛	...
250,000	10	5/6	Eastern Extension	12⅝ 13⅛	4 19 3	Jan., Apr., July, Oct.	13 1/16	12⅞
22,050	10	8/3	German Union Telegraph and Trust	9 9½	7 7 4	January and March	...	...
179,177	10	2/0	Globe Telegraph and Trust	5⅜ 6	5 4 3	Jan., Apr., July, Oct.	5 1/16	...
178,992	10	3/0	Do. 6 per Cent. Preference	13⅜ 14	4 5 0	,, ,,	14	13⅜
150,000	10	7½% '87	Great Northern	13⅜ 14⅛	5 6 3	Jan., July, and April	13⅜	...
17,000	25	37/6	Indo-European	36 38	6 11 9	April and October	...	...
38,348	10	3%	London Platino Brazilian xd	5⅜ 6⅛	...	May and November	...	...
9,000	8	4/0	Reuter's	7⅜ 8	5 0 0	April and October	...	...
338,225	Stock	15½%	Submarine	140 150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America	5⅝ 6⅛	8 0 0	January and July	6⅛	5 1/16
150,000	100	8%	Do. Debentures	112 117	6 16 2	June and December	...	...
88,321	10	nil.	West India and Panama	⅞ 1⅛	...	...	1	...
34,563	10	*10/0	Do. 1st Preference xd	10⅜ 11	8 12 8	April and October	10⅝	10⅜
45,181	15	9/0	Western Brazilian	10 10½	6 2 9	March & September	10⅛	10⅛
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	⅜ ½	5 0 0	Yearly	...	...
220,000	£1	...	Oriental (11s. paid) xd	½ ⅝	...	...	1/16	...
80,000	5	5/0	United	14⅜ 15	4 6 8	June and December	15 1/16	14⅜
50,000	5	2/6	United River Plate	5 5⅛	...	April and October	5⅛	...
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb. '86	Anglo-American Brush (£4 paid)	2⅛ 3	...	...	...	...
25,692	5	nil.	Do. (fully paid)	3⅛ 4	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2 2⅛	...	...	2 1/16	2 1/16
312,000	½	5% '86	Maxim-Weston	1/16 1/8	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39½ 40½	5 18 4	March and July	40½	40
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 3	February & August	17⅜	17

* On account of arrears of dividends.

THE TRUSTEES, EXECUTORS & SECURITIES'

INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

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The principal objects of the Corporation are :—

1. Performing the duties of Trustee, Executor and Administrator.
2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the uties of the family solicitor.

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For terms, &c., application should be made to the General Manager at the Company's Office.

GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 526.—Vol. XXI. FRIDAY, JUNE 15, 1888. Price 4d.

NOTES.

In another column will be found a report of a most phenomenal character upon the behaviour of a secondary cell which has recently been brought out in Germany under the name of the "Tudor" Accumulator. If the report had been signed with a name of any less authority than that of Prof. Kohlrausch we should have been disposed to dismiss the statements as very much too good to be true. It is a pity that the experiments were not carried out upon a scale commensurate with practical work. A full-size battery rarely behaves quite in the same way as one or two selected cells. We also regret that the report contains so little information with regard to the construction of the plates. But after all that can be said in depreciation it seems impossible to doubt that the results obtained by Prof. Kohlrausch mark a very distinct advance in secondary batteries, such as may well gladden the hearts of the advocates of what Mr. Crompton is pleased to call the B.-T. system.

Our issue of the 25th of May contained an abstract of a Paper by Prof. Galileo Ferraris describing a method of producing a revolving resultant magnetic field by means of a pair of coils with their axes at right angles, and traversed by alternating currents, and we drew attention to the possibility that the principle of this apparatus might be applied to the construction of an alternating-current motor. The Paper by Mr. Nicola Tesla, which appears in our columns this week, contains a description of such a motor, founded on exactly the same principle.

In our correspondence columns will be found a very interesting communication from the Postmaster-General of South Australia describing the arrangements which have been carried out in order to effect telephonic connection between Port Adelaide and the mail steamers lying at anchor in the Gulf of St. Vincent. It will be seen that the arrangement is of a very simple character, and also that it is quite successful. The same thing has been done by or for the Messageries Maritimes Company at Havre, as we described in February last; and it will also be remembered that a cable of nine miles in length connects the Sunk lightship to the Post Office at Walton-on-the-Naze; but this, as a permanent connection, scarcely comes under the same category. It is, however, surprising that the convenience and utility of such a device has not long ago led to its far more frequent use. To take only one instance, at Liverpool the Transatlantic liners always lie at anchor in mid-stream for some ten or twelve hours before their final departure, and one would suppose that telephonic communication with the shore would be of very considerable service. We recommend Mr. Todd's interesting communication to the attention of all concerned with either telephonic or shipping enterprise.

At the meeting of the Académie des Sciences on the 7th of May, M. Blondlot described an experiment which he apparently believed to be new, according to which a tube filled with a weak solution of perchloride of iron, a paramagnetic salt, immersed in a stronger solution of the same salt, and placed between the poles of an electro-magnet, sets itself, like a diamagnetic body, at right angles to the lines of force. M. Blondlot takes it for granted that the tube when immersed in the stronger solution still becomes magnetised like iron, and he adduces the experiment as a proof that Tyndall's crucial experiment, showing the diamagnetic polarity of bismuth, can be explained on Becquerel's theory, namely, that the magnetic permeability of diamagnetic bodies is less than that of space, while that of paramagnetic bodies is greater. At the following meeting, M. Mascart asserted that while the experiment was in accordance with Becquerel's theory, M. Blondlot was not warranted in assuming the magnetisation of the tube to be the same as that of iron, for theory shows that when the magnetisation is proportional to the magnetising force, as is found to be the case with all diamagnetic and feebly paramagnetic bodies, the superficial magnetisation of a body changes its sign when the body is removed from a medium of less to one of greater permeability than its own, and the effect of this superficial magnetisation is all that can be observed. The experiment is by no means a new one, being given in the first edition of "Maxwell's Electricity and Magnetism," as an illustration of Faraday's theory that the phenomena were simply due to a tendency in diamagnetic bodies to move from stronger to weaker parts of the magnetic field. Maxwell shows that where the coefficient of magnetisation is so small that the induced magnetisation of the body produces only such slight alteration of the forces in the magnetic field that the magnetic force within the body may, to a first approximation, be assumed to be the same as if the body had not been there, the effect of the superficial distribution of magnetism is such as to make a paramagnetic body in a medium of greater magnetic permeability than its own behave as though it were diamagnetic.

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THE unique position of the Sheffield Telephone Exchange Company has, as was to be expected, led to litigation between it and the United Telephone Company. The arrangement temporarily enjoined by Mr. JUSTICE KAY is, perhaps, in the circumstances, as fair and satisfactory to both parties as could be expected. To prevent, on the one hand, a wilful infringement of the last named company's patents, and to protect, on the other, the Sheffield Company from being extinguished by the patentees, it has been decided that good and practical telephones shall be supplied to the Sheffield Exchange in place of its worn out or obsolete patterns, pending a final settlement of the main points in dispute. The very existence of the Sheffield Exchange Company is, no doubt, threatened; but if Mr. JUSTICE KAY's remarks on Friday last may be taken as an indication of what is likely to happen, we may anticipate that some conclusion less disastrous than this will be arrived at. Whether the Sheffield Company owes its existence to fortunate accident or to commercial foresight, the fact remains that it has discharged its functions satisfactorily; and to deprive it of the means of carrying on a business honestly acquired would be, it seems to us, not only unfair but highly impolitic.

THE French Atlantic Cable Company do not appear to have profited much by their withdrawal from the pool. According to the report of the directors just issued, the working expenses of the company during the past year amounted to £67,000, the net earnings reaching only a trifle over £23,000. The actual receipts are given as £68,873; but from this sum £45,800 had to be paid out to foreign and other companies—a large portion, no doubt, being swallowed up in payments made to them during the four serious interruptions to which the company's own cable was subjected, and which would have cost nothing beyond their repairs had the company remained in the pool. It is instructive to note also the confession of the directors that the sixpenny tariff has not answered the expectations formed respecting it. In point of fact, this experiment of working an Atlantic cable independently at the sixpence-a-word rate has proved a disastrous failure.

AMONG the uncovenanted European servants of the Indian Government there are, we believe, a considerable number attached to the Telegraph Service, many, indeed, occupying positions of great responsibility. It appears from what transpired in the Parliamentary discussion on Mr. KING'S motion last Friday that some of the more crying grievances of the uncovenanted telegraph officers have been remedied, their status in respect to pay and leave of absence being now assimilated to that of the covenanted service. But they are still in the same position as regards their prospective pensions, which, owing to the fall in the value of the rupee, have within the last ten years been reduced by about 30 per cent., and may probably fall even lower. The motion for an inquiry was rejected by 166 against 55, chiefly on the ground that to pay the pensions in sterling would give rise to a claim for the salaries also to be paid in sterling. We fancy, however, the subject will not be allowed to drop on such a plea as this, seeing that the salaries are paid in India, where the relative value of the sovereign and rupee remains unaltered, the pensions alone, which are mostly paid in England, being affected by the difference of exchange.

DISCUSSION on our national defences goes on as briskly and as hotly as ever, and with as little appearance of agreement among those who take part in it. Two things, however, have been declared with precision—first, that an invasion is possible, and, secondly, that when it takes place we have only to repel it by pouring every available man upon the landing force and exterminating it. No doubt; but granting that a sudden landing is possible, it is possible at almost any point of a very long stretch of our southern coast; and this being the case, the number of "available men" at any given point must be limited by our knowledge of what point is being selected by the invaders. Only by the instrumentality of the telegraph can such information be communicated with sufficient rapidity, and at present there is certainly no continuous line of telegraph along the accessible coast to serve this useful purpose.

WE have received this week a copy of the thirteenth edition of "The Phœnix Fire Office Rules." In the present edition Mr. HEAPHY has eliminated the greater portion of the saving clauses to which so much objection was taken at the Society of Telegraph-Engineers and Electricians, in so far that they are no longer included in the rules. As, however, it would be practically impossible to draw up a set of regulations applicable to every case that may occur without leaving anything to the discretion of the inspector, a clause has been added to the effect that "No departure whatever from any of these rules will be allowed, unless express permission is given by the inspector from the fire office. The whole of the work and materials must be to his entire satisfaction." The first part of Rule 21 in the present edition, namely, "Where accumulators or primary batteries are used, the mains, both positive and negative, must have a switch and a cut-out upon each," is worded better than the corresponding clause in former editions, where the term double-pole was used in reference to the switches and cut-outs, which might possibly tend to encourage the practice of bringing the conductors near together, and placing both the switches or cut-outs on the same base, which is very undesirable.

THE use of torches for fishing purposes at night-time is necessarily restricted to the capture of fish in shallow waters, or of those which swim near the surface, and if, as seems to be the case, the use of the electric light can be made to diminish in any degree the uncertainty of the deep-sea fisherman's pursuit, it will be hailed as another of the long series of benefits which electricity has conferred upon us. If, however, incandescent lamps come to be generally used we shall expect to hear of amateur fishermen who have added a lamp and battery to their fishing gear telling dismal stories of sport brought to an abrupt and unexpected conclusion through a conger or a dogfish preferring the lamp to the bait, and carrying it off to digest at its leisure. In all seriousness such an event is by no means impossible, and if the lamps are used for line fishing they will have to be provided with some protection against piscine voracity.

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SOME of our readers may remember that Dr. RICHARDSON once advocated the slaughtering of animals intended for human food by means of electricity. We do not exactly recollect the object; but the idea was splendid, and, like many another sanitary reform, it failed only because it did not succeed. The electric shock, Dr. RICHARDSON now informs us, is quite capable of killing, and generally does kill; but sometimes it fails, and the result of his experiments went to satisfy him that the deadly effect of the electric current on living bodies could not always be relied upon. He therefore agrees with the *Lancet* that the New York authorities are acting a little recklessly in adopting the electric current for the performance of capital punishment. And so think we. But really, when the learned doctor goes on to advise that the *coup de grâce* of the electric shock be always supplemented by a "*post-mortem* examination" to avoid the risk of "burying the victim *alive*," we should like to ask him—unless he is an Irishman, in which case no explanation is needed—which of two deaths would be preferable, that of burial alive or——. But the subject is too grim for jesting; and we note the palpable bull only as evidence of the doctor's extreme anxiety to prevent a public scandal, or worse.

The Electric Lighting Act Amendment Bill.—Lord Thurlow's Bill passed through Committee on Monday.

Epernay.—The Epernay Gas Company has decided to supply electricity for lighting purposes.

Domestic Lighting.—Mr. W. Abercrombie is introducing the electric light throughout the whole of his new house at Brooklands, the work being in the hands of Messrs. Drake and Gorham.

The Lighting of Queenstown.—Tenders are invited for lighting the public streets of Queenstown by electricity, and are to be lodged with Mr. Jas. Ahern, clerk to the commissioners, Town Hall, by the 2nd prox.

St. James's and the Electric Light.—The St. James's and Pall-mall Electric Light Company were on Thursday week last granted, by the unanimous voice of the vestry, a license for the supply of the electric light in the parish of St. James's.

Racing Telegrams.—During the morning and afternoon of Friday last 7,300 messages were sent from the Manchester Grand Stand, including 32,000 words for the press. This was the heaviest day's work ever known at the Manchester Meeting.

Scarlet Day at Cambridge.—Among the recipients of honorary degrees conferred at Cambridge last Saturday, an unusual proportion belonged to the scientific profession. Prof. Stokes, Prof. Cayley, Lord Rayleigh, Prof. Adams, and Sir F. Abel were thus distinguished.

Bologna University.—Among the recipients of honorary degrees at the recent celebration of the eighth centenary of the University of Bologna, we note the names of Sir William Thomson, Prof. Cayley, Prof. Huxley, and Prof. Adams, upon whom the Doctorate in Science was conferred.

Berlin.—The Schwartzkopf Company has recently constructed a new locomotive for electrical traction purposes. The current is supplied by a battery of 60 accumulators, of 320 ampere-hour capacity. The motor is of the disc pattern, with two windings on the armature and two commutators.

The Petroleum Engine.—A company has been formed, with a capital of £150,000 in shares of £5 each, to acquire and work the American patents of the Priestman petroleum engine n the United States. The purchase consideration is £100,000 in cash and shares, leaving £50,000 as working capital.

Brighton Electric Railway.—At a special meeting of the Town Council on Wednesdey, convened to consider a report from the Works Committee, recommending that the proprietor of the electric railway running from the Aquarium to Paston-place groyne should be required to remove his plant, it was decided by 21 votes to seven to retain the electric railway.

City and Guilds of London Technical Institute Old Students' Association.—At the next meeting of this association, which will be held on Wednesday, the 20th inst., at 7:30 p.m., Mr. W. J. Tomes will read a Paper on "Milling Machines." The association will hold their next smoking concert on the following Wednesday, the 27th inst., at Anderton's Hotel, Fleet-street.

Birmingham.—The scheme of the Midland Electric Lighting and Power Company for lighting the block of buildings in Birmingham bounded by Corporation-street, New-street, and Union-street, is said to be making slow progress, owing to the reluctance of many of the shopkeepers to dispense with the costly gas fittings with which many of their premises have recently been provided.

The Electric Light at Bristol Cathedral.—The electric lighting of Bristol Cathedral, which we announced in a recent issue as about to be carried out on the Thomson-Houston system by Messrs. Laing, Wharton and Down, was completed last week. Twenty-five arc lights, each of 1,200 candle-power, are fitted up in the nave, the temporary orchestra, and the choir, and incandescent lamps have been placed in the passages.

Society of Telegraph-Engineers and Electricians, Students' Meeting.—The last meeting of the students of this Society was held on the 9th inst., Prof. J. Perry, M.E., D.Sc., F.R.S., in the chair. The following Paper was read:—"Belts and Belt Driving," by J. N. Cooper. A discussion followed, in which Messrs. Marsh, Paul, Lamb, Mitchell, Sanders, M'Mahon, Poynton, Rance, Hume, Shephard, and Allan took part.

Edison-Swan v. Holland.—We understand that it has now been arranged that the experiments which are to be carried out by order of the judge will be conducted on the part of the plaintiffs by Dr. Hopkinson and Prof. Dewar, and on the part of the defendants by Profs. Crookes and S. P. Thompson. Prof. Stokes will act as moderator, and will make an independent report. The experiments were only commenced a few days ago and are expected to occupy a week or ten days.

Tangier and the Telegraph.—The laying by the Eastern Telegraph Company of a cable between Tangier and Gibraltar, thus placing Tangier in telegraphic communication with the civilised world, is, in the opinion of Consul White, the most important step in advance that has been made in that backward country for many years. The *Investors' Guardian* also says that "it has proved an inestimable boon to those engaged in commerce in that country, as, indeed, to all residents; and, if current report speaks true, is a great financial success. The Moorish Government had for many years opposed the laying of this cable, and great credit is due to Her Majesty's Minister for having at last overcome this opposition."

The Iron and Metal Trades Exhibition.—Under the above title an exhibition, certified by the Board of Trade as "International," is to be held at the Royal Agricultural Hall,

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Islington, in November of the present year. Although this is a private venture, yet the success of the various trade exhibitions which have already been conducted in the same hall under the management of Mr. Etherington may be taken as a guarantee of the success of the present undertaking. Electrical manufacturers are not specifically included in the title of the exhibition, but we gather that an effort will be made to secure a representative display under this head, and we commend the scheme to the attention of our readers.

The Police Telegraph System.—Since the riots which took place in the West End, and the meetings of the unemployed in Trafalgar-square, the attention of the authorities has been directed to the perfecting and extension of the police telegraph system throughout the metropolis. The scheme has been carried out on an extensive scale. The central police offices are connected either by telegraph or telephone with the fire brigade stations, the War Office, the Home Office, the House of Commons, and the House of Lords, as well as with the private residences of the superior officers. In addition to these extensions, in case of emergency a message handed in at any postal telegraph office by a police officer is to take precedence of any others.

The Hanover-square School of Electrical Engineering and Submarine Telegraphy.—The managers of this school have just appointed Mr. Charles Capito, Member of the Institute of Mechanical Engineers and M.S.T.E. and E., to the post of senior instructor, soon to be vacant by the resignation of Mr. Henry D. Wilkinson. Mr. Capito was for three years apprenticed to mechanical engineering works in Copenhagen, and studied for seven years in the Polytechnical Academy there, passing all the examinations with the highest honours. Subsequently he held office in the City and Guilds of London Institute at Finsbury, under Prof. Ayrton, for about two years, when he became chief electrician to the Electrical Power Storage Company.

Boys Struck by Lightning.—On Saturday evening, says the *Manchester Guardian*, a number of boys were playing cricket close to the celebrated Crich "Stand," near Matlock Bath, when, a thunderstorm visiting the district, they took shelter in the basement of the structure, which has an elevation of 1,000ft. above the level of the sea. A flash of lightning struck the "stand," and seven boys were thrown to the ground and injured. Fears were entertained that a number were killed, but with the assistance of Dr. Graves, of Crich, five were restored and enabled to proceed home. The other two, Thomas Holmes and Arthur Tomlinson, were most seriously injured, and remained in an unconscious condition for four hours. As yet they are not declared out of danger.

The Telephone in the Western Counties.—The Western Counties and South Wales Telephone Company have issued an excellent map, showing the present position and contemplated extensions of their system. At this moment the latter (that is to say, the contemplated extensions) are considerably in excess of the work actually carried out, but seeing that the increase in the mileage of wires is now proceeding at a rate of something like 50 per cent. per annum, it does not seem likely that this condition of affairs will be of permanent duration. From the accounts rendered at the meeting of the shareholders which has just been held it will be seen that the financial position is excellent, and with a continuation of the active and judicious policy which has hitherto characterised the company's operations, we have no doubt that the future will be even more successful than the past.

An "Accident" in Germany.—A very singular accident happened in Hamburg some weeks ago, according to the *Journal für Gasbeleuchtung*. In an empty back room, behind a moulding, there were a number of electric light wires. A half-inch iron gas pipe was thrust through among these, and one of the wires was broken. Its ends lay on the gas pipe and melted a hole two-fifths of an inch in diameter. When the gas was next turned on the current happened to be off, but, of course, the gas escaped through the hole in the pipe. Then, as soon as the escape was discovered, the electric current was turned on in order to look for it. Every possible precaution having thus been taken in laying the train, an explosion of a highly successful character immediately followed.

The French Government and the Telephone.—In view of the amalgamation project at home, it is interesting to hear what is thought about telephone monopoly across the Channel. The concession granted to the Société Générale des Téléphones expires in September, 1889, and there seems to be a widespread feeling that it ought not to be renewed. *Le Bulletin de l'Electricité*, in the course of a long article, urges the Government to refuse to renew this concession and to take over the whole of the telephone business itself, citing in support of their view the dictum of M. Portalis, who said in 1837 that "every new mode of rapid communication of intelligence ought to be appropriated by the State at all costs;" the article concludes by calling on the State not to permit "the profits of such a fruitful monopoly to go into the pockets of greedy cosmopolitan fiananciers."

Dundee Telephone Service.—The National Telephone Company have issued in a very handy form a "Guide to the Public Telephone Call Offices in the Dundee District and in the Towns Connected with Dundee by Trunk Wires," showing the rates in force for three minutes' conversation from any call office over any trunk wire. The issue of this guide is a proof of the extent to which the National Company have developed their service in the district north of the Tay. As soon as the completion of the Forth Bridge enables the company to bring their cables over the estuary communication will be opened up between the Dundee and the Edinburgh districts. Glasgow is already within speaking distance of Dundee by a roundabout route through Stirling, Kirkcaldy, and Cupar; but the public are not at present invited to avail themselves of the service. A much shorter route will eventually be opened up on the completion of a line now in progress between Perth and Alloa.

Exports of Telegraphic Wire, &c.—Comparing the monthly returns this year with the corresponding returns of 1887 and 1886, we find that for the first time this year last month's exports of telegraphic wires and apparatus connected therewith were larger than in the corresponding month of the two previous years. The figures for May have also brought up the aggregate from January 1st to a larger item than in the first five months of 1887, though we are still below the total for the first five months of 1886. The following is a comparative statement to date:—

EXPORTS OF TELEGRAPHIC WIRES AND APPARATUS CONNECTED THEREWITH.

	1886.	1887.	1888.
Jan. 1 to March 31 ...	£124,074	... £131,879	... £88,077
April	111,847	... 27,616	... 27,012
May	49,460	... 10,447	... 67,905
Five months.....	£285,381	... £169,942	... £182,994

Proposed New Telegraph Cable in the Hebrides.—A movement for the extension of the telegraph system in the Outer Hebrides, in order to facilitate the increasing work in the telegraphic department of the Post Office, is, we understand, likely soon to be brought under the notice of the postal authorities.

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To accomplish this it is proposed that Lochmaddy, in Uist, and Dunvegan, in Skye, should be connected by a cable, the distance across the Minch between those two places being rather less than 24 miles, thus making a direct communication between the southern portion of the Long Island and the mainland. The scheme, if carried out, would very materially expedite the transmission of messages, which by the existing arrangement, and more particularly in busy seasons, is very slow and complicated. This is more especially felt while the herring fishing lasts, when owing to the large amount of telegraphic business done on the line which connects Castlebay and Stornoway with the mainland, all local and intermediate business is frequently at a standstill.

Copper.—The *Investors' Guardian*, commenting on what it considers the critical position of the Copper Syndicate, says :—"If we take it that the contracts of the Syndicate with the Copper Companies have about three years to run from December last, and that the excess of receipts over deliveries continues at the same ratio, this excess will then amount to 146,208 tons. If the quantity purchased by the company in order to advance the price from £40 to £80 per ton was only 25,000 tons, the stock unsold in their hands on the 31st December, 1890, will amount to 171,208 tons. It is possible that the deliveries may somewhat increase, even if the high price should continue, but these would be more than counterbalanced by the product from new sources of supply over which the company has now no control." The plan for taking over the liabilities of the Copper Syndicate in Paris by the formation of a new company, with a capital of £7,000,000, has been ill-received in this country, and is severely handled by most of the English financial organs.

A New Constant Cell.—MM. Fabingi and Farkas in a communication to the Académie des Sciences on the 4th inst. described a new constant cell devised by them. It consists of a small platinum vessel coated on the inside with a compound having the empirical composition $Na_2 H_{12} Pt_2 O_{11}$, and which is formed by heating the platinum in contact with caustic soda. The vessel is filled with fused caustic soda maintained in a fluid condition by means of a small gas jet. The positive electrode consists of platinum, the negative one of gas carbon. On closing the circuit the E.M.F. soon assumes a steady value as the carbonate of soda produced is continuously eliminated and deposited in a crystalline form on the free surfaces of the electrodes. The E.M.F. depends on the temperature, but the temperature coefficient is so small that with an ordinary gas flame the E.M.F. may be maintained sensibly constant for several hours. Large and sudden alterations in the external resistance only cause a momentary change in the E.M.F., which almost immediately returns to its original value.

The Electrification of Aqueous Vapour.—MM. Lang and Lecher have lately laid the results of their experiments upon the transference of electricity by water vapour before the Académie des Sciences of Vienna. It is generally known that the friction of steam against solid bodies increases its electric charge, and this phenomenon has been made use of in the well-known Armstrong machine. M. Lecher has shown by thermometric experiments that an electrified liquid evaporates more quickly than one in a neutral condition. This, however, is nothing new; M. Mascart and, more recently still, Prof. Exner have shown the same thing. M. Lecher, however, attributes the increase in the amount of vapour to energetic electrical action taking place at the surface of the liquid, and which, according to him, renders all thermometric measurements exceedingly difficult. Others have attributed the phenomenon to the actual electrification of the steam itself, and that the steam is electrified M. Lecher's experiments have shown. These investigations are very important from a purely theoretical point of view, since they tend to throw light on the theory of atmospheric electricity.

The Use of Electric Light for Sea Fishing.—In a Note under this heading in our last issue we stated that some German fishermen had been making some experiments in this direction. We now learn from *Nature* that experiments of a somewhat similar character have been successfully carried out on our own shores. On the 19th of last month, as in previous years, the Liverpool Salvage Association placed a steamer at the disposal of the Liverpool Marine Biology Committee for a three days' Whitsuntide holiday cruise. The present cruise was devoted to dredging and sounding between the Mersey and the Isle of Man, and on the first night the experiment was tried of placing a 60 candle-power Edison-Swan submarine incandescent lamp in one of the tow nets, while the other was left in the dark. Experiments were made in three, and in six fathoms of water, while the vessel was stationary, the nets being simply distended by the tide. On each occasion the net furnished with the lamps contained an abundant haul, consisting chiefly of crustaceans, while the dark one contained practically nothing. Owing to the marked effect produced by the presence of the light, lamps were placed in both nets, the next night, and similar success was obtained.

A New Galvanometer.—The *Electrical World* of the 2nd inst. contains an account of a galvanometer designed by Dr. W. E. Geyer and Mr. H. Bristol, of the Stevens Institute of Technology, Hoboken, N.J. A compound bar, formed of a wide strip of some suitable metal, such as German silver, and a wire of the same material, riveted together at short intervals, is bent into the form of the greater portion of the circumference of a circle, with the wire inside. The bar is rigidly fixed at one end, and the two metals attached to binding screws; at the other extremity the metals are connected together, and the free end is connected by gearing with an indicating band moving over a dial plate. When a current passes through the instrument the temperature of the wire is increased in a greater ratio than that of the strip, owing to its smaller radiating surface, so that the bar tends to straighten out. The instrument is very similar in its appearance and the arrangement of its gearing to the well-known Bourdon steam pressure gauge. The deflections are made proportional to the strength of current by a suitable adjustment of the gearing. It is evident that the indications of the instrument will be independent of external changes of temperature, as these will affect both the bars equally.

An Electro-Chemical Radiophone.—In a communication to the Académie des Sciences, on the 4th inst., MM. Chaperon and Mercadier described a galvanic cell made by them which is sensitive to the action of light. It consists of a plate of bright silver, and a plate of silver, covered by the electrolysis of sulphide of sodium, with a thin layer of sulphide of silver, immersed in some electrolyte other than an alkaline sulphide, water containing a trace of sulphuric acid being as good as anything. The E.M.F. is very feeble and variable, and the cell polarises very rapidly, but its current undergoes instantaneous change when exposed to daylight or even to weak artificial light. The authors investigated the rapidity of the action by exposing the cell to the beam of the oxyhydrogen light made intermittent by passing through a revolving wheel pierced with holes. A telephone was included in the battery circuit, and sounds were produced so high in the scale as to correspond to more than 1,000 vibrations a second, which showed that the electro-chemical effect must be produced in less than $\frac{1}{2000}$th

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of a second. No corresponding changes are observed in the resistance of the cell, so that the effect of the light must be to cause a variation in the E.M.F.

Death by Electricity.—Dr. Richardson writes on this subject (in the *Asclepiad*) as follows:—"In some researches on the application of the electric discharge for the painless extinction of the lives of animals to be used as food, the details of which I recorded in the *Medical Times and Gazette* for the year 1869, this mode of death was anything but certain in its effects. Sheep stricken apparently into instant and irrevocable death by electricity, after a few minutes showed signs of life, and if they had not been dispatched in the ordinary way by the knife would have been restored to consciousness. The same fact has been observed in attempts to kill dogs by the electric shock, and I once published an instance in which a large dog, struck into perfect unconsciousness by the stroke from a powerful battery, was submitted to a surgical operation whilst lying, to all appearances, dead, and was yet so little affected as to make an easy and sound recovery. It need not be inferred from such facts as these that the electric shock will not kill at one discharge—it most cases it will—but, exceptionally, instead of killing outright it will simply stun, and may induce the semblance of death instead of the real event. It will be only comman humanity, therefore, for the authorities of New York, when they begin to give the *coup de grâce* by the electric shock, to supplement the process by a *post-mortem* examination of the victims, so that the act may not be crowned by burying the victims alive."

Spanish Electrical Engineers and the Electric Light.—Commenting upon a report from Cadiz to the effect that the Municipality of Ubrique had decided to adopt the electric light, the *Revista Minera*, a recognised mining, metallurgical, and engineering weekly journal, published in Madrid, fails to see how the adoption of the electric light in Spain can be satisfactorily carried out under the present conditions. Our contemporary states that the number of skilled electricians in Spain is quite inadequate for the installation and management of the electric light in a satisfactory manner. What is wanted is a body of electricians capable of supplying and managing an installation profitably. Without such a skilled *personnel*, argues the Madrid journal, "money will be spent, the electric light will be discredited, and the industry will be thrown back eight or ten years." We last week referred to the difficulties that have arisen in connection with the lighting of the Comedy Theatre, Madrid, by electricity. The *Revista Minera* complains that, notwithstanding the decisions of the civic authorities and the Theatrical Board that the installation fulfilled the requirements of the Royal Decree, the system adopted is open to grave objections. The *Revista* is totally opposed to the employment of motors for generating the electricity in theatres, especially if the engine is working when the theatre is being used. The installation at the Comedy Theatre is declared to be an excellent one of its kind, but the *Revista* strongly advocates the employment of accumulators. Any increase of expense in the installation and production of the light would, it is argued, be more than compensated by the safety and convenience of the system it advocates, viz., that of accumulators of transformers.

Bradford.—At a meeting of the Bradford Town Council on Tuesday a communication which had been received from the Local Government Board with regard to the electric lighting scheme for Bradford was read by the Town Clerk. The communication was to the effect that the authorities had had under consideration the Council's application for borrowing powers for the purposes of the scheme, and now sent down an authorisation for the Council to borrow £20,000. Alderman F. Priestman (chairman of the Gas Supply Committee) moved the adoption of the minutes of that committee, which included resolutions accepting the tender of Messrs. J. and W. Beanland for excavating, brickwork, ironfounder and smith's work, masonry, carpentering, joinery, plumbing, glazing, &c., in connection with the electric-lighting works, for £3,690; the tender of Messrs. Holdsworth and Sons for the supply and fixing of three mild steel boilers and fittings for £2,125; and the tender of Messrs. Siemens Brothers and Co. (Limited) for the supply and fixing of dynamos and all the appliances for £12,543, the total cost of the proposed installation being £18,358. Further, the committee recommended that the Council should authorise the Gas Supply Committee to apply to the Local Government Board for authority to increase the sum to be borrowed for electricity works to an amount not exceeding in the whole £25,000. Alderman Priestman said he did not think it necessary to go at any great length into the details of the proposed scheme, inasmuch as it was practically the same scheme as that which had been brought before the Council in December last, when they had passed a resolution authorising the Gas Supply Committee to spend not more than £15,000 upon the scheme. That resolution was confirmed on February 14th, when the Council instructed the Town Clerk to apply to the Local Government Board for leave to borrow £20,000 to carry out the scheme. After some discussion the resolution embodying these proposals was carried with only two dissentient votes.

The Watkin Range-Finder. — The Government have awarded the sum of £25,000 and a retaining fee of £1,000 a year for ten years to Major H. Watkin, R.A., the inventor of the position-finder which for fifteen years past has been associated with his name. Besides being an exceptionably able gunner, Major Watkin is a first-class electrician, and to this fact is mainly due the perfecting of his remarkable invention. As originally designed, an accurate chart of the anchorage or approaches to be defended was divided into squares of twelve inches to a mile, each square having recorded on it its distance from the fort, together with the elevation and deflection due to such range. The chart was then placed under the arms of an instrument at the "directing station," a retired spot, the outlook from which would not be likely to be obscured by smoke. Well-hidden "observing stations," giving half a mile of base, were also established on each side of the fort, and a man at each station followed with a telescope the movements of the object to be fired at. The telescopes being electrically connected, moved two corresponding arms on the face of the chart at the "directing station" in such a manner that the point of intersection of the arms showed the exact position of the target on the squares. On the number of any square being telegraphed from the "directing station" to the battery, it was reproduced on a dial placed between every two guns; and all that the gun detachments had to do was to train and elevate their pieces accordingly. The essential features of the subsequent and perfected apparatus are kept secret; but it may be stated that the squares are done away with, and the simple act of laying the telescope from the directing station indicates to the batteries, which in some cases may be miles away, the training and elevation; so that the guns may be laid without the target being visible from the battery. They might, for example, be fired over a hill. Nay, more, the instrument foretells the position which a moving target, such as a ship, will occupy several seconds ahead, and sends the indication to the gun commanders, who make ready. The officer at the directing station then watches through his glass, and, when the vessel arrives at the predicted position, he presses a key and fires.

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UNIPOLAR INDUCTION.—II.

BY G. W. DE TUNZELMANN, B.SC.

(Continued from page 141.)

In the year 1839 W. Weber ("Resultate des Magnetischen Vereins," 1839, p. 63; *Poggendorff's Annalen*, Vol. LII., p. 352) gave an account of some experiments made by him of a character similar to some of those which we have described. The arrangement used by him consisted of a cylindrical magnet, supported by means of two steel points pressing into depressions in its ends, just as the magnet in Fig. 4 of our last article was supported vertically, and capable of being set in rapid rotation by means of a train of wheel work. At or near the centre of the magnet a copper disc was fitted over it, and this dipped into a mercury trough placed below it. Currents were then obtained through a galvanometer with its terminals in connection with the copper disc through the mercury trough and one of the steel points respectively. In a paper by Plücker, in *Poggendorff's Annalen*, Vol. LXXXVII., p. 352, 1852, an apparatus designed by Fessel, and shown in Fig. 9, is described.* It consists of a cylindrical magnet, *n s*, rigidly attached to a pulley, *a*, with a coaxial copper cylinder, *c*, rigidly attached to a pulley, *b*. The magnet is supported on the two screws *d* and *i*, which make electrical contact with its ends, and it can be prevented from rotating by tightening the screw *d*. Contact springs pressing against the cylinder are attached to the binding-screws *f*, *g*, *h*.

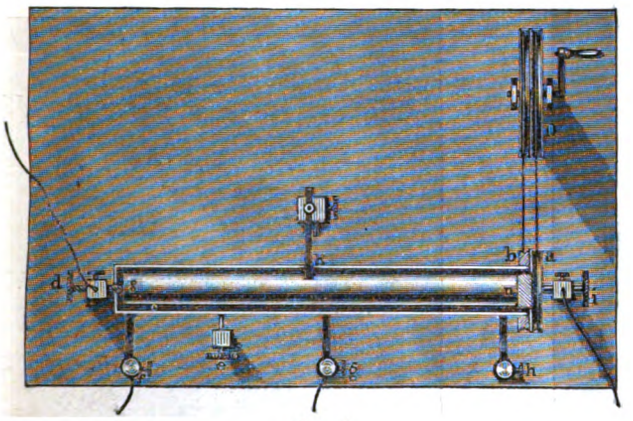

FIG. 9.

N S, steel magnet; *c*, copper cylinder; *a*, *b* and *o*, driving pulleys; *d i*, screws on which magnet turns; *f*, *g*, *h*, binding screws attached to contact springs pressing against *c*; *k*, contact spring pressing against magnet; *e*, screw for fixing cylinder.

A contact spring, *k*, passes through an opening in the cylinder, and presses against the magnet. The cylinder can be prevented from rotating by means of the screw *e*. It will therefore be seen that by means of the driving pulley O the magnet and cylinder can be rotated together, or either separately, so that the copper cylinder plays the same part as the wire *g e* in Fig. 8 of our last article, or the fixed portion of the circuit when this was removed.

If the galvanometer terminals are connected with *g* and *h*, and the magnet is rotated while the cylinder remains fixed, no current is obtained.

If the magnet and cylinder rotate together, or if the magnet is fixed and the cylinder rotates, a current in the same direction and of the same strength is obtained in each case.

If the cylinder is fixed and the galvanometer terminals connected, one with *k* and the other with *d* or *i*, a current is obtained, the arrangement being similar to that of Fig. 4 in our last article.

If the magnet and cylinder are placed in electrical contact and rotated together, and the galvanometer terminals are connected, one with *g* and the other with *d* or *i*, the current obtained is stronger than in the preceding experiment.

Fig. 10 shows a piece of apparatus in which a magnet, *n s*, and two copper discs, *a* and *b*, can be made to rotate about a common axis, and contact springs *c* and *d* press against the two discs. If the terminals of a galvanometer are connected with the binding screws to which *c* and *d* are attached, a current will always be produced on rotating the magnet, when, as shown in the figure, the contact point *d* is farther from the axis than *c*. If *d* is close to the axis and *c* at some distance from it a current will be produced in the opposite direction on rotating the magnet in the same direction as before. It will be found that no current will be obtained for a given position of *c*, when *d* is at a point slightly nearer to the axis, the difference between the

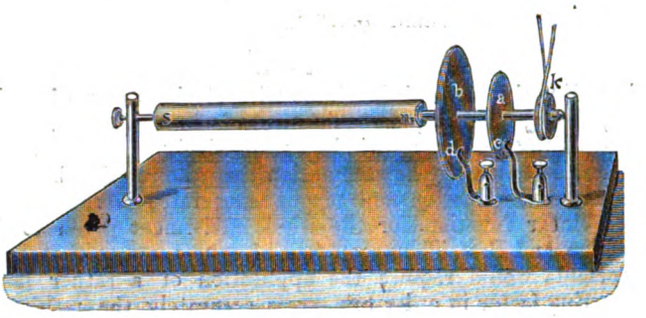

FIG. 10.

N S, steel magnet; *k*, driving pulley; *a* and *b*, copper discs; *c* and *d*, contact springs.

distances of *c* and *d* from the axis, for no current, being increased by moving *b* nearer to the magnet or *a* farther from it.

If the two springs are arranged to make contact with the same disc, but at different distances from the centre, as shown in Fig. 11, a current will also be obtained.

If the electrodes *c* and *d* are fixed to the magnet and rotate with it, while the disc *a* remains fixed, a current will be obtained in the same direction as if *c* and *d* were fixed, while the disc rotated with the magnet.

Finally, if the magnet and the electrodes are both fixed, and the disc is made to rotate in the opposite direction to that of its former rotation with the magnet, a current will be obtained in the same direction as before.

We may here note that in all cases where a current is produced by rotation of the magnet, or of a conductor in its magnetic field, if the galvanometer be replaced by a battery giving a current in the same direction as that through the galvanometer

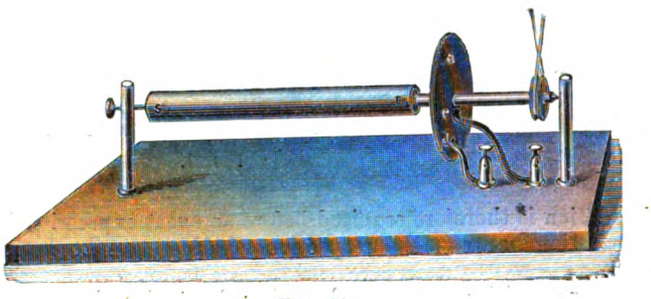

FIG. 11.

N S, steel magnet; *a*, copper disc; *c* and *d*, contact springs.

a rotation will be produced in the opposite direction to that which produced the current, as, of course, follows from Lenz's law.

(To be continued.)

* This and the two following illustrations are taken from Wiedemann's "Lehre von der Electricität."

A Collodion Electroscope.—Prof. Jouravski, of St. Petersburg, has discovered that the dry pellicle of collodion becomes negatively electrified when stretched. It is only necessary to pour a little collodion on a plate of glass and allow the ether to evaporate, when an extremely thin membrane remains behind, which is easily detached from the glass. All that has now to be done is to cut the membrane into strips and keep them in a dark place, and you have so many ready-made electroscopes.

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NOTE ON THE CONDITIONS OF REGULATION IN DYNAMOS FOR CONSTANT POTENTIAL.

BY W. B. ESSON.

In *The Electrician* of May 18th is given the abstract of a short Paper on the above subject recently read by Prof. Silvanus P. Thompson before the Physical Society. It will be remembered that in his book on "Dynamo-Electric Machinery," Prof. Thompson gives for the proportion between the shunt and series windings on a constant potential machine the relation

$$\frac{Z}{S} = \frac{r_s}{r_a + r_m},$$

where Z is the turns of the shunt wire, S the turns of series wire, and r_s r_a and r_m the resistances of shunt-winding, armature-winding and series-winding respectively. The above expression is based on the assumption that the relation between the magnetic induction and magnetising force is represented by a linear function for the whole excitement given to the machine, and Prof. Thompson was, of course, aware that such a formula would require the application of a rather large correcting factor in order to express accurately the results of practice. A correcting factor Prof. Thompson applies in the Paper referred to, but the correction is inadequate, and further elucidation is therefore required before an exact expression for the relation between the respective windings can be formulated.

In two articles contributed to *The Electrician* three years ago the writer stated in a general way the principal reason why the above formula could not express the relation in actual machines. It was said that owing to the partial saturation of the magnets by the shunt coil, the value per ampere-turn of the series winding was much less than the value per ampere-turn of the shunt. The former was also shown to be proportional to the tangent of the angle which the saturation curve of the machine made with the horizontal at the point representing the excitement given to the magnets when there was no current flowing in the external circuit. Were there no correction necessary save that required by the saturation effect, Prof. Thompson's amended formula would undoubtedly be right, but inasmuch as there are other considerations which cannot be neglected, any formula which recognises the circumstance referred to as alone influencing the regulation will not give accurate results.

The curve (Fig. 1) reproduced by the courtesy of Messrs. Paterson and Cooper, and obtained from one of their "Phœnix" dynamos, will illustrate the remarks which follow. The machine was of the single-magnet upright-type similar in design to the one illustrated in *The Electrician*, Vol. XX., page 568, and compound-wound for 150 100 volt 16 candle-power lamps. The ring core of the armature had about 22 square inches of iron in its cross-section, and was wound with 180 convolutions. The magnet had a cross-section of 62 square inches. At 1,420 revolutions per minute the machine had an output of 90 amperes at 100 volts. The curve was obtained by running the machine at this speed, and exciting the magnets from the shunt-coil only, introducing resistances to vary the excitement There was no current in the armature save that going round the shunt, and no lead was given to the brushes. The exciting current and E.M.F. being simultaneously observed, the curve in which the former in ampere-turns is plotted as abscissæ and the latter as ordinates gives the "satural" data of the machine.

If in a compound dynamo with long-shunt winding v is the difference of potentials required at the terminals, V the difference of potentials required to send the external current through the armature and series coil, i_1 the current in the shunt and i_2 the external current, then $\frac{v}{i_1(Z+S)}$ and $\frac{V}{i_2 S}$ as measured from the curve Fig. 1 represent the ratios which were called the mean value per ampere-turn of the shunt and series windings respectively. They are the ratios of induced magnetism to magnetising force, and are now termed by Prof. Thompson the average permeability corresponding to no external current, and the average permeability over the working range. These can be determined quite easily from the curve. Calling the former p_1 and the latter p_2, since to produce a given effect the product of the turns and permeability is a constant, we have, inserting these factors,

$$\frac{Z}{S} \times \frac{p_1}{p_2} = \frac{r_s}{r_a + r_m}$$

as the amended expression for the relation between the shunt and series windings; in other words, the correcting factor is the ratio of the average permeability over the range of excitement on open circuit to the average permeability over the excitement range of the series wire.

The formula thus modified would doubtless express the relation which Prof. Thompson wishes it to express were there no current flowing in the armature, no reactions therefrom, no self-induction, and no magnetic leakage. As it stands dynamo makers well know that the series turns which it indicates are still too few. The correction is, in fact, based upon

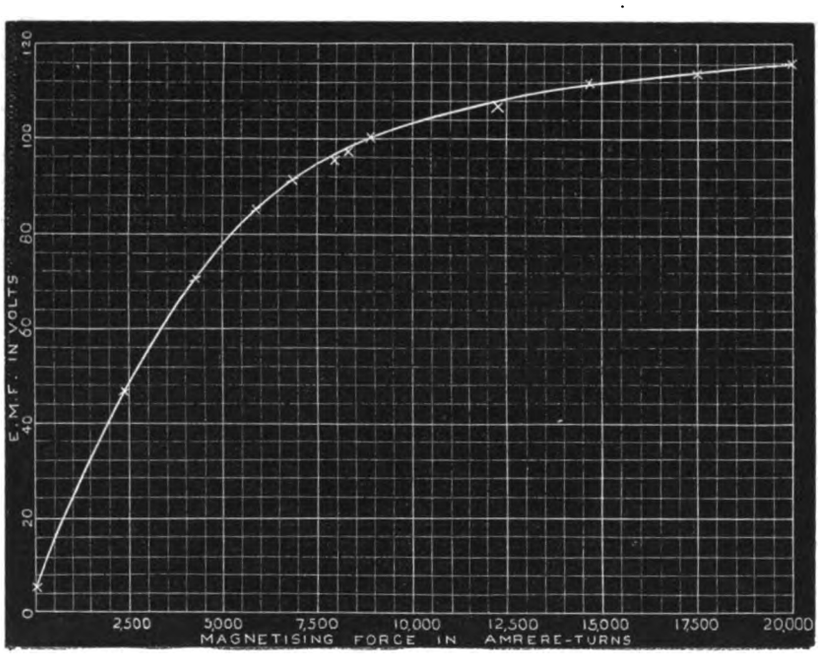

FIG. 1.

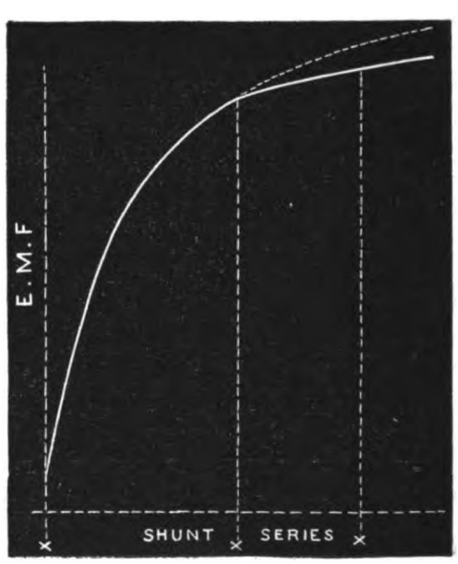

FIG. 2.

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another assumption, which is not justified by practice, and that is that the curve connecting the E.M.F. with the magnetising force is, after the series wire comes into action and a current flows in, a continuation of the curve due to the excitement on open circuit. That this is not the case, that there is an angle in the curve, as in Fig. 2, is shown by a very simple experiment. Run the machine on open circuit to obtain the necessary E.M.F., say 100 volts, and measure the excitement given to the magnets. Now run with the circuit closed, the brushes having their proper lead, and the full current flowing through the armature, the machine giving the same virtual E.M.F. as before. The difference of potential at the brushes will now be 100 volts, *minus* the difference of potentials required to send the current through the armature. It will be found that the excitement required to obtain this has been considerably increased, and the difference represents what might be called the waste excitement. These turns cannot be utilised to add to the E.M.F.; their function is purely compensatory, if one might say so, counteracting the fall of potential due to the influences above mentioned. If, the conditions remaining otherwise similar, the excitement is further increased until the E.M.F. required to send the current through the armature and series is added, the increase represents the turns inductively serviceable. The turns thus added probably accord with those which would be indicated by the saturation curve of the machine.

On examining the curve of the dynamo referred to, it will be seen that 8,750 ampere-turns were required to produce an E.M.F. of 100 volts. The resistance of the armature and series coil was ·061 ohm, and the E.M.F. required to send through this resistance the external current of 90 amperes was, roughly, 5·5 volts. The resistance of the shunt was 650 times that of the armature and series. From the curve we learn that 105·5 volts can be produced by a magnetising force of 11,000 ampere-turns, or, 8,750 being furnished by the shunt and series on open circuit, 2,250 ought to be added by the series when 90 amperes are flowing. This is the series excitement as indicated by the "satural" data, but, as a matter of fact, in this machine there were added 4,860 ampere-turns, the total excitement on full load being 13,610. The above is a very usual proportion for the windings of compound machines.

It appears, then, that a further modification in the formula is necessary, and that it is delusive to deduce the amount of series wire from the satural data alone, since there are several considerations besides this which determine the relation of the shunt and series windings. In the writer's opinion these considerations are too important to be neglected in any formula by which it is desired to express with exactitude this relation. It would seem desirable, moreover, to abandon a formula by which it is attempted to express it in terms of the resistances of the coils and armature, the utility of such a formula not being apparent to those engaged in dynamo construction.

A NEW ALTERNATING CURRENT MOTOR.

BY NICOLA TESLA.*

In the presence of the existing diversity of opinion regarding the relative merits of the alternate and continuous current systems, great importance is attached to the question whether alternate currents can be successfully utilised in the operation of motors. The transformers, with their numerous advantages, have afforded us a relatively perfect system of distribution, and although, as in all branches of the art, many improvements are desirable, comparatively little remains to be done in this direction. The transmission of power, on the contrary, has been almost entirely confined to the use of continuous currents, and notwithstanding that many efforts have been made to utilise alternate currents for this purpose, they have, up to the present, at least as far as known, failed to give the result desired. Of the various motors adapted to be used on alternate current circuits the following have been mentioned: (1) A series motor with subdivided field. (2) An alternate-current generator having its field excited by continuous currents. (3) Elihu Thomson's motor. (4) A combined alternate and continuous current motor. Two more motors of this kind have suggested themselves to me: (1) A motor with one of its circuits in series with a transformer, and the other in the secondary of the transformer. (2) A motor having its armature circuit connected to the generator, and the field coils closed upon themselves. These, however, I mention only incidentally.

The subject which I now have the pleasure of bringing to your notice is a novel system of electric distribution and transmission of power by means of alternate currents, affording peculiar advantages, particularly in the way of motors, which I am confident will at once establish the superior adaptability of these currents to the transmission of power, and will show that many results heretofore unattainable can be reached by their use, results which are very much desired in the practical operation of such systems, and which cannot be accomplished by means of continuous currents.

Before going into a detailed description of this system I think it necessary to make a few remarks with reference to certain conditions existing in continuous current generators and motors, which, although generally known, are frequently disregarded.

In our dynamo machines, it is well known, we generate alternate currents which we direct by means of a commutator—a complicated device, and, it may be justly said, the source of most of the troubles experienced in the operation of the machines. Now, the currents so directed cannot be utilised in the motor, but they must—again by means of a similar unreliable device—be reconverted into their original state of alternate currents. The function of the commutator is entirely external, and in no way does it affect the internal working of the machines. In reality, therefore, all machines are alternate-current machines, the current appearing as continuous only in the external circuit during their transit from generator to motor. In view simply of this fact, alternate currents would commend themselves as a more direct application of electrical energy, and the employment of continuous currents would only be justified if we had dynamos which would primarily generate, and motors which would be directly actuated by such currents.

But the operation of the commutator on a motor is twofold—firstly, it reverses the currents through the motor; and, secondly, it effects, automatically, a progressive shifting of the poles of one of its magnetic constituents. Assuming, therefore, that both of the useless operations in the system—that is to say, the directing of the alternate currents on the generator, and reversing the direct currents on the motor—be eliminated, it would still be necessary, in order to cause a rotation of the motor, to produce a progressive shifting of the poles of one of its elements, and the question presented itself, how to perform this operation by the direct action of alternate currents. I will now proceed to show how this result was accomplished.

In the first experiment a drum armature was provided with two coils at right angles to each other, and the ends of these coils were connected to two pairs of insulated contact rings, as usual. A ring was then made of thin insulated plates of sheet iron and wound with four coils, each two opposite coils being connected together so as to produce free poles on diametrically opposite sides of the ring. The remaining free ends of the coils were then connected to the contact rings of the generator armature so as to form two independent circuits, as indicated in Fig 9. It may now be seen what results were secured in this combination, and with this view I would refer to the diagrams Figs. 1 to 8A. The field of the generator being independently excited, the rotation of the armature sets up currents in the coils varying in strength and direction in the well-known manner. In the position shown in Fig. 1 the current in coil c is *nil* while c_1 is traversed by its maximum current, and the connections may be such that the ring is magnetised by the coils c_1 c_1, as indicated by the letters N S in Fig. 1A, the magnetising effect of the coils c c being *nil*, since these coils are included in the circuit of coil c.

In Fig. 2 the armature coils are shown in a more advanced position, one-eighth of one revolution being completed. Fig. 2A illustrates the corresponding magnetic condition of the ring. At this moment the coil c_1 generates a current of the same direction as previously, but weaker, producing the poles n_1 s_1 upon the ring; the coil c also generates a current of the same direction, and the connections may be such that the coils c c produce the poles n s, as shown in Fig. 2A. The resulting polarity is indicated by the letters N S, and it will be observed that the poles of the ring have been shifted one-eighth of the periphery.

In Fig. 3 the armature has completed one-quarter of one revolution. In this phase the current in coil c is a maximum, and of such direction as to produce the poles N S in Fig. 3A, whereas the current in coil c_1 is *nil*, this coil being at its neutral position. The poles N S in Fig. 3A are thus shifted one-quarter of the circumference of the ring.

Fig. 4 shows the coils in a still more advanced position, the armature having completed three-eighths of one revolution. At that moment the coil c still generates a current of the same direction as before, but of less strength, producing the comparatively weaker poles n s in Fig. 4A. The current in the coil c_1 is of the same strength, but of opposite direction. Its effect is therefore to pro-

* Paper read before the American Institute of Electrical Engineers, May 15th, 1888.

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duce upon the ring the poles n_1 and s_1 as indicated, and a polarity N S results, the poles now being shifted three-eighths of the periphery of the ring.

In Fig. 5 one-half of one revolution of the armature is completed, and the resulting magnetic condition of the ring is indicated in Fig. 5A. Now, the current in coil c is *nil*, while the coil c_1 yields its maximum current, which is of the same direction as previously; the magnetising effect is therefore due to the coils c_1 c_1 alone, and referring to Fig. 5A it will be observed that the poles N S are shifted one-half of the circumference of the ring. During the next half revolution the operations are repeated, as represented in the Figs. 6 to 8A.

A reference to the diagrams will make it clear that during one revolution of the armature the poles of the ring are shifted once around its periphery, and each revolution producing like effects a rapid whirling of the poles in harmony with the rotation of the armature is the result. If the connections of either one of the circuits in the ring are reversed, the shifting of the poles is made to progress in the opposite direction; but the operation is identically the same. Instead of using four wires, with like result, three wires may be used, one forming a common return for both circuits.

The rotation or whirling of the poles manifests itself in a series of curious phenomena. If a delicately-pivoted disc of steel or

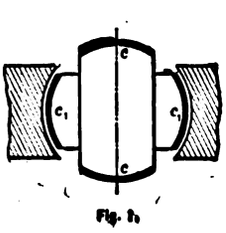
Fig. 5.

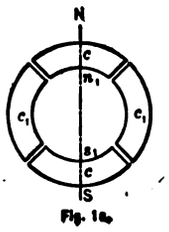
Fig. 5A.

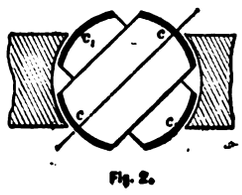
Fig. 2.

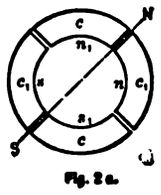
Fig. 2A.

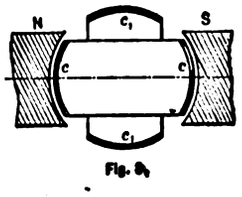
Fig. 3.

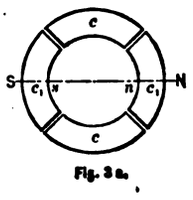
Fig. 3A.

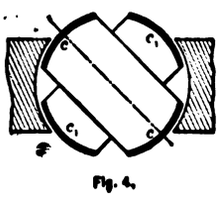
Fig. 4.

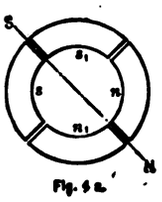
Fig. 4A.

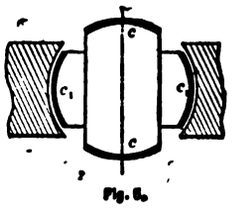
Fig. 6.

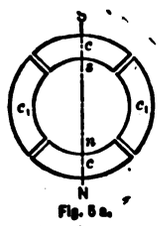
Fig. 6A.

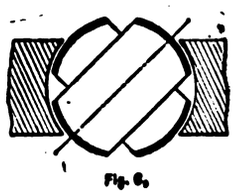
Fig. 6.

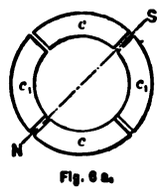
Fig. 6A.

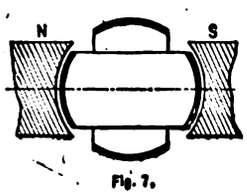
Fig. 7.

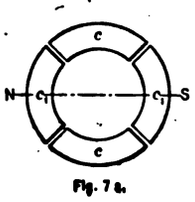
Fig. 7A.

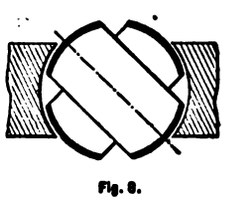
Fig. 8.

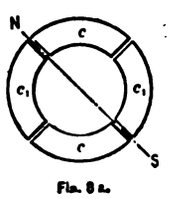
Fig. 8A.

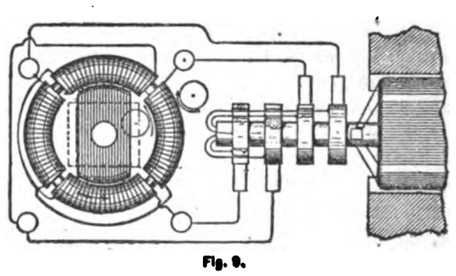
Fig. 9.

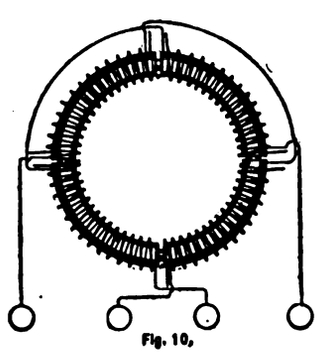
Fig. 10.

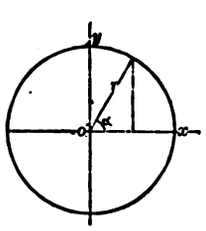
Fig. 11.

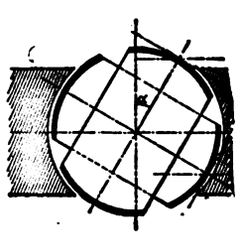
Fig. 12.

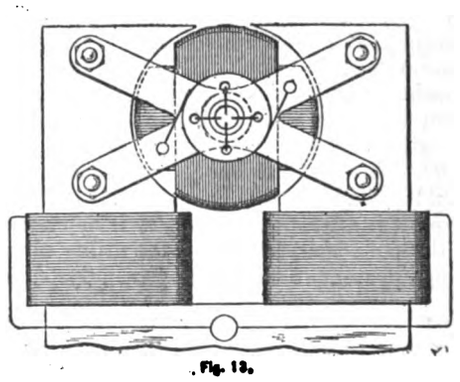
Fig. 13.

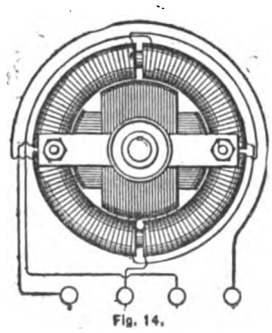
Fig. 14.

Fig. 15.

Fig. 16.

Fig. 17.

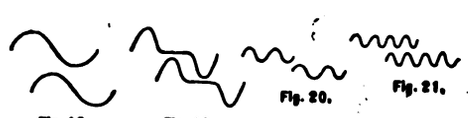
Fig. 18. Fig. 19. Fig. 20. Fig. 21.

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other magnetic metal is approached to the ring it is set in rapid rotation, the direction of rotation varying with the position of the disc. For instance, noting the direction outside of the ring, it will be found that inside the ring it turns in an opposite direction, while it is unaffected if placed in a position symmetrical to the ring. This is easily explained. Each time that a pole approaches it induces an opposite pole in the nearest point on the disc, and an attraction is produced upon that point; owing to this, as the pole is shifted further away from the disc, a tangential pull is exerted upon the same, and the action being constantly repeated, a more or less rapid rotation of the disc is the result. As the pull is exerted mainly upon that part which is nearest to the ring, the rotation outside and inside, or right and left, respectively, is in opposite directions. When placed symmetrically to the ring, the pull on opposite sides of the disc being equal, no rotation results. The action is based on the magnetic inertia of the iron; for this reason a disc of hard steel is much more affected than a disc of soft iron, the latter being capable of very rapid variations of magnetism. Such a disc has proved to be a very useful instrument in all these investigations, as it has enabled me to detect any irregularity in the action. A curious effect is also produced upon iron filings. By placing some upon a paper, and holding them externally quite close to the ring, they are set in a vibrating motion, remaining in the same place, although the paper may be moved back and forth; but in lifting the paper to a certain height, which seems to be dependent on the intensity of the poles and the speed of rotation, they are thrown away in a direction always opposite to the supposed movement of the poles. If a paper with filings is put flat upon the ring, and the current turned on suddenly, the existence of a magnetic whirl may be easily observed.

To demonstrate the complete analogy between the ring and a revolving magnet, a strongly energised electromagnet was rotated by mechanical power, and phenomena identical in every particular to those mentioned above were observed.

Obviously, the rotation of the poles produces corresponding inductive effects, and may be utilised to generate currents in a closed conductor placed within the influence of the poles. For this purpose it is convenient to wind a ring with two sets of superimposed coils, forming respectively the primary and secondary circuits. In order to secure the most economical results, the magnetic circuit should be completely closed, as shown in Fig. 10, and with this object in view the construction may be modified at will.

The inductive effect exerted upon the secondary coils will be mainly due to the shifting or movement of the magnetic action; but there may also be currents set up in the circuits in consequence of the variations in the intensity of the poles. However, by properly designing the generator, and determining the magnetising effect of the primary coils, the latter element may be made to disappear. The intensity of the poles being maintained constant, the action of the apparatus will be perfect, and the same result will be secured as though the shifting were effected by means of a commutator with an infinite number of bars. In such case the theoretical relation between the energising effect of each set of primary coils and their resultant magnetising effect may be expressed by the equation of a circle having its centre coinciding with that of an orthogonal system of axes, and in which the radius represents the resultant and the coordinates both of its components. These are then respectively the sine and cosine of the angle a between the radius and one of the axes (OX). Referring to Fig. 11 we have $r^2=x^2+y^2$; where $x=r\cos a$, and $y=r\sin a$.

Assuming the magnetising effect of each set of coils in the transformer to be proportional to the current—which may be admitted for weak degrees of magnetisation—then $x=\mathrm{K}c$ and $y=\mathrm{K}c_1$, where K is a constant and c and c_1 the current in both sets of coils respectively. Supposing further, the field of the generator to be uniform, we have for constant speed $c_1=\mathrm{K}^1\sin a$ and $c=\mathrm{K}^1\sin(90^\circ+a)=\mathrm{K}^1\cos a$, where K^1 is a constant (*see* Fig. 12). Therefore

$$x=\mathrm{K}c=\mathrm{K}\,\mathrm{K}^1\cos a;$$
$$y=\mathrm{K}c_1=\mathrm{K}\,\mathrm{K}^1\sin a, \text{ and}$$
$$\mathrm{K}\,\mathrm{K}^1=r.$$

That is, for a uniform field the disposition of the two coils at right angles will secure the theoretical result, and the intensity of the shifting poles will be constant. But from $r^2=x^2+y^2$ it follows that for $y=0$, $r=x$; it follows that the joint magnetising effect of both sets of coils should be equal to the effect of one set when at its maximum action. In transformers and in a certain class of motors the fluctuation of the poles is not of great importance, but in another class of these motors it is desirable to obtain the theoretical result.

In applying this principle to the construction of motors, two typical forms of motor have been developed. First, a form having a comparatively small rotary effort at the start, but maintaining a perfectly uniform speed at all loads, which motor has been termed synchronous. Second, a form possessing a great rotary effort at the start, the speed being dependent on the load.

These motors may be operated in three different ways:—(1) By the alternate currents of the source only; (2) by a combined action of these and of induced currents; (3) by the joint action of alternate and continuous currents.

The simplest form of a synchronous motor is obtained by winding a laminated ring provided with pole projections with four coils, and connecting the same in the manner before indicated. An iron disc having a segment cut away on each side may be used as an armature. Such a motor is shown in Fig. 9. The disc being arranged to rotate freely within the ring, in close proximity to the projections, it is evident that as the poles are shifted it will, owing to its tendency to place itself in such a position as to embrace the greatest number of the lines of force, closely follow the movement of the poles, and its motion will be synchronous with that of the armature of the generator; that is, in the peculiar disposition shown in Fig. 9, in which the armature produces by one revolution two current impulses in each of the circuits. It is evident that if, by one revolution of the armature, a greater number of impulses is produced, the speed of the motor will be correspondingly increased. Considering that the attraction exerted upon the disc is greatest when the same is in close proximity to the poles, it follows that such a motor will maintain exactly the same speed at all loads within the limits of its capacity.

To facilitate the starting, the disc may be provided with a coil closed upon itself. The advantage secured by such a coil is evident. On the start the currents set up in the coil strongly energise the disc, and increase the attraction exerted upon the same by the ring, and currents are generated in the coil as long as the speed of the armature is inferior to that of the poles. Considerable work may be performed by such a motor, even if the speed be below normal. The intensity of the poles being constant, no currents will be generated in the coil when the motor is turning at its normal speed.

Instead of closing the coil upon itself, ends may be connected by two insulated sliding rings, and a continuous current supplied to these from a suitable generator. The proper way to start such a motor is to close the coil upon itself until the normal speed is reached, or nearly so, and then turn on the continuous current. If the disc be very strongly energised by a continuous current the motor may not be able to start; but if it be weakly energised, or generally so that the magnetising effect of the ring is preponderating, it will start and reach the normal speed. Such a motor will maintain absolutely the same speed at all loads. It has also been found that if the motive power of the generator is not excessive, by checking the motor the speed of the generator is diminished in synchronism with that of the motor. It is characteristic of this form of motor that it cannot be reversed by reversing the continuous current through the coil.

The synchronism of these motors may be demonstrated experimentally in a variety of ways. For this purpose it is best to employ a motor consisting of a stationary field-magnet, and an armature arranged to rotate within the same, as indicated in Fig. 13. In this case the shifting of the poles of the armature produces a rotation of the latter in the opposite direction. It results therefrom that when the normal speed is reached, the poles of the armature assume fixed positions relatively to the field-magnet, and the same is magnetised by induction, exhibiting a distinct pole on each of the pole-pieces. If a piece of soft iron is approached to the field-magnet, it will at the start be attracted with a rapid vibrating motion produced by the reversals of polarity of the magnet; but as the speed of the armature increases the vibrations become less and less frequent, and finally entirely cease. Then the iron is weakly but permanently attracted, showing that the synchronism is reached, and the field-magnet energised by induction.

The disc may also be used for the experiment. If held quite close to the armature it will turn as long as the speed of rotation of the poles exceeds that of the armature; but when the normal speed is reached, or very nearly so, it ceases to rotate, and is permanently attracted.

A crude but illustrative experiment is made with an incandescent lamp. Placing the lamp in circuit with the continuous-current generator, and in series with the magnet coil, rapid fluctuations are observed in the light, in consequence of the induced currents set up in the coil at the start; the speed increasing, the fluctuations occur at longer intervals, until they entirely disappear, showing that the motor has attained its normal speed.

A telephone receiver affords a most sensitive instrument; when connected to any circuit in the motor the synchronism may be easily detected on the disappearance of the induced currents.

In motors of the synchronous type it is desirable to maintain the quantity of the shifting magnetism constant, especially if the magnets are not properly subdivided.

To obtain a rotary effort in these motors was the subject of long thought. In order to secure this result it was necessary to make such a disposition that while the poles of one element of the motor

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are shifted by the alternate currents of the source, the poles produced upon the other element should always be maintained in the proper relation to the former, irrespective of the speed of the motor. Such a condition exists in a continuous-current motor; but in a synchronous motor, such as described, this condition is fulfilled only when the speed is normal.

The object has been attained by placing within the ring a properly subdivided cylindrical iron core wound with several independent coils closed upon themselves. Two coils at right angles are sufficient; but a greater number may be advantageously employed, as in Fig. 14. It results from this disposition that when the poles of the ring are shifted currents are generated in the closed armature coils. These currents are the most intense at or near the points of the greatest density of the lines of force, and their effect is to produce poles upon the armature at right angles to those of the ring, at least theoretically so; and since this action is entirely independent of the speed—that is, so far as the location of the poles is concerned—a continuous pull is exerted upon the periphery of the armature. In many respects these motors are similar to the continuous current motors. If load is put on, the speed, and also the resistance of the motor, is diminished, and more current is made to pass through the energising coils, thus increasing the effect. Upon the load being taken off, the counter E.M.F. increases, and less current passes through the primary or energising coils. Without any load the speed is very nearly equal to that of the shifting poles of the field-magnet.

It will be found that the rotary effort in these motors fully equals that of the continuous-current motors. The effort seems to be greatest when both armature and field-magnet are without any projections; but as in such dispositions the field cannot be very concentrated, probably the best results will be obtained by leaving pole projections on one of the elements only. Generally, it may be stated that the projections diminish the torque, and produce a tendency to synchronism.

A characteristic feature of motors of this kind is their capacity of being very rapidly reversed. This follows from the peculiar action of the motor. Suppose the armature to be rotating, and the direction of rotation of the poles to be reversed. The apparatus then represents a dynamo machine, the power to drive this machine being the momentum stored up in the armature, and its speed being the sum of the speeds of the armature and the poles. If we now consider that the power to drive such a dynamo would be very nearly proportional to the third power of the speed, for this reason alone the armature should be quickly reversed. But simultaneously with the reversal another element is brought into action, viz., as the movement of the poles with respect to the armature is reversed, the motor acts like a transformer in which the resistance of the secondary circuit would be abnormally diminished by producing in this circuit an additional E.M.F. Owing to these causes the reversal is instantaneous.

If it is desirable to secure a constant speed, and at the same time a certain effort at the start, this result may be easily attained in a variety of ways. For instance, two armatures, one for torque and the other for synchronism, may be fastened on the same shaft, and any desired preponderance may be given to either one, or an armature may be wound for rotary effort; but a more or less pronounced tendency to synchronism may be given to it by properly constructing the iron core, and in many other ways.

As a means of obtaining the required phase of the currents in both the circuits, the disposition of the two coils at right angles is the simplest, securing the most uniform action; but the phase may be obtained in many other ways, varying with the machine employed. Any of the dynamos at present in use may be easily adapted for this purpose by making connections to proper points of the generating coils. In closed-circuit armatures, such as used in the continuous-current systems, it is best to make four derivations from equi-distant points or bars of the commutator, and to connect the same to four insulated sliding rings on the shaft. In this case each of the motor circuits is connected to two diametrically opposite bars of the commutator. In such a disposition the motor may also be operated at half the potential and on the three-wire plan, by connecting the motor circuits in the proper order to three of the contact rings.

In multipolar dynamo machines, such as use the converter systems, the phase is conveniently obtained by winding upon the armature two series of coils, in such a manner that while the coils of one set or series are at their maximum production of current the coils of the other will be at their neutral position, or nearly so, whereby both sets of coils may be subjected simultaneously or successively to the inducing action of the field-magnets.

Generally, the circuits in the motor will be similarly disposed, and various arrangements may be made to fulfil the requirements; but the simplest and most practicable is to arrange primary circuits on stationary parts of the motor, thereby obviating, at least in certain forms, the employment of sliding contacts. In such a case the magnet coils are connected alternately in both the circuits; that is, 1, 3, 5 in one, and 2, 4, 6 in the other, and the coils of each set of series may be connected, all in the same manner, or alternately in opposition; in the latter case, a motor with half the number of poles will result, and its action will be correspondingly modified.

The employment of multipolar motors secures in this system an advantage much desired and unattainable in the continuous current system, and that is, that a motor may be made to run exactly at a pre-determined speed, irrespective of imperfections in construction of the load, and within certain limits, of E.M.F. and current strength.

In a general distribution system of this kind the following plan should be adopted:—At the central station a supply generator should be provided having a considerable number of poles. The motors operated from this generator should be of the synchronous type, but possessing sufficient rotary effort to insure their starting. With the observance of proper rules of construction, it may be admitted that the speed of each motor will be in some inverse proportion to its size, and the number of poles should be chosen accordingly. Still exceptional demands may modify this rule. In view of this, it will be advantageous to provide each motor with a greater number of pole projections or coils, the number being preferably a multiple of two and three. By this means, by simply changing the connections of the coils, the motor may be adapted to any probable demands.

If the number of the poles in the motor is even the action will be harmonious, and the proper result will be obtained; if this is not the case the best plan to be followed is to make a motor with a double number of poles, and connect the same in the manner before indicated, so that half the number of poles result. Suppose, for instance, that the generator has twelve poles, and it would be desired to obtain a speed equal to 12/7 of the speed of the generator. This would require a motor with seven pole projections or magnets, and such a motor could not be properly connected in the circuits unless fourteen armature coils were provided, which would necessitate the employment of sliding contacts. To avoid this, the motor should be provided with fourteen magnets, and seven connected in each circuit, the magnets in each circuit alternating among themselves. The armature should have fourteen closed coils. The action of the motor will not be quite so perfect as in the case of an even number of poles, but the drawback will not be of a serious nature.

However, the disadvantages resulting from this unsymmetrical form will be reduced in the same proportion as the number of the poles is augmented.

If the generator has, say, n, and the motor n_1 poles, the speed of the motor will be equal to that of the generator multiplied by $\frac{n}{n_1}$.

The speed of the motor will generally be dependent on the number of the poles, but there may be exceptions to this rule. The speed may be modified by the phase of the currents in the circuits or by the character of the current impulses, or by intervals between each or between groups of impulses. Some of the possible cases are indicated in the diagrams Figs. 18, 19, 20, and 21, which are self-explanatory. Fig. 18 represents the condition generally existing, and which secures the best result. In such a case, if the typical form of motor illustrated in Fig. 14 is employed, one complete wave in each circuit will produce one revolution of the motor. In Fig. 19 the same result will be effected by one wave in each circuit; in Fig. 20 by two, and in Fig. 21 by four waves.

By such means any desired speed may be attained; that is, at least, within the limits of practical demands. This system possesses this advantage besides others, resulting from simplicity. At full loads the motors show an efficiency fully equal to that of the continuous-current motors. The transformers present an additional advantage in their capability of operating motors. They are capable of similar modifications in construction, and will facilitate the introduction of motors, and their adaptation to practical demands. Their efficiency should be higher than that of the present transformers, and I base my assertion on the following:—

In a transformer as constructed at present we produce the currents in the secondary circuit by varying the strength of the primary or exciting currents. If we admit proportionality with respect to the iron core, the inductive effect exerted upon the secondary coil will be proportional to the numerical sum of the variations in the strength of the exciting current per unit of time; whence it follows that for a given variation any prolongation of the primary current will result in a proportional loss. In order to obtain rapid variations in the strength of the current, essential to efficient induction, a great number of undulations are required and employed. From this various disadvantages result. These are increased cost and diminished efficiency of the generator, more waste of energy in heating the cores and also diminished output of the transformer, since the core is not properly utilised, the reversals being too rapid. The inductive effect is also very small in certain phases, as will be apparent from a graphic representation, and there

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may be periods of inaction, if there are intervals between the succeeding current impulses or waves. In producing a shifting of the poles in the transformer, and thereby inducing currents, the induction is of the ideal character, being always maintained at its maximum action. It is also reasonable to assume that by a shifting of the poles less energy will be wasted than by reversals.

PROF. G. FORBES ON TRANSFORMERS IN THE STATES.

The current issue of the *Journal* of the Society of Telegraph-Engineers and Electricians (No. 73, Vol. XVII.) contains the report of the discussion on Mr. Crompton's Paper "On Continuous Current *versus* Alternating Current Transformers." To the report of Prof. Forbes's speech (see *Electrician*, May 4th, p. 749, Vol. XX.) the following "postscript" is added :—

Having been asked by the Society to add some further account of the manner of working converters in America, I will now briefly comply with that request.

Engines and Dynamos.—It is a mistake to suppose that one or two large engines are more economical than a number of small ones. A large engine working far below its power is very wasteful of steam.

One engine drives one dynamo by belt direct, without countershafting. It is well to have each unit in a station of the same size, so that parts are interchangeable and the attendant has less to think of. The size of the unit may be chosen so as to supply, at sufficient load, the minimum current required in the twenty-four hours. One exciter is generally used for four machines in series, with an adjustable resistance. A shunt resistance largely made up of lamps may be put on each field for regulation.

Feeders.—These are generally overhead. Waring cable underground (lead-covered) is perfectly successful. Simplex wire is generally used for overhead work. Five or six feeders are often fed by one dynamo. A loss of 2 to 2½ per cent. of potential is generally adopted. Double bell insulators are used.

Converters.—These are made for 5, 10, 20, 30, and 40 lights. The wiring of a large house is best done with separate circuits for each 40 lights. It is unadvisable to "bank" or group in parallel a number of converters. These converters are very light, and have a smaller quantity of iron than might be thought good. They reduce the potential from 1,000 to 50 volts. The primary and secondary fuses are put inside the converter. The mode of manufacture of these has been described elsewhere. The insulation between the primary and secondary coils is indestructible.

Lamps.—It is found that 50-volt lamps last longer than those with thinner filaments, and are generally used. The potential in the primary is 1,000 volts. No man has ever been killed by a 1,000-volt alternating current. It is well here to mention that you cannot get an arc from the low-potential circuit when an alternating current is used.

Meters.—The Westinghouse Company has made such arrangements as will enable them to charge customers by means of the coulomb-meter.

Station Ampere-Meters.—The same instrument as Edison uses is adopted, but with a bundle of wires sucked into the coil. Both the bundle and the coil form part of an arc of a circle, and the former moves on an axis at the centre of the circle. The force of the current acts against the weight of a counterpoise, and an index indicates the amperes.

Station Voltmeter.—A "three-point" converter reduces the potential either ten-fold or twenty-fold. A compound-wound "compensator" reduces the measured potential to that at the centre of consumption. The voltmeter is solenoidal in action, and is true only when the speed of engine is quite constant. The wire bundles for these solenoids are ingeniously constructed. A metal cylinder is covered with varnished paper or muslin. Iron wire is wound round the cylinder, sticking to the varnish. The iron wire ring thus formed is cut through and a flat web of iron wire is produced, which can be cut into lengths and rolled into bundles.

Ground Detector.—Two converters have a lamp on each secondary. The primaries are connected in series to the mains. The intermediate contact is connected to earth. If one of the mains has an earth its lamp goes out. A multiple switch is provided by which each circuit can be tested in turn.

Synchroniser.—To synchronise any two dynamos, secondary wires are led to a switch-board. A wire from one converter is connected to a wire from the other. The two other wires are connected through two lamps. If the connected wires are in the same phase the lamps go out. A switch is provided by which, as soon as the lamp goes out, the second dynamo is connected to the mains of the first. The dynamos work well in parallel from half to full load. Allegheny station sometimes calls to Pittsburg, across the river, for assistance in current, and the synchronism is good. Synchronism is found to be quite satisfactory from half to full load, but not below.

Switch-Boards.—A switch-board is generally set up for each dynamo, and for five or six feeders. The conductors going to feeders run up and down; those going to dynamos are horizontal. The dynamo wires are connected with three instruments in a vertical row—an ampere meter, a converter, and a voltmeter. Each feeder has a vertical row of instruments, a three-point converter, a compensator, and a voltmeter. There are six switches for six feeders in a horizontal row, to switch any feeder into either of two pairs of dynamo conductors. One of these pairs is connected to the switch-board dynamo; the other can be connected, by means of a switch at the side of the board, to the conductors of either of the neighbouring dynamos. An adjustable resistance, with six lamps in series for additional resistance, is at the bottom and middle of the board, and acts as a shunt on the field-magnets. Another adjustable resistance is in series with all the field-magnets. Another switch connects either of two exciters with the field-magnets.

There are some other devices connected with street-lighting and theatre-lighting which I am not at liberty to describe, owing to the English patents being not yet completed.

BOOKS, &c., RECEIVED.

"Technology Quarterly." Massachusetts Institute of Technology, Vol. I., No. 4 (Boston).

"*Proceedings* of the Royal Society," Vol. XLIV., No. 267. (London: Harrison and Sons.)

"The Phœnix Fire Office Rules for Electric Light Installations and Electrical Power Installations." (Thirteenth Edition.)

MEETINGS OF SCIENTIFIC SOCIETIES.

SATURDAY, June 16th.

ROYAL INSTITUTION.

3 p.m. Lecture, "Count Tolstoi as Novelist and Thinker" (3). By Prof. C. E. TURNER, of the University of St. Petersburg.

WEDNESDAY, June 20th.

SOCIETY OF ARTS.

Annual *Conversazione.*

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting at the Institution of Civil Engineers, 25, Great George-street, Westminster. The following papers will be read :—"First Report of the Thunderstorm Committee—On the Photographs of Lightning Flashes." Drawn up by the Hon. RALPH ABERCROMBY, F.R.Met.Soc. "The Cold Period from September, 1887, to May, 1888." By Mr. CHARLES HARDING, F.R.Met.Soc, and "Observations on Cloud Movements near the Equator, and on the General Character of the Weather in the Doldrums." By the Hon. RALPH ABERCROMBY, F.R.Met.Soc.

THURSDAY, June 21st.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting.

ROYAL SOCIETY.

4:30 p.m. Ordinary Meeting.

SATURDAY, June 23rd.

PHYSICAL SOCIETY.

3 p.m. Note on "Continuous Current Transformers." By Prof. S. P. THOMPSON, D.Sc.

Ship Lighting.—The Queen's yacht "Victoria and Albert" is being lit throughout by means of the electric light, and a battery of Messrs. Drake and Gorham's largest size ship lighting cells are being installed for the supply of all the lamps which will be required at night, and also to guard against any sudden extinction of the lamps. In connection with these cells Messrs. Drake and Gorham are supplying a special switch-board fitted with their patent ring contact switches.

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TECHNICAL EDUCATION FOR SOUTH LONDON.

Next to that of national defence, there is, perhaps, no question which at the present moment occupies so much of the attention of statesmen and philanthropists as the technical education of the working classes. Originally taken up by the City and Guilds of London, the movement has spread with a rapidity which, like the one for guarding the country against invasion, may be ascribed in some degree to panic. Industrial and commercial depression have come upon us gradually; but that they were largely due to national inferiority in technical knowledge and skill was a quite sudden discovery, and no sooner was it made than steps were taken to remedy the defects. Technical schools and colleges on an extensive and expensive scale were established and liberally endowed, and almost before they have had time to make a fair start Parliament is invoked to aid a similar system which shall cover the whole country through the agency of the Board Schools. Simultaneously private charity has come to the help of particular districts, providing them with the means of instruction which but a few years ago would have been thought superfluous and fanciful. The East End of London has been exceptionally favoured in this respect, its rivals in the South and South-West complaining that it was getting more than its rightful share of the good things going. To the fact that South London is as poor as the East, and its population, if possible, more exclusively industrial, we owe the meeting at the Mansion House last Friday, where a scheme was set on foot for establishing on the Surrey side of the Thames three Polytechnic Institutes which will vie with any that the "pampered East" can boast of. The project was influentially supported, and although a very large sum of money—£150,000—is asked for, we have no doubt that, supplemented by a similar sum promised from the Charity Commissioners, the needful endowments will be forthcoming. In the South-West of London a like appeal is being made under the promising auspices of Lord Cadogan.

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The warmth with which these schemes have been backed up in the daily press is an encouraging augury for their success, although we cannot always agree with the grounds on which it has lent its powerful assistance. Lord SALISBURY, as he always does, brought some fresh ideas to bear on the subject at the Mansion House meeting. It is true that towards the end of his speech he let fall a sentence or two of those stereotyped arguments which the newspapers are never tired of repeating, such, for example, as that in the unskilled labour of the masses we cannot find the means by which the teeming millions of this country shall be able to maintain themselves in a prosperous, decent, and comfortable condition; and that our difficulties are enhanced by the fact that our neighbours in other countries have been sensible of the superiority which skilled education can confer, and have taken advantage of it to our discomfiture. But in the main the PRIME MINISTER occupied himself with more original and less questionable propositions than these. Starting with the axiom that the knowledge which we do not use and improve disappears from our memories very rapidly, he deduced the rational conclusion that the elementary education which the law has been enforcing for eighteen years past will be lost on the rising generation of workpeople unless we provide them with the means of following it up. The classes immediately above them, and those who are still higher in the social scale, are all well provided with suitable places for advancing their secondary education; but the lower classes are very ill-provided in this respect, and, quite apart from any question of industrial supremacy, it is highly expedient that this deficiency should be supplied. Indirectly, of course, the national well-being will be promoted by opening to every class, the lowest as well as the highest, the opportunities of an education which may develop for each man the faculties that nature has given him in order that he may become as intelligent, as active, and as prosperous a member of the community as possible. But a higher object than this will be achieved by assuaging that sullen discontent which so often finds vent in outbursts of political passion because the opportunities of intellectual improvement have been withheld. A still greater advantage may be looked for in raising the dignity of work by systematically insisting on its excellence; and this is a task which the technical school is best calculated to accomplish.

The proposed establishment of work-schools attached to our Board Schools has a most promising future, looked at from this point of view. The fears of those who apprehended that universal education would result in universal rebellion against manual labour have proved not wholly without foundation. As people with education before the era of Board Schools were commonly supposed to be exempted from manual labour, it has come to be thought that everybody who has obtained the education which a Board School can give has a right to this exemption; and when we remember the enormous sacrifices that have been made on mere schooling since 1870, and the little that has been done for handicraft, it need not surprise us that the latter has fallen somewhat in popular estimation while the former has risen inordinately. It is idle to deny what every honest observer knows to be the fact, and the sooner we let the scholars understand that their education is intended to improve their work, not to supersede it, the better it will be for them and for the nation. In other words, although we are more alive than formerly to the fact that the first necessity of mankind is to live, we are not absolved from inculcating that the first duty of mankind is to work; and, as Lord Salisbury puts it, the chief object of all education should be to fit them for labour which will enable them to live. These truths were not sufficiently considered when we established the scheme of primary national education under which the present generation of workmen have been reared, and it is to correct this oversight that the present movement on behalf of secondary education has been started.

One of the most satisfactory features of the programme is its voluntary character. It will be supported by public subscription, and consequently free from the obligations which a State-aided system would necessarily impose. This is of the greatest importance, for it leaves the student free to choose the particular study which suits him best. The plan which is said to have answered so well at the old Polytechnic Institute is to be followed in the new Institutes; each branch of learning is open to those who are attracted by it, but is forced upon nobody. Accepting the experience of the Polytechnic as a criterion of what may be expected from an extension of its operations, we find that secondary education may be given at a very small cost, and that it is so much in demand that any institutions we can provide will be filled as rapidly as they are built. If these expectations are realised, then it is probable, as *The Times* remarks, that the practical problem of finding the means of diffusing technical education may be solved before we have quite agreed as to why it should be promoted. Every speaker and writer seems to have his own pet reason for it; but as all are of one mind on the main point, their objects need not be criticised too closely. Sir LYON PLAYFAIR'S is perhaps as good as any other. According to him "the best educated nation, technically and industrially, will become the greatest nation, if not to-day certainly to-morrow." Evidently the ideal of national greatness here implied is not exactly that conceived by Lord SALISBURY; but this does not hinder their respective exponents working together harmoniously in a cause which both confess to be of great national importance; and indeed the secondary education and technical training of the masses are in themselves so wholesome and so invigorating, that no modern nation can afford to neglect the elements of greatness which these advantages are likely to create in the bulk of its population.

REVIEW.

Electricity and Magnetism. By E. MASCART and J. JOUBERT. Vol. II. Translated by E. Atkinson, Ph.D. (London: De La Rue and Co.).

This volume completes the translation of this well-known and, needless to say, valuable work. The first volume treated of the phenomena and the mathematical theory of electricity; this volume is devoted to electrical measurements and applications of the theory. The plan of dividing up the subject is unusual, but is natural, and very much more convenient than the usual method of mingling two branches of a subject together when they are really distinct.

The body of the work is really a treatise on exact electrical measurement for laboratory use. Much of it presupposes considerable mathematical knowledge on the reader's part, and in all cases where magnitudes of possible errors can be treated by mathematical methods they are so treated down to the minutest detail. On looking into a medical book one always feels that one has at least six fatal diseases. Similarly, after perusal of this volume, one feels that really nothing can be measured, which is, after all, the truth. Enormous care is necessary in many classes of measurement to secure an approximately accurate result.

The only weakness, if, indeed, the authors have any, is a tendency to eliminate errors by complicated calculations of their values, when in many cases they could be determined empirically with greater ease.

The authors begin by calling attention to the displacement error in weighing, which is frequently overlooked. They do not mention errors due to differences of temperature producing air currents and affecting the balance. Perhaps such an error is too elementary, but it might have been mentioned.

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Considerable attention is devoted to the management and use of mirror instruments. The use of the mirror in such instruments is generally ascribed to Gauss and Weber, or to Sir W. Thomson, but the authors point out that it is due to Poggendorff. The information about suspensions is full and interesting, but we miss a definite notice of one source of error. If an instrument be made with, say, a glass, or wire suspension, it does not come to zero after torsion for some time. A glass suspension will often take a day or so to come back to the original zero after use.

Under the head of "properties of circular currents," we have the usual calculations as to the best resistance for a galvanometer. The discussion of the case in which the wire has always the same thickness of insulation might be of some use; but calculations of that in which the wire is supposed to be bare, or to have an insulation thickness proportional to the diameter, are simply reprehensible waste of paper. Of course such calculations are to be found in most books; but that is so much the worse. The authors might have copied in the table from Lord Rayleigh's "Electro-Chemical Equivalent of Silver," as useful to those who can understand it in calculating mutual induction or attraction of coils. The method of testing for leaks from one winding to another by means of an induction balance is also too important to be omitted.

The subject of self and mutual induction is fully treated, and this will be interesting to many readers. There has lately been a sort of self-induction epidemic in electrical circles. It is difficult to see what caused it, but the subject seems to have a curious fascination, though improvements in methods can be of little practical importance, as no one would want to measure coefficients of induction. We note, by the way, the omission of Ayrton and Perry's spherical needles for ballistic galvanometers.

The information as to standardising or calibrating by electrolyses of silver and copper is far too meagre. The directions would not enable anyone to get results to be relied upon.

In the discussion of the Wheatstone bridge we have the question of maximum sensitiveness, and here again, as in other books, it is assumed that the greatest sensitiveness of a galvanometer is when its internal resistance is equal to the external. We do not draw attention to this again with the wish to cavil at such a very small matter, but as another instance of the tendency of mathematical men to indulge in long and often useless calculations whenever there is the least excuse. One would imagine that an experimenter kept shelves full of galvanometers of various windings, and that when he wished to take an accurate resistance he calculated it out and selected a suitable coil or instrument, preferably wound either with bare wire or proportional insulation. Our electrical literature is full of comparatively useless calculations of this sort. The right place for most of the calculations extant about Wheatstone bridges is among the examples in a book on the differential calculus or on determinants. They might in some cases even become instructive examples.

We have the same complaint to make about the description of standard cells as about standardising by electrolysis. The information is far too meagre. It is just as important that a standard cell should be correct as that a standard resistance should. 1·435 legal volts, quoted as given by Lord Rayleigh, is inaccurate; Lord Rayleigh gave 1·435 Rayleigh volts.

Probably neither Ewing's nor Hopkinson's Papers were published in time, but we hope their experiments on iron, especially Ewing's, will find a place in the next edition.

The smaller part of the book, that on "Industrial Applications," is, in comparison with the rest, very weak; it is very inadequate, and frequently the information, such as that on accumulators, is quite out of date.

The sections on dynamos are full of false conclusions. The old fallacy of spurious armature resistance crops up, and the lead of brushes is supposed to depend on the speed; in fact we are afraid these sections are useless. The usual fallacious arguments as to output and dimensions of machines appear. It is really impossible to make such comparisons, as a large dynamo is not like a small one enlarged to scale.

In the treatment of alternate currents the authors, as might be expected, make the unwarrantable assumption that they follow the sine law, and that the circuits to be dealt with have constant coefficients of self-induction.

In conclusion, the book, written by two of the ablest experimentalists and teachers, will of course become the standard text-book of exact electrical measurement. In reviewing it, we have pointed out what we consider small blemishes, with the view that some may be corrected in future editions. To criticise such a work as this in any other sense would be absurd, as it is beyond criticism.

The translation has been very ably done by Dr. Atkinson. It generally reads as if originally writen in English. There are a few slips here and there, but they are generally unimportant. For instance, a Clark's cell is made up with mercurous sulphate, not mercuric. There are 746 watts in an English horse-power, though 736 is correct for the French horse-power. Arc tan θ is not necessarily intelligible to one who does not read French or German, and we do not call dynamos "electromotors." We only hope Dr. Atkinson has the same command of German as he has of French, and that he will soon undertake the colossal task of translating Wiedemann. German books are not only valuable in themselves, but their foot notes always give most complete references; so that, as Maxwell remarked, if you want to find what has been done on any subject, you buy a German book, which will give you references to every paper published.

The type and get up are better than in the French original; in fact, nothing is more unpleasing than a French book, which arrives dogeared, with no back, and separates into two wherever you open it. The woodcuts, however, are not so well printed in the English translation.

REPORT BY PROF. KOHLRAUSCH ON THE "TUDOR" ACCUMULATOR.

We have received from Messrs. Büsche and Müller, of Hagen, Westphalia, a copy of Prof. Kohlrausch's report on the "Tudor" accumulator, based upon experiments carried out by the professor upon a couple of cells of 45 ampere-hours' capacity. The following is an abstract of the more important points:—

Total weight of plates	29·3lb.
Surface of the four + plates	1·29 square feet.
Volume of acid	6 pints.
Specific gravity when charged	1·147
Normal charging current	5 amperes.
Normal discharging current	6·5 ,,
Internal resistance charged	·015
,, ,, discharged	·02
Capacity per pound	1·6 ampere-hours.

The two cells had already been in continuous use from 1st November, 1881, till December 22nd, 1887. During the tests they were charged and discharged thirty-four times, and between charge and discharge a period of about 15 hours was allowed to elapse. A series of six ordinary charges and discharges agreeing very well amongst themselves showed a total capacity of 47 ampere-hours, and an efficiency of 94 per cent. for current and 82·4 per cent. for work, with a drop of 12·6 per cent. for E.M.F. After this several tests of an abnormal character were made. The cells were charged, and then left alone for various periods of time; the results at first obtained generally showed a loss of 7 ampere-hours, but after this there was practically no further loss in a week. When charged with a current of 8 amperes, and discharged with 10 amperes, an efficiency of 77 per cent. and 64·7 per cent. for amperes and watts respectively was obtained. When discharged through a constant resistance, with a current beginning with 50 amperes, they gave 23·5 ampere-hours and 40·5 watt-hours, the current having fallen off at the end of the test to 40 amperes, and E.M.F. from 1·8 to 1·3 volt. They were then recharged, and discharged with 90 amperes, giving 20·1 ampere-hours and 32·7 watt-hours, the current falling to 62 amperes. After this enormous strain the cells, when recharged, gave their normal discharge just as before.

Lastly, they were run down for four days starting at one ampere until the E.M.F. had fallen to 0·2 volt and the specific

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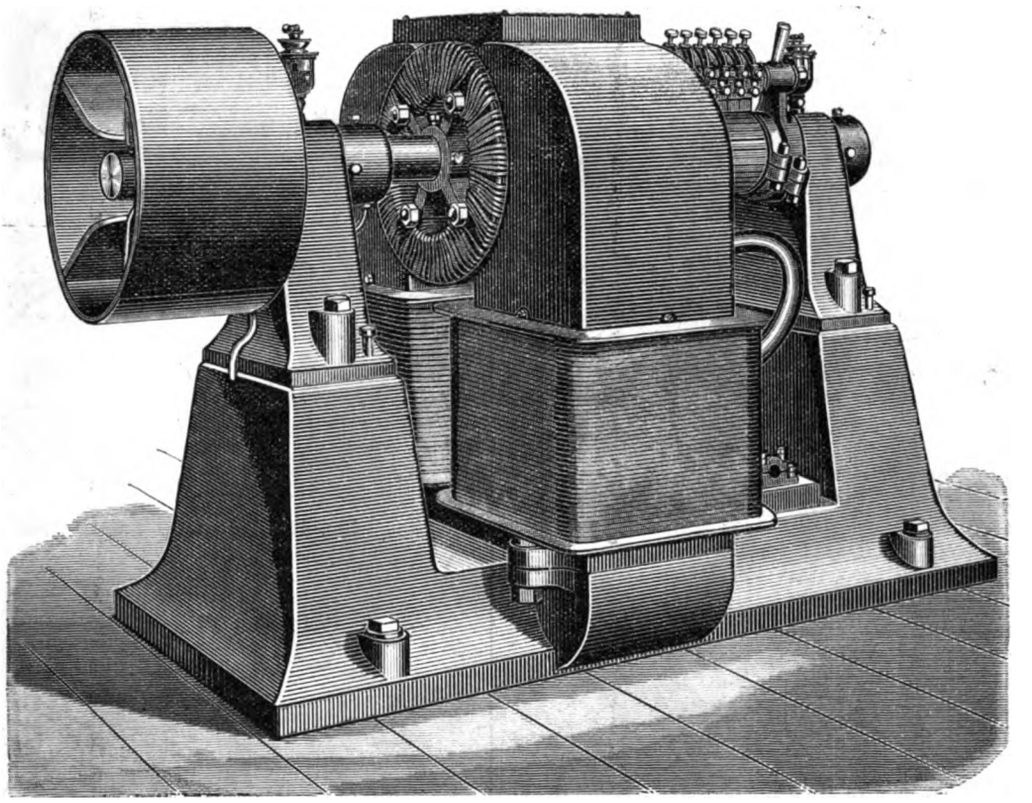
gravity of the acid to 1·1. The cells were then recharged until gas began to come off pretty freely, and on discharge they returned 46·8 ampere-hours and an efficiency of 90 per cent. for current and 80 per cent. for work.

50-UNIT DYNAMO, BY PATERSON AND COOPER.

Our illustration shows a 50-unit "Phœnix" shunt-wound dynamo, one of several recently constructed by Messrs. Paterson and Cooper for the Hermite electric bleaching process. At 600 revolutions per minute it is designed for a current of 1,200 amperes, the difference of potentials at the terminals being 42 volts. The design is very similar to that illustrated in *The Electrician*, Vol. XX., p. 568. The cross-section of the field-magnet contains 258 square inches of cast iron, and the armature core about 105 square inches of charcoal iron. The armature is wound in 38 convolutions, joined up to a 38 part collector. The resistance of the magnet coil is ·976 ohm. There are six brushes on each brush-holder, which is capable of independent spring adjustment in a direction parallel to itself. The machine measures 7ft. 3in. over the pulley in the direction of the shaft, has a width of 4ft. 4in., and a height of 4ft. 6in. The pulley is 24in. diameter, and driven by a 12in. belt.



Paterson and Cooper's 50-unit Dynamo.

"INFLUENCE MACHINES, FROM 1788 TO 1888."*

BY PROF. S. P. THOMPSON.

(Continued from page 153.)

Varley's apparatus of 1860 was followed not very many years afterwards by a whole host of beautiful devices. Holtz and Toepler in Germany produced almost simultaneously new forms of influence machines. I believe it is to Holtz that we owe the very name "Influence Machine." Sir William Thomson's machines followed a year or two later. Now to come to the devices of Toepler and Holtz. Toepler produced a very remarkable apparatus in which there were two discs going round on one shaft in the same direction. There is a drawing of it here in Figs. 8 and 9. Those two discs were excited from one side of the surface only. Take the upper plate. The disc goes round, but underneath it there is an inducing plate on one side—a field-plate. This notion of working at one side of a diameter only had, indeed, been used by Nicholson in his spinning condenser. There is a diagrammatic representation of Toepler's apparatus in Fig. 9, where one field-plate—say, for example, charged negatively—is in the neighbourhood of the rotating plate, which has two carriers on it, this being touched by a brush of some sort as they go round the second plate. The second disc is represented on this diagram as having also one field-plate, and that a positive one. Toepler made this up in several forms, some of which were highly complex. At the very same time Holtz had attacked the problem, but had solved it in quite a different way. Up to this time there had always been metallic carriers going round. Holtz abandoned the metallic carriers and depended only upon electrification which can be produced upon the surface of an insulating body such as glass. There are, of course, more ways than one of electrifying a piece of glass—one is to rub it; but there is another way, namely, to let off from points opposite to it an electrified wind. The electrified air repelled from a sharp point when it is directed to flow against the surface of the glass will charge it. That is virtually what Holtz did on that well-known machine (Fig. 10), where you have one rotating glass plate to serve as an armature and one fixed glass sheet, which has paper pieces attached to it right and left to serve as field-plates. Those paper plates are provided with tongues, which project through holes or windows cut in the fixed sheet, and serve to let off electrified winds against the back of the rotating plate, and there are two combs at the end of a rod, which let off electrified winds against the front of the plate as it goes round. Very soon after Holtz had brought out this machine it was further improved by Prof. Poggendorf, who suggested that its action might be increased by doubling the parts, by putting two fixed plates together in the middle, and then two rotating plates, one in front and one behind. A still more compact pattern of double Holtz machine was designed by Ruhmkorff. This machine is kindly lent me by Prof. Rücker for to-night, and comes from his laboratory at South Kensington. There are two interior plates which have holes through the glass windows, through which there project the paper tongues from the field-plates, as I have called them. As the glass plates go round they receive their charges in front from the action of these combs. As in Varley's machine, and as in Belli's machine, there is a conducting circuit going across the machine, the object of which is to touch the carriers whilst they are under the influence of the field-plates. Belli furnished the ends of this neutralising conductor with springs,

* A Paper read before the Society of Telegraph-Engineers on May 31st, 1888.

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Varley with knobs, Holtz with spiked combs. Neither Belli nor Varley proposed to make any use of the discharge that flowed through the neutralising conductor. Varley, indeed, provided the field-plates with metal balls projecting above to give discharges.

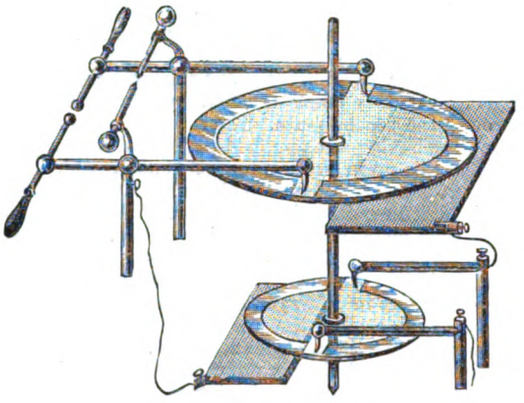

FIG. 8.—Toepler (1865).

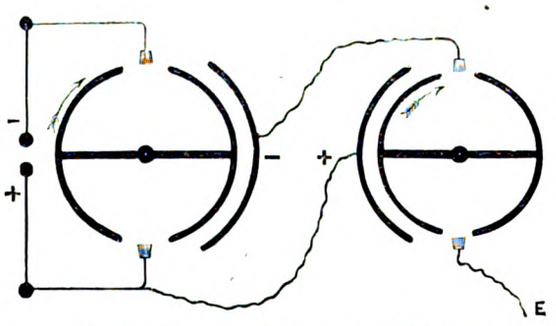

FIG. 9.—Diagram of Toepler's 1865 Machine.

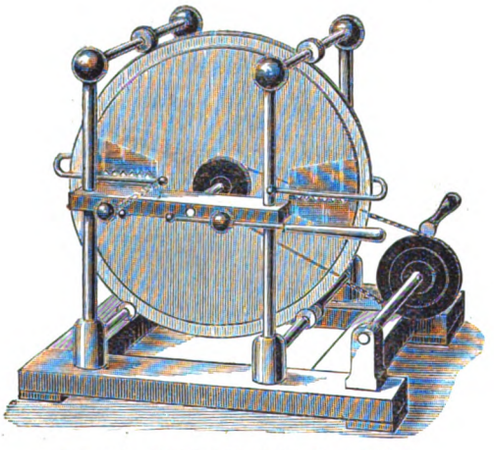

FIG. 10.—Holtz's First Machine (1865).

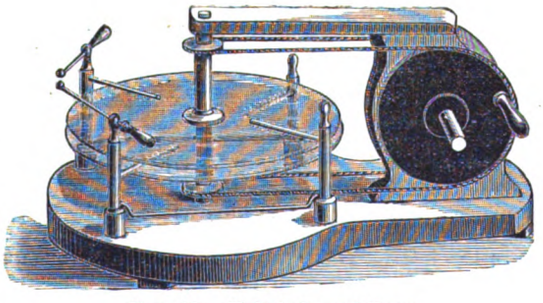

FIG. 11.—Holtz's Second Form.

Holtz, however, proposed another course; instead of interfering with or using up the charges that had accumulated on the field-plates, he proposed to introduce into the middle of the neutralising circuit a discharging apparatus; so that in this first pattern of his machine you actually employ the current in this circuit to give you the sparks. After the machine has been started, and not before, you draw back the discharging rod, and you have a stream of sparks. If that stream once gets broken you must put the knobs of the dischargers together again, in order to make the machine start itself. I mention that fact because it is a defect of the Holtz machine that you must put the discharging parts together before it can go on again. In his later machines Holtz abandoned this device, and added a special "diagonal conductor" to serve as a neutralising circuit, which should always be closed. In this point

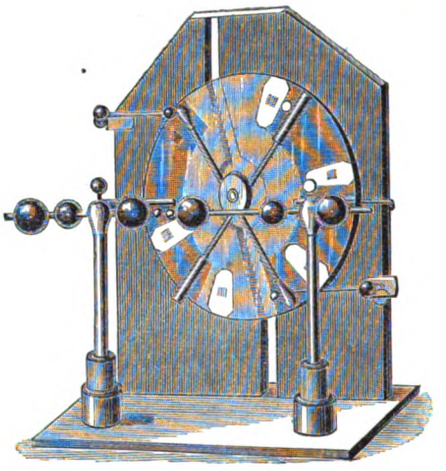

FIG. 12.—Toepler (1880).

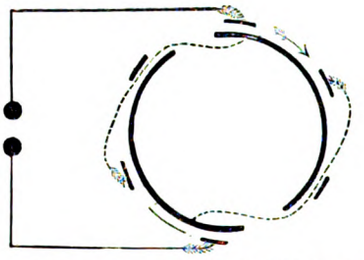

FIG. 13.—Diagram of Toepler's 1882 Machine.

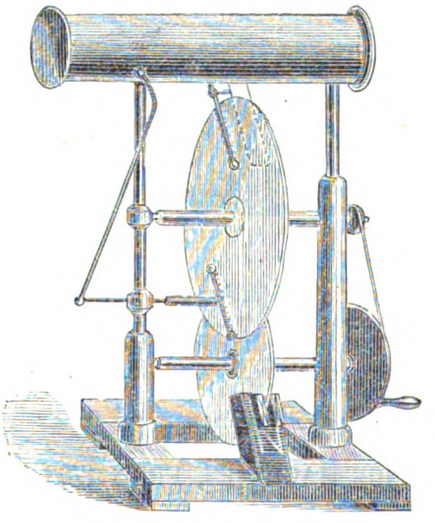

FIG. 14.—Carré (about 1866).

there is a beautiful analogy with the behaviour of dynamo machines. If you use as an external circuit that which contains the exciting coils of the field-magnet, then on breaking the external circuit the machine discharges its magnetism; whereas, if by introducing a shunt you keep the exciting circuit always closed, the complete opening of the external circuit does not discharge the machine. The influence machines with a diagonal conductor may be therefore compared to dynamo machines provided with a shunt circuit. In the further development of this subject we can only follow the most important points; in the complete manuscript of my paper there will

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be found a full analysis of Holtz's work. Holtz poured forth paper after paper through the pages of Poggendorf's *Annalen*, to which almost every year he contributed something further to the subject of the influence machine, some little paper either on the Leyden jars or on the material for the discs or on the modes of combining them. Holtz's memoirs are very remarkable ; but he came to some rather peculiar conclusions. He came to the conclusion that it was far better not to have metal carriers on the discs, and he also preferred that form of machine in which the glass plates had windows cut into them, which, however, is a form difficult to make and impossible to repair if broken. He devised also another form of machine (Fig. 11), known as the "second kind" of Holtz machine, consisting merely of two circular glass plates, without metal carriers, revolving in an opposite direction, driven from above by strings. The device of two plates going round in opposite directions you will find in the more modern machines, but it was not a success in Holtz's hands. I have never found any one who used one of those machines or even saw one. The description exists and the picture exists, but nothing more. In the meantime, Toepler also was working, and produced the machine shown in Fig. 12. I think the date of this form is about 1879 or 1880. The machine illustrated here is rather a late type of Toepler's machine (Fig. 13). But far earlier than this he was employing carriers on the surface of a disc, those carriers consisting of small metal plates furnished with small projecting metal knobs to be touched by the brushes as they go round ; and in the later forms he, too, attached the neutralising brushes to a special diagonal conductor. In 1866 he draws comparisons between machines constructed with and without metallic carriers, and concludes that those with carriers are more readily self-exciting, are less dependent on the state of the weather, and give a more definite spark-length than machines without metallic carriers. On the other hand, the discharges which they furnish are discontinuous. He, like Holtz, published a great number of papers, an analysis of which will be printed in my paper in the *Journal*. Carré about the same time brought out a machine (Fig. 14) which works partly by friction and partly by induction. I will not trouble you by reading in detail all the references which I have collected respecting this and a number of contemporary forms of machine such as those of Piche, Bertsch, Pouchkoff and others, some of which are of no great importance.

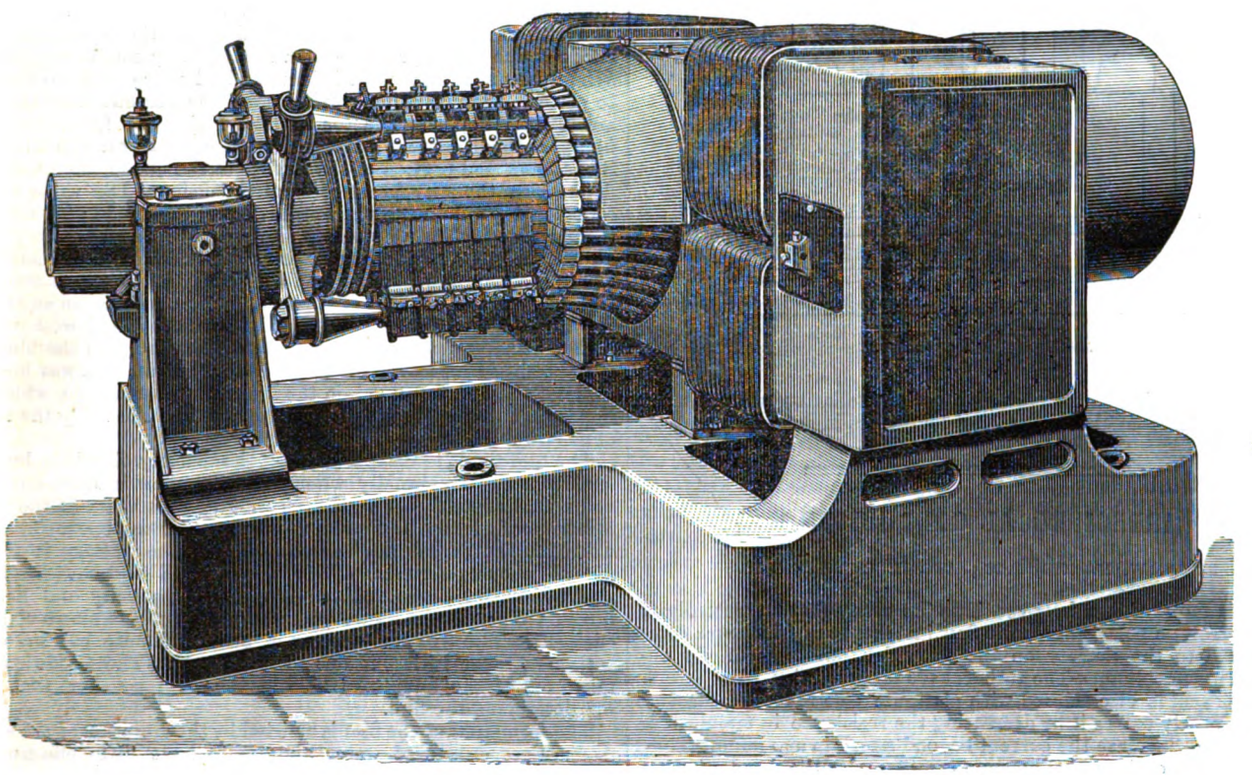
(To be continued.)

Paris.—The Edison Continental Company have started work on their subterranean central station at the Palais Royal. It is intended to instal six 1,000-light Edison dynamos.

MESSRS. ELWELL-PARKER'S DEPOSITING DYNAMO.

The accompanying illustration shows a 4-pole machine, wound for 1,500 amperes at an E.M.F. of 50 volts, the speed being 450 revolutions per minute. The armature is 22in. finished diameter by 20in. in length, of the drum type. There are 80 wires on the circumference, each having a section of 0·2 sq. in., the density of current being 1,880 amperes per square inch of the conductor. The length of active conductor is 1,600in. ; this gives 8in. per volt at a peripheral speed of 2,500 feet per minute. The ratio of the active to the total length of wire on the armature is about 47 per cent. The magnets are plain shunt-wound. Two machines similar to that described have been at work for over six months ; they run day and night, their usual run being about 160 hours per week. There is no sparking with full load.

A machine similar to the above, except that the commutator is shortened, has now been in use for several months driving the Portrush Tramway. This machine is wound for a current of 200 amperes, an E.M.F. of 300 volts with no load, rising to 400 volts with full load, at a speed of 500 revolutions. The armature is the same size as in the depositing machines ; there are 304 wires, the length of active wire being 6,080in. This gives $\left(\frac{6,080}{4 \times 400}\right) \times 3{\cdot}8$in. per volt at a peripheral speed of 2,750ft. The total length of wire on the armature is 13,032in.; thus 46·7 per cent. of the total wire is active.



Messrs. Elwell-Parker's Depositing Dynamo.

SIEMENS' COULOMB METER.

In 1887 Dr. Werner Siemens, of Berlin, invented and constructed the very simple motor coulomb meter shown in the accompanying figure, and which has not hitherto been described in our columns. It consists of a Gramme ring, P, fixed to a vertical axle, x, which actuates a system of indicator-dials, C. This ring is placed within the field of the magnet N S, and to the spindle is attached the copper tube K K, surrounded by an iron fixed tube E. The rotary movement is due to a motive couple proportional to the current traversing the Gramme ring and to an opposing couple due to the Foucault currents generated in the copper tube as it revolves round the magnet. There is, therefore, for every value of the current a corresponding speed of rotation. Since the two couples are equally and similarly affected by any change in the magnetisation of N S, the speed of rotation is within certain limits, independent of the magnet. The actual speed is regulated by suit-

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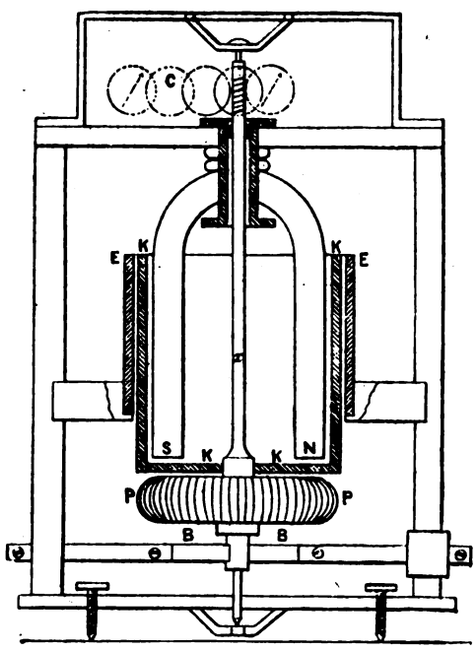
ably tightening the brushes B B. The apparatus is intended to be placed as a shunt upon the mains, and it is regulated by interposing resistance in its circuit. When the current is weak an error is introduced in the indications. The proportionality is satisfactory except at the start, and Dr. Siemens proposes to correct this defect by using two meters of different sensitiveness arranged in parallel and brought into play by means of a spring electro-magnet, according as the current is strong or weak. The sum of the indications of the two meters would of course give the total quantity of electricity passed through the mains. It is, however, to be feared that the



Siemens' Coulomb Meter.

suggestion of using two meters for each installation will not meet with approval from electric lighting companies in general.

IRRECIPROCAL CONDUCTION.*

BY W. W. H. GEE, B.SC., AND H. HOLDEN, B.SC.

In this Paper the authors continue the researches on electrolysis and electrolytic polarisation, the first instalment of which was communicated to the Society on the 25th Feb., and was briefly abstracted in our columns. The authors have observed that when strong sulphuric acid is electrolysed with platinum electrodes the decomposition nearly ceases if by decreasing the resistance in circuit it is attempted to increase the current beyond a certain maximum. They find that this curious phenomenon comes under the head of what Christiani has called irreciprocal conduction—namely, conduction in which the magnitude of the current is altered when its direction is reversed. The Paper, which is a very elaborate one, opens with a critical and historical sketch. Prof. Erman, of Berlin (Gilbert's *Annalen der Physik*, Vol. XXII., 1806), used the term unipolar conduction, and studied among other cases the unequal conductivity of soap in the direction in which the current had been flowing for some time, and in the opposite direction, respectively. These experiments were subsequently repeated by Ohm, who confirmed Erman's results with regard to soap, but attributed the high resistance at the anode to the production of a film of fatty acid, an explanation which Erman had rejected. Ohm also studied the conductivity of sulphuric acid and of caustic potash; but the results obtained by these early investigators appear to have been due either to what is now known as polarisation, or to chemical transition resistance—namely, a resistance due to the products of electrolysis, according as the electrodes were not oxidisable or otherwise. In 1876 Prof. Christiani published a pamphlet describing a series of researches on the irreciprocal conduction of transient electric currents, in which he studied the effect of using electrodes of unequal size in the electrolysis of various substances, and came to the conclusion that as a rule with low E.M.F. the current is able to pass more easily from the smaller to the larger electrode, and *vice versâ* with high E.M.F., and he comes to the conclusion that this difference remains after the elimination of any effects due to polarisation or to chemical transition resistance. He builds up an elaborate and interesting theory on the results of his experiments, but the present authors show that in various points his methods were so far open to criticism that his results cannot be considered as forming an adequate basis for an elaborate theory; which must therefore, for the present, be considered only as a speculation. Messrs. Gee and Holden give a pretty full account of Christiani's theory and methods of experiments, but for these we must refer our readers to the original Paper.

The authors find that the size of the electrodes is an important factor in determining the stoppage of the currents, and in the electrolysis of strong pure sulphuric acid with one platinum electrode much larger than the other they find that with certain strengths of current the current from the larger to the smaller electrode, which they call the α direction, may be more than a thousand times as great as when the current is reversed (β direction). The obstruction is found to be produced at the anode, for when the insulating condition is once set up no effect is produced by replacing the cathode by a large clean electrode; but if the anode be similarly exchanged the current passes readily. After the production of the insulating condition the resistance in the β direction is found to be much greater than in the α direction, and it continues to increase for some time after the insulating condition is set up. It is found that the polarisation is not abnormal, and, therefore, cannot be a determining factor. It was difficult to obtain more than approximate measurements of the resistance in the insulating condition, as the passage of alternate currents tends to break down the insulation. The authors have come to the conclusion that the resistance at the anode is due to the presence of a film of badly conducting matter. When the size of the anode is increased a larger current is required to produce the insulating condition, so the current density at the anode is an important factor in determining the formation of the film. If C is the minimum current which will form the film, and S the immersed portion of the surface of the anode, then $C/S=\Delta$ is defined as the *film-forming* current density. The value of Δ is found to depend on the previous history of the anode; for example, if the anode has been heated to redness and washed before putting on the current, the film forms with a smaller value of Δ than if the anode has been previously used for electrolysis, either as anode or cathode. When the end of a platinum wire used as an anode was just lowered into the acid, and the film formed by the lowest value of Δ, if the anode was then lowered slowly into the acid the film was found to be formed over the whole wire; but when it was lowered rapidly, the film remained on the lower part for a time, while the upper part was conducting the current, as was shown by the escape of gas from it.

The film tends to disappear when the battery circuit is broken; it disappears very rapidly when the voltameter is short-circuited, and instantaneously when the current is reversed. If the anode is taken out of the liquid and wiped the film disappears at once; when in the liquid and in circuit with the battery it may be moved about or rubbed with a glass rod without being destroyed, except if the rubbing is vigorous, partially and momentarily. When in the liquid a stream of air bubbles blown violently against the film will not destroy it, but a moderate current of air will do so after lifting it out of the liquid. The anode may be taken out of the liquid and held in the air for a short time without destroying the film.

The formation of the film is assisted by the vibration of the anode. A small percentage of water appears to have little effect on the value of Δ, but the authors were unable to obtain the film when the proportion of water exceeded 70 per cent. by volume. When the temperature is increased Δ has to be increased before a film is formed, and the higher the temperature the more rapid is the rate of increase of Δ with the temperature. Attempts were made to obtain the film with dilute acid rendered viscous with glycerine or gelatine, but without success.

The authors endeavoured to obtain the film with carbon electrodes, in which they encountered considerable difficulty from the disintegration of the anode; but ultimately they succeeded in overcoming this difficulty by the use of the coherent carbon filaments used in incandescent electric lamps. When gold was used as the anode and platinum as the cathode the film formed readily, but soon disappeared, and did not reappear until the circuit had been broken. The gold was rapidly destroyed. When the gold wire was first made the cathode and then the anode it was found that the current was either large at first, then decreased rather rapidly to a small value, and ultimately increased again to its former value; or the current was small at first and then made a sudden jump to a high value, at which it remained. The authors were not successful in obtaining the film with phosphoric acid, nitric acid, a mixture of sulphuric and nitric acids, or hydrochloric acid; but in the case of caustic potash a difference was observed in the transition resistance when the current passed in the α and in the β direction respectively.

With benzoate of sodium, an electrolytic deposit of solid benzoic acid with oxygen bubbles entangled in it was formed on the anode

* Abstract of Paper read before the Physical Society on May 26th.

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when strong currents were used, and the current was thereby stopped; but when the current was weak the oxygen bubbles were able to break through the layer of benzoic acid and prevent the formation of a film.

This behaviour of benzoic acid suggested to the authors that the film formed in the case of sulphuric acid may consist simply of concentrated acid, the specific resistance of H_2SO_4 increasing very rapidly with the degree of concentration.

This appears to be confirmed by the following considerations:—

The rate of concentration at the anode is partially prevented, as pointed out in the Paper by the same authors, previously referred to, by the evolution of oxygen, and also by dilution, the rapidity of which depends on the viscosity and the strength of the acid solution used. With low current densities the concentrated acid would be formed in too small quantity to withstand these two causes tending to disperse it. With great current density the rate of formation of the concentrated acid would overcome the rapidity of the dilution, and the resistance of the layer of acid surrounding the anode might increase so rapidly as to form an insulating film before enough gas had been evolved to cause its destruction, the gas produced becoming entangled in the viscous layer, which, once formed, would not be easily removed by friction, &c. Again, with a current density exceeding a certain limit, the layer would probably be broken up by the escaping gas, for it would be expected that the tendency of the gas to escape would increase at a greater rate than the tendency of the acid to prevent its escape. There ought, therefore, to be an upper limit to the value of Δ, beyond which no film would be produced. The authors have succeeded in discovering such an upper limit, which also explains the sudden jumps in the current strength which were sometimes observed with platinum electrodes in strong sulphuric acid, as when near the upper limit small disturbing causes, such as the heating of the liquid, would cause the disappearance of the film. The authors do not consider that the jumps observed with gold electrodes are to be similarly explained, as gold was found to be dissolved, so that the phenomena would in this case be altogether more complicated. Palladium comes under the same head as gold in this respect, for when used as an anode in moderately strong sulphuric acid it is always found to dissolve. The authors' theory, which they only regard as a provisional one, accounts also for the non-formation of a film in dilute sulphuric acid, for the rate of dilution would be so rapid that a long time would be required for its formation, and thus the oxygen gas might be expected to accumulate with sufficient rapidity to break it down.

The want of success in obtaining a film-formation with the other electrolytes experimented on may probably be attributed to the slower rate of increase of their specific resistance with concentration. It will be of interest to compare the results obtained in this Paper with those obtained by Froeme—an abstract of whose Paper is given in our present issue—with regard to the effect of the size of the platinum electrodes on the degree of polarisation in the electrolysis of dilute sulphuric acid.

ON THE MAXIMUM GALVANIC POLARISATION OF PLATINUM ELECTRODES IN SULPHURIC ACID.

C. Fromme, who has been recently making some experiments with acid varying in concentration from 0·18 to 65 per cent., finds that the relation between polarisation and concentration is most complex in very dilute solutions. With increasing concentration the polarisation at first rises to a maximum, then falls to a minimum, and if the anode is small it attains a second maximum, falls again to a minimum, and finally shows a steady increase as the concentration increases. The author finds that when a larger anode is used there is only one maximum and minimum previous to the steady increase. The material of the vessels used in distilling the water was found to have a marked effect on the amount of polarisation in extremely dilute solutions, due, no doubt, to the presence of glass or metal respectively in the distillate. A small cathode was found to have its surface blackened by the passage of the current, but no sensible alteration was observed when a larger cathode was used.

When both electrodes were small, and the solution very dilute, a yellow deposit was observed on the anode, and when a larger anode was used, a dark yellow coloration appeared after some time. This yellow deposit was unaffected by treatment with concentrated sulphuric acid or *aqua regia*. The author was unable to form any conclusion as to its origin, except that it was not due to any impurity in the solutions.

The black deposit had already been observed by De La Rive and Poggendorff, who showed that it consisted of platinum in a fine state of division, mechanically detached from the cathode. The author found that it could be removed by reversing the current for a sufficiently long time.

In some of the experiments where glass vessels had been used for distillation a greyish brown deposit was observed on the cathode, even when the latter was comparatively large. It was rapidly dissolved by concentrated sulphuric acid, and the author concludes that it consisted of particles of glass.

The amount of the polarisation was found to depend on the size of the electrodes, the size of the anode having a greater influence in the case of dilute solutions, and that of the cathode in stronger solutions.

The principal numerical results obtained by the author were as follows, the E.M.F. being measured in terms of the E.M.F. of a Daniell cell:—

	E.M.F. of polarisation with 0·18 per cent. of acid.	E.M.F. of polarisation with 65 per cent. of acid.
Large anode and large cathode...	1·94	2·43
Large anode and small cathode..	1·45	2·98
Small anode and small cathode..	1·90	4·18
Small anode and large cathode...	1·89	4·31

When the voltameter was traversed by a strong, steady current its resistance was found to diminish as the concentration of the acid increased, reaching a minimum except when a small anode was used, at about the same concentration for which it is found to be a minimum by observations with alternate currents. When the anode was small the resistance had no minimum value, but continued to diminish as the concentration was increased up to the highest value to which the observations extended.—Wiedemann's *Annalen*.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June 2nd*, 1888.

The past week has seen a very interesting experiment made as to the relative speed of the telegraph and the long-distance telephone in the transmission of news. The trial originated with the New York *Sun*, which undertook to find out how much news matter could be transmitted to Boston, for the *Herald* there, over the respective wires, in the space of ten minutes. A despatch was chosen which gave an account of a shipwreck and piratical attack in Chinese waters, and hence the matter with its abundance of unfamiliar names was not very easy to handle. At the end of ten minutes time was called, when it was found that the telephone had sent 346 words, while the telegraph had sent 330 words. This appeared to give the advantage to the telephone; but at the other end the tables were turned in favour of the telegraph, from the fact that the telegraph message was delivered all right and in good shape for the printers, while the telephone message was passed over with abbreviations which the "comps." could not understand. The result is interesting, but very far from conclusive, and another trial has been arranged in which the message will be reproduced on the typewriter. There are one or two very material points in favour of the long-distance telephone that may not appear on the surface. In the first place, the telephone message could have been sent through at a very much higher rate of speed than it was, and taken down by a stenographer, leaving the wire clear for more business. In the second place, the telegraph at both ends had to be handled by experts, men whose skill and quickness are the result of long years of training; but with the telephone the message could be sent by anybody, even by the office boy, and could be taken off by an office boy at the other end. Here, of course, is an immense saving in the hire of skilled labour, and perhaps a still greater saving would be effected by the transmission of the despatch by its inditer, without any intermediaries whatever. Now that the typewriter is to be employed as an element in the competition, I think the points in favour of the telephone will come out more clearly. Typewriters have been used since 1883 by telegraphers here in taking copy direct from the wire, but, of course, the rate of receipt has been limited by the sending rate. Now with the telephone, the despatch may be dictated at as high a rate of speed as from 75 to even 85 words a minute, that actually being the speed attained by typewriter experts in this country, while a speed not greatly inferior is common. Probably considerations of this character prompted the New York newspaper to make the test, and I opine that

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the results will be found of interest to journalists everywhere. It should perhaps be scored against the telephone that where the matter was not first prepared there would be an absence of record.

While this progressive work is in hand a number of the members of the Stock Exchange here are seriously urging their governing committee to step backward, and to adopt a system of pneumatic tubes in place of the telephone for all purposes of communication between brokers "on the floor" and their offices. The objection to the telephone is the publicity necessarily given the messages in sending them. I cannot exactly see the necessity in the case; but the difficulty is said to be experienced, and is said to be felt as well in connection with the telegraph and messenger service. You are already aware of the charges made about tapping the telegraph wires for stockjobbing purposes, and Wall Street is full of stories about tapping the messengers too. One leading broker is said to frustrate the corruption of his messengers by sending orders to buy and sell at the same time; but this, of course, though an exciting way of carrying on one's business, must be highly unsatisfactory. Hence the present movement for the pneumatic tube system, which is said to find many supporters.

While I am on the telephone, I ought to mention the interesting fact that Prof. Alex. G. Bell is about to visit Europe; he leaves for England to-day; his mission is a scientific one. He is to appear before one of your Royal Commissions now investigating the best methods of educating and improving the condition of deaf mutes. This is a subject on which Prof. Bell is probably better informed than any man in America; he has made a persistent, devoted, and exhaustive study of it for years, and has reached a number of very important conclusions. The evidence that he will give to the commission will be of great value, as he has made special preparations for laying before that body the results of his best work and deepest thought.

Among the curiosities of invention must be classed the scheme recently brought to notice by a genius of Norwich, Conn., for securing the safe escape of theatre audiences in case of fire. This inventor proposes to place under each chair in the auditorium a trapdoor connected with a safety shoot. These traps may be sprung singly at the will of the occupant by pressing on electric buttons, or they may be operated at once by electricity from a central point. Now, should the alarm of fire be given, all that the occupier of the seat has to do is to press on his button, and he drops at once out of sight and of danger. In case this process should not prove rapid enough, the manager of the theatre can display his presence of mind by rushing to the main switch-board, throwing the lever, and pricipitating his whole audience, like a ton of coals, into the cellar below. One can easily imagine that the introduction of this device would lead to some very funny spectacles. For instance, a gentleman sitting behind a lady with a high hat might surreptitiously press the button of her chair, and so clear her out of the range of vision; or Edwin Booth, when urging Ophelia to "get her to a nunnery," might be surprised to see his audience suddenly seeking a seclusion not less profound. Of course there would be incidental advantages in the arrangement, such as that of enabling a gentleman in the middle of a row to go out and take a drink without disturbing the people around him. What puzzles me, however, is the working of the device in the galleries. Since these cannot be provided with trapdoors underneath, perhaps the inventor proposes to put trapdoors above and to eject the audience from that part of the house by the release of strong springs.

This is one of the freaks of invention, but we see around us to-day many applications of electricity which strike the public no less comically. Especially is this the case in connection with electric motors and the uses to which they are put. People are still very much amused at motors driving churns, and blacking boots, but they think that the height of absurdity is reached when they see a popular manicure operate by electric motor her various delicate little appliances for buffing, polishing, and cutting finger and toe nails. Such an application I see noted in the electrical papers this week, and I am told that it proves a very attractive feature. Another novel use for the motor is that of operating the cash systems in our large stores. These systems, of which you may perhaps have the counterparts in England, consist of apparatus for communicating between the salespeople and the cashier, over the heads of the customers, expediting greatly the operation known as "shopping." These cash systems are now being worked very successfully by electric motors in some of our best "dry goods stores," and there is reason to believe that in this field, as in so many others where the employment for it was not expected, the motor will find abundance of occupation.

Another galvanometer has just been patented here by Dr. Geyer and an Associate of the Stevens Institute of Technology, based on the heating principle of the electric current. The apparatus is very ingenious. It is composed of a compound arm, or bar, the two arms of which are made of the same metal and are joined at the ends, but are insulated from each other throughout their entire length. The peculiarity of the device lies in the fact that these two arms, although of the same metal, are of different shape and size, and hence are differently heated and expanded by exactly the same current passing in series through each. The apparatus is so arranged that the deflections of the pointer are in direct proportion to the strength of the current passing through the compound bar, and it is noticeable also that the apparatus is independent of effects from the surrounding temperature, as both parts of the bar are equally affected, and to the same extent, by any external changes of temperature. This instrument will serve as well for alternating as direct current.

I have already advised you from time to time of the progress of the movement for patent reform here. The National Electric Light Association, which has taken a special interest in this matter, has arranged to bring two Bills to the attention of Congress: one for releasing American patents from all limitations by similar foreign patents, and the other for establishing a patent court. Both Bills are very well received, and the latter Bill has elicited letters of approval, not only from the Patent Bar Association of Washington, but from the justices of the United States Supreme Court.

A few weeks ago I wrote you to the effect that some of the daily papers here were doing their best to get up a scare on the subject of arc light wires. The best answer to all this superfluous agitation has been given by Mayor Hewitt himself, who comes out boldly and firmly with the statement that the danger is exaggerated. He says that he has investigated the subject, and finds that although there are 7,000 arc lights in use in this city, there have been up to date only four deaths resulting from their use, giving a remarkably small and insignificant percentage for the 9 or 10 years during which the system has been in use. The Mayor says that so small a proportion of accidents is almost unworthy of notice, and I think that most people will agree with him. The manner in which some of the newspapers have handled the subject is highly absurd. One of them sent its "electrician" all round the city to spy out the nakedness of the wires, and whenever he found one that was bare of insulation, he made a report. Nobody knows who this electrician is; perhaps it was the same gentleman who supplied the material to one of our illustrated weekly papers for a sketch which shows all traffic on Broadway stopped on account of a broken wire, which lies in the roadway with its end turned up in the air and touching nothing, but sending out a big shower of sparks like a Fifth of November squib!

SWEDISH NOTES.

(FROM OUR CORRESPONDENT.)

The Gothenburg Electric Company, Limited (Göteborgs elektriska aktiebalag), held a special meeting last week, when the directors made a communication regarding two proposals which they had received for the extension of the company. One proposal was from an English firm, and had several alternative features, but it was considered to give too great advantages to the foreigners at the expense of the Swedish shareholders, and

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did not meet with much approval. The other proposal was made by the directors of the Gothenburg Engineering Company, and was to the effect that the Gothenburg Electric Company should purchase the central station at Otterhallen. This proposal was favourably received, and the directors were empowered to take the necessary steps. There is every prospect of this amalgamation proving a decided move in the direction of a more general and efficient electric lighting in Gothenburg, which is a town considerably in advance of most others in Scandinavia. The necessary funds will now be raised within the town, and the electric light will in all probability be adopted to a considerable extent. The company has already secured sufficient accommodation for a large central station, which will be immediately proceeded with, and from this station the larger subscribers in the proximity of the harbour can be supplied with light. When the central station at Otterhallen has been connected with the company it is intended to supply from there lights from the best obtainable arc lamps to all squares and places where such light may be decided upon, as well as incandescent lamp light to some neighbouring parts of the town, and by the transformer system also to more distant portions of the town. Through the fact of comparatively cheaper working expenses at larger central stations, the Company will be able to reduce their prices, so that they will be better able to compete with the prices charged for gas and petroleum. It is also the intention to work the central stations through the whole of the twenty-four hours from the end of the approaching summer, and to supply the lamps free of charge to the subscribers.

CORRESPONDENCE.

TELEPHONIC COMMUNICATION WITH SHIPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In compliance with the request in your foot note to Mr. Unbehaun's letter of Feb. 6, 1888 (vide *The Electrician*, No. 512, Vol. XX, p. 484), I now beg to forward a diagram and description of our arrangements for effecting telephonic communication with the mail steamers lying at the Semaphore and Largs Bay anchorage in Gulf St. Vincent.

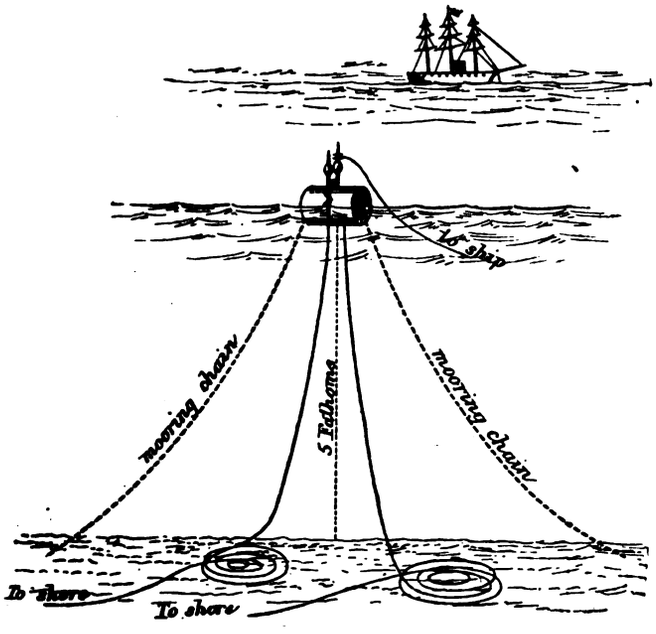

FIG. 1.

At the request of the agents for the Orient Company, Messrs. Stilling and Co., and the agents for the Messageries Maritimes, Messrs. Harrold Brothers, we laid in the early part of 1886 two cables of the B type, manufactured for us by the Telegraph Construction and Maintenance Company, each about 1¼ mile long, from the end of Largs Bay jetty, connected at the sea end with a buoy securely moored in about five fathoms of water.

The mode of fastening the cables to the buoy is shown in Fig. 1. A few coils of slack lie at the bottom below the buoy. The cables are fastened by means of rope, in such a manner as to relieve the cable from friction, to an eye bolt on either side of the buoy, and project about four feet above the surface of the water, the ends being tightly fitted into and connected with Chatterton's compound ebonite insulators (see shaded part of Fig. 2), the core passing through the top of the insulator so as to bring the wire into metallic contact with a pointed or conical copper tube screwed over the top of the insulator, forming a water-tight cap.

The insulated wire (Siemens double G.P. coated, taped and tarred No. 16 copper) is wound on a light reel (Fig. 4), which holds 800 yards of the flexible wire. To the end of the wire is attached a thimble (Fig. 3) of gunmetal, which is bored out to fit about two-thirds down the copper cone. This thimble is so shaped that it can be easily held on the end of a boat-hook, and as the steam launch slowly passes the buoy it is deftly slipped over the cone and the wire paid out to the ship.

FIG. 2.

FIG. 3

To undo it it is merely necessary to lightly tap it with the boat-hook from below, when it slips off.

It is necessary to pay out some slack wire to prevent its breaking when the ship swings with the tide.

The copper cones require an occasional scrubbing with sandpaper, but as a rule the weight of the thimble and the strain of the wire make a very good connection.

The cables at the shore end connect with aerial wires leading to the agent's offices at Port Adelaide. The communication is effective, and is found to be a great convenience to the agents and captains. I may add that the cables were laid

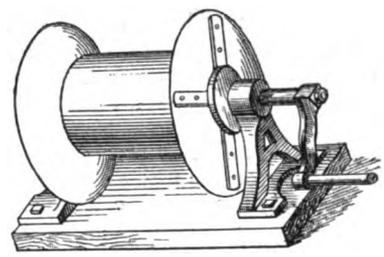

FIG. 4.

during my absence in England, in accordance with arrangements made before I left the colony, and the details for connecting them, &c., were planned by Mr. Unbehaun.

I have the honour to be, Sir,

Your obedient servant,

CHARLES TODD,

Postmaster-General and Superintendent of Telegraphs.

General Post Office, Adelaide, May 7, 1888.

LIGHTNING, INDUCTION IN "BEARER" WIRES, AND OTHER THINGS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 18th ult., Mr. A. P. Trotter asks if it is known whether a lightning discharge is continuous. I do not know, but can offer a little piece of evidence which may possibly assist the judgment of some more capable than I.

Some three years ago, when I was in charge of the East-

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bourne Central Lighting Station, a thunderstorm occurred one night soon after the lights had been stopped. I took the opportunity of putting a telephone in the line circuit, first without any earth connection and afterwards between one line terminal and earth. In both cases I succeeded in catching the effect of a lightning discharge. It made a curious guttural sound, like the first part of the word "ground," for example, with the "r" rolled very much.

The Eastbourne lines (as everyone knows now, even Mr. Crompton) are underground, so that I must have got an induced effect from currents passing through the earth itself, or from rapid changes of polarity therein. Judging from the time between the flashes and the first thunder the discharges were about a mile and a-half away, while the most distant point of the line was about half that distance in a straight line, and in about the same direction as the storm. It may be noted that the line was a "series" one, and formed a loop enclosing a large area. There was no battery or other source of E.M.F. in the line, so that the effect was not due to any microphonic action started by the thunder. One point struck me at the time, viz., that the sound seemed to commence before I saw the lightning flash. The interval seemed extremely small, but perceptible. However, this may have been an illusion.

Perhaps this experience may suggest a means of investigating some phenomena of lightning discharge without the possible inconveniences incidental to the use of overhead wires during thunderstorms.

In Mr. Kenneth Mackenzie's Paper on "Distribution by means of Secondary Generators" there is a little passage which I do not understand. I stumbled over it in *The Electrician* report, but waited for the *Journal* of the Society to see whether it was repeated in the official report. It is so repeated, and it consists of the paragraph commencing on the last line of page 1ϟ1 of No. 71 of the Society's *Journal*, and filling about one-third of the next page.

Mr. Mackenzie says that when "bearers" are used, and their ends left open, so that no current can flow through them, a counter-electromotive force is generated, which retards that in the main wires; and, further, that earthing the ends of the bearers through lightning arresters obviates this retardation. Mr. Mackenzie does not explain the *modus operandi* of the disease or the remedy, and I am really curious to know what the effect is.

Obviously, if the bearer ends are insulated no current can flow in them, and therefore no effect can be produced upon the primary or main wires. The analogy with a series transformer is not on all fours, because the transformer has a magnetic circuit of iron.

It is perfectly true that if the bearer circuit were closed the apparent self-induction of the mains would be diminished on account of the current in the bearer wires; but there would then be some loss of energy corresponding to that current. Mr. Mackenzie does not desire this, of course.

Besides, "closing the bearer circuit through lightning protectors" is not closing it at all to such E.M.F.'s as it will have generated in it, and one cannot see what difference it can make.

Briefly, then, the presence of the insulated bearer wire can make no appreciable difference to the self-induction of the mains, though a very small increase may be produced if the bearer is of iron. A closed bearer circuit means an induced current in it, with, of course, a loss of energy, and a smaller self-induction in the mains. And, lastly, earthing the bearers through lightning conductors—presuming that the latter are made, as usual, with L and E terminals well insulated from each other—can make no difference.

Then if the effect is laid off to static induction (Mr. Mackenzie offers no opinion) the same thing occurs. The insulated bearers can have no appreciable effect upon the capacity of the line. Closing the bearer circuit increases the capacity, and so causes some loss (very small, no doubt); and closing the bearer circuit through lightning arresters is about the same as leaving it open.

I, for one, shall be glad to know what the effect really is which Mr. Mackenzie has observed, and some explanation of its cause and cure.

By the way, there seems to be no particular loss in underground conductors on the parallel alternation system, even when the wires are in iron tubes (as at Eastbourne, for example). It is doubtful whether it is worth while to use concentric cable for underground work, but of course both wires must be in the same tube and tolerably close together.

And while on this point, I must take the opportunity of stating—not without a fair amount of experience—that there is no difficulty now in laying a cable underground to carry 2,000 volts E.M.F. for an indefinite period. You must buy good cable, of course, and must have the joints so made that the minute cracks spoken of by Mr. Crompton do not appear. This, again, is only a matter of care, experience and good materials.

Several plans have been lately proposed to guard against contacts between the primary and secondary wires in transformers, and perhaps another is superfluous. A vacuum tube, like those used for lightning arresters on cables, put between the secondary coil and earth, with an electromagnet in the the circuit, might be used to short-circuit the mains whenever the tension between earth and the secondary exceeded a certain amount. There is, however, one weakness incident to all these "relay" plans, as they may be called, viz., that if the contact between the two circuits occurs about midway in the primary, the potential difference between that point and earth may be very small. The earthed sheet of metal between the two coils seems the best device. In the Lowrie-Hall transformer, it may be noted, the danger contact is very slight, and earthing the iron core in such a transformer is all that is necessary for safety.

I ought to apologise for a somewhat rambling letter; but it is a relief to write "shop" when in an out-of-the-way place like this, where there is no one to talk "shop" to.

This out-of-the-way place, by the way, has some 500 telephone subscribers amongst its 140,000 inhabitants, a considerably larger proportion than in London; and the demand for electric light from the central station recently opened is very promising, so that additional machinery is already necessary.—Yours, &c.,

HENRY M. SAYERS.

Rua du Carvathosa 79, Oporto, June 6th, 1888.

THUNDERSTORMS AND LIGHTNING ACCIDENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As the season of thunderstorms and lightning accidents is now approaching, I hope you will kindly allow me to make known through your columns the fact that, in the interest of science, the Institute of Medical Electricity is very desirous of obtaining authentic information concerning lightning accidents, whether fatal or otherwise.

I should therefore esteem it a favour if some of the many friends of humanity among your readers will assist us to investigate these phenomena by sending me such particulars of accidents of this nature as they may have personal or reliable knowledge of, as soon after they occur as possible.

Of course electrical and physiological details are what we most require, but reliable general information is often very valuable, and will be gratefully received.—Yours, &c.,

H. NEWMAN LAWRENCE, A.S.T.E. and E.,
Electrician to the Institute of Medical Electricity.

24, Regent-street, London, S.W.

THE ELECTROLYSIS OF MERCURY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The letter of Mr. Lowrie-Hall on the "Electrolysis of Mercury" in last week's issue recalls some phenomena of interest in the use of mercury electrodes which may not have been observed by some of your readers, and which will, perhaps, explain the formation of the insoluble salt by currents in one direction, which is not reduced by those in the reverse direction.

I think it doubtful, however, that the arrangement in question will form an accurate current meter, as the results of decomposition will disappear to a greater extent with the enlarge-

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ment of the surfaces of the electrodes, or with the diminution of the volume of current passing.

When a surface of pure mercury in sulphuric acid is employed as the cathode in electrolysis, the mercury absorbs a considerable quantity of hydrogen. If, when in this condition a compact pinch of bisulphate of mercury be dropped upon it, decomposition takes place; the surface of salt resting on the metal yields metallic mercury and sulphuric acid. As soon as the hydrogen immediately beneath the sulphate is absorbed the latter will move to a fresh position, until it has gracefully skated over the whole surface, and if the quantity be smaller than that which is necessary to depolarise the electrode it will entirely disappear.

A battery consisting of an amalgamated zinc plate, suspended in sulphuric acid solution above an electrode of mercury, upon which a layer of fine dry bi-sulphate of mercury has been evenly sprinkled, exhibits some remarkable phenomena when the circuit is closed.

A perfect storm arises, and in a glass vessel the mercury is seen to be violently agitated, and if the shape of the bottom of the glass is such that there is something like a sloping beach, ponderous looking little waves roll up resembling those of the sea. At the same time, clouds and whirlwinds are formed above, gradually increasing, until the whole is completely obscured.

The sulphate of mercury may be formed for this purpose in the cell itself by electrolysis.

The action is of course attended with the disengagement of a considerable quantity of electricity, and I think the surface agitation is due to the diminished cohesion of the molecules of metal when charged with hydrogen.

The changing tension of the mercurial surface is beautifully shown by opening and closing the battery circuit rapidly.

To avoid failure in using this arrangement as a secondary or primary battery the solution must always be strongly acid, or the bisulphate will be reduced to a subsalt, which is the cause of what Du Moncel calls the unaccountable failure to which at times the Marié-Davy battery is subject.—Yours, &c.,

F. HIGGINS.

17, Cornhill, E.C., June 13th, 1888.

A NEW INSULATOR FOR DELICATE APPARATUS.

M. Palmieri, of the observatory on Mount Vesuvius, possesses an electrometer which, says *La Lumière Electrique*, is superior to all other instruments of the same kind. "It is so perfect," said M. Mascart at the Meteorological Congress, held at Rome, "that it could be used to standardise every other instrument in the whole world." The superiority of this remarkable instrument is held to be due to the good qualities of the insulating material which was used in its construction: and we are happy to be able to make known to the electrical world the constituents of so admirable an insulating substance. It is a mastic composed of two parts of Greek pitch (*poix grecque*) and one part of calcined plaster (of Paris). The plaster is made from pure gypsum, which is raised to a high temperature in order to drive off one half of the water of crystallisation, and is then thrown while hot into a bath of cold water. The mastic is formed by mixing these ingredients while hot, and it yields a viscous pasty substance, which can readily be moulded into any required form. It possesses the insulating properties of ebonite, but is much more plastic. In colour it resembles dark amber. Its great advantage for electrical purposes arises from a characteristic property, by which the insulation resistance does not decrease with rise of temperature, and it is also said to be even unaffected by moisture. The former property is certainly a very valuable one, so also would be the latter, although we confess to some doubt of the accuracy of the statement, seeing that the effect of moisture is to cause leakage over the *surface*. However, the responsibility for the entire paragraph must rest with our esteemed contemporary, *La Lumière Electrique*.

THE ELECTRIC LIGHT SCHEME IN EXETER.

TENDERS INVITED.

A special meeting of the Exeter Town Council was held on June 6th to consider the report of a special committee on the electric lighting of the city.

At the last meeting of the Council a report was presented from the committee, but the Council broke up for want of a quorum without coming to any decision. The mayor convened this meeting at the request of 25 members of the Council, to especially consider this report. The report presented at the last meeting recommended that tenders be invited by advertisement for lighting a specified area by means of the electric light, subject to the terms of the specification prepared by the surveyor, and to the stipulations of the Board of Trade.

Mr. TOWNSEND, in moving the adoption of the report, thought that the Council were persuaded already that the question was of so much importance that the advocacy of electric lighting did not require much speechifying. They were anxious that nothing should be done to the detriment of the existing Company which was at present lighting the city with gas, but seeing that this question was of so much importance and that the citizens demanded a better light the Council were in duty bound to take it up. In doing so they could not do better than adopt the principle which this committee recommended, that tenders should be issued for contracts. The resolution did not bind them to any particular company or the scheme of any particular engineer, but they were bound in honour to accept the best tenders whoever they might come from. He wished it to be understood that he had no particular interest in any company that had been started. He had been charged with having some motive, and with holding a retainer on behalf of one company. The only brief he held was one from the ratepayers to get a better and cheaper light. The committee recommended that the tenders should be in two forms, one for overhead and the other for underground wires, so that the Council might see the difference in the cost and the comparative position of the two sets of wires. Further, the tenders were to be advertised for in the same form and with the restrictions that the Board of Trade required, with the addition of some safeguards which were thought by the surveyor to be required in the case of a city like Exeter. This would involve a little expense. The committee had obtained a great deal of information on the subject, but since they had met other information had reached him, not from persons interested on either side but from an official source. The information was from the Town Clerk of Bath. One of the questions asked by the Corporation of Bath before they decided to adopt electricity was, did they find the electric light a success? Taunton said, Yes; Waterford said, Yes; Eastbourne said, Yes; and Leamington said, Yes, in public buildings. The reason why the light had not been so successful in the streets of Leamington was because there the system had been adopted of laying the wires underground. He read the figures obtained from these towns, showing that the cost of electricity was somewhat in excess of gas; but he went on to say that seeing the strides which electricity was making every effort would be made to keep the cost down. If the cost of electricity was much more than gas they would not find him a supporter of the scheme, but if it could be adopted at a reasonable cost he thought they would be justified in trying it. They were not going to interfere with the Gas Company to any extent. They only said to them, if you are a public company you must be able to compete with the inventions of the age, and you suit your supply according to the requirements of the public. It was their duty as a Council to encourage competition in the hope and with the view that the public would eventually get the benefit of it.

Mr. BALE seconded the motion.

Mr. DAW asked the Town Clerk as a point of law, if tenders were advertised for, could the Council do anything upon that? As he read the law, a company supplying the light must either get an Act of Parliament or a license from the Board of Trade, or a provisional order.

The TOWN CLERK said that was the law with regard to the manufacture of this light.

Mr. DAW said a company could not carry out their contract without going to the Board of Trade.

The TOWN CLERK replied that persons who tendered must be duly authorised to supply this particular area.

Mr. DUNN said his objection was that the Committee was appointed for the purpose of obtaining information as regarded the terms upon which electricity could be obtained. He had been of opinion in the committee, as he was now, that the issuing of a notice for tenders was not the best means of obtaining what they required. Information had been obtained since the committee met, and they ought to have been put in possession of it, but instead of that, Mr. Townsend hugged it up all to himself and made use of it for the first time that day.

The MAYOR said it would be remembered that Mr. Massingham handed it round when he attended a meeting of the Council.

Mr. WIPPELL argued that the system of tendering was absolutely necessary if they were going to arrive at any definite conclusion, and he thought it was absolutely necessary that all the tenders should be upon exactly the same specification.

Mr. WILSON said they had come to a conclusion in committee that a certain specified area should be lighted, and that for that area they should issue an advertisement for tenders.

Mr. BOWDEN moved as an amendment that no further steps be taken until each member of the Council had been supplied with a printed copy of the specifications.

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Mr. BECKIT seconded.

Mr. DAW said he did not see how, then, they could invite tenders upon specifications which had not been approved. That was a very strange way of doing business.

Mr. WIPPELL inquired whether the committee were in possession of the specifications?

The MAYOR distinctly understood from the chairman of the committee and other speakers that the specifications had been before the committee, and that they recommended that tenders be invited upon those specifications.

Mr. DAW: Since the specifications were before the committee on the 19th May, have they been altered in any particular?

The TOWN CLERK replied in the negative.

The SURVEYOR said that although the specifications had been before the committee and approved by them, they were referred to the town clerk to see the legal aspect of the case.

The MAYOR said as a matter of order he should rule that by recommending that tenders be invited upon certain specifications the committee thereby approved of those specifications. Otherwise it was child's play.

The SURVEYOR said the point referred to the town clerk was as to the liability of the Corporation.

The MAYOR pointed out that it was quite open to the Council if they adopted that report to give any instructions they thought proper to the committee or the town clerk, or to both, with reference to these specifications.

Mr. ANDREW said he did not like to vote against the report, but he was not strongly in favour of it because he did not think that the method proposed to be adopted was the best one. They were not acting in good faith towards the parties from whom they asked tenders by not having first made up their minds whether they would accept any. That was not the most honourable way of getting information, and there were other ways of getting it besides giving parties a lot of perhaps unnecessary trouble. If the information obtained by Mr. Townsend had been laid before the committee it would have been better. But the main point was whether the expense of obtaining what they believed to be a better illuminant would be greater. Everybody conceded to electricity superiority in lighting over gas, and if there was anything like an equality of cost he should not hesitate for a moment to vote for the report; but they had heard that those places which had been lit by electricity paid nearly double what it had cost them for gas. He did not think that in such a case the Council would make the change proposed. There was no kind of standing-still about the science of electricity, and he thought they were a little too soon in their inquiries. He should like the matter to go back to the committee and see if they could not furnish them with some better information, although he did not say he should vote against the resolution if it were pressed. It would be considered a very unreasonable thing for a private gentleman to send out tenders for the erection of a villa, if it were known that he only wanted to obtain information of the cost of erecting a villa.

Mr. POPE: It is constantly done.

Mr. DOMVILLE said as to whether tendering was the best method of getting the information they wanted he was bound to say that he thought it was the only method.

Mr. ANDREW said he was sorry to hear it.

Mr. DOMVILLE said Exeter was so situated, as some of the electricians informed them, that the citizens were in a better position for obtaining motive power than almost any other city in the country. They had water-power of almost unlimited extent at their doors, and it was necessary that they should know whether they could adapt that water power or not as a motive power for the electric light. At that moment electric lighting companies were looking out, not only upon Exeter, but everywhere else, for an opportunity of exercising their powers, and probably several companies were willing to tender if they knew that this Council had taken up the question seriously. He did not think that the Council would be taking any unfair advantage of any company if they asked them to tender to light a portion of the city on the understanding, tacit or expressed, that if they could offer to do it at anything like the price of gas, the Council would be willing to entertain their offer. He hoped they would not be led aside by anybody who was interested in preserving the rights of any existing companies in the city.

Mr. BOWDEN protested against the idea that there was any endeavour to get rid of this question by a side wind. They knew the messes they had got into in days gone by by adopting measures that they did not understand, and he was not prepared to give a vote on this question until he knew what he was voting for.

Mr. FORCE agreed that tendering was the best means of getting at the prices, but he feared that after the observations which had been made that position was seriously damaged. If twenty persons had intended sending in tenders, probably that number would be reduced to ten when it became known that the Council wanted the tenders only to see the prices, with the option of accepting any one of them or not.

A division then took place upon the amendment, which was that printed copies of the specification should be printed and circulated before tenders were invited. The amendment having been declared to be lost, the report was adopted.

Mr. DAW moved, and Mr. WIPPELL seconded, that a period of three months should be allowed to lapse before the tenders were sent in.

Mr. WREFORD did not know whether this delay was proposed in order to give the Exeter Gas Company the chance of tendering for the electric light.

Mr. WILSON said he did not see why the gas company should not supply the new light.

Mr. BOWDEN protested against the jibes which had been directed against Mr. Daw. It was true that Mr. Daw was solicitor to the Gas Company, but there were members present who belonged to the Electric Light Company, and who were waiting anxiously for the decision of the Council. He thought that they should not hastily commit themselves to a course which they might eventually regret that they had adopted.

Mr. BLACKBURN said if the Council waited three months for tenders they would not have any electric light this year, and he thought six weeks would be ample time.

Mr. WREFORD moved, and Mr. TOWNSEND seconded, as an amendment, that the time be two months.

Mr. DAW asked why they should hurry this on in the interest of one particular company, because that was what it was? The existing Electric Light Company had been maturing their plans for months, and probably they had got the tenders in their pockets now. He should ask the citizens seriously to consider whether three months was too long a period.

Mr. POPE said the electric lighting companies were prepared at the shortest notice to submit tenders, and did not want three months.

On a division the resolution of three months was carried by a majority of one. It was agreed that tenders should be sent in not earlier than the 22nd September.

LEGAL INTELLIGENCE.

United Telephone Company v. Tasker, Son and Co.

In the Chancery Division of the High Court of Justice, on Friday last, the case of the United Telephone Company *versus* Tasker, Son and Co. came before Mr. Justice Kay.

This was a motion by the plaintiffs for an interim injunction to restrain the defendants, who are the proprietors of a telephone exchange at Sheffield, from infringing the plaintiffs' patent for telephone transmitters and receivers.

Mr. Aston, Q.C., Mr. Moulton, Q.C., and Mr. Micklem appeared for the plaintiffs; and Mr. Ince, Q.C., and Mr. Bousfield for the defendants.

Mr. JUSTICE KAY: I come to my judgment in this case without the least hesitation. The defendants admit that they are using telephones which are an infringement of the patent dated in 1876, and which belong now to the plaintiffs. The making of these telephones would be an infringement, and clearly that is a continuing wrong. Every day they use them they are infringing the patent. They admit the user, and they admit the telephones are the telephones which are infringements of that patent; but they attempt to justify in this way—they say that the defendants have formed an Exchange Company in Sheffield; they did that at the instance of the plaintiffs or their predecessors in title and by agreement with them. That agreement they say the plaintiffs now refuse to carry out, and they say, "They refused to supply us with any telephones at all; therefore we have for the preservation of our business made these telephones, which we admit are infringements, and we are now using them." Obviously that is not a justification. Of course that will not do for a moment. I put the case during the argument of an agreement by a man for value that he would out of a balance then at his banker's make a certain payment, and a flagrant breach of that agreement, would that authorise the person to whom the payment was to be made forging a cheque on the bank? Really that is a very analogous case. The infringement of a patent because another contract has not been carried out by the patentee is a taking of the law into your own hands which of course cannot be listened to for a moment. Because a contract has been broken, a person who alleges that contract to be broken takes upon himself to infringe the patent of the other party to the contract, of course could be no justification in the world. At the same time it is suggested that there is considerable question as to whether the contract under which the Exchange Company of Sheffield has been formed (perhaps I am wrong in calling it a company, but I will say the exchange in Sheffield has been formed) has been broken in a flagrant manner by the plaintiff company. On the other hand it is denied. I cannot determine the rights of that now. It is said the plaintiffs have set up a rival exchange in Sheffield, and, of course, it is possible. I do not say it is so at all, but it might be suggested that the main purpose and object of this application now is to destroy the one company and encourage the other. I do not say it is so, but that might be suggested. In order to prevent any suggestion of that kind I intimated to the plaintiffs that it would be a fair thing that until the trial of this action they should replace the telephones, which the injunction I am now about to grant will prevent the defendants from using or selling or disposing of in any way, by telephones of their own, which they may either lend or let for hire, or sell or supply on any terms they please, the object being that the business which the defendants have set up by this exchange in Sheffield should not by this order be brought to an end or be very seriously interfered with. I think that will be quite fair. Of course, there will be the usual undertaking as to damages. Upon those terms I now grant the injunction to prevent the defendants, their servants and agents, from making use, selling, or otherwise disposing of any telephones which are an infringement of the plaintiffs' patent, the plaintiffs undertaking to supply to the defendants upon usual terms as to costs, but otherwise either by way of loan, or sale, or letting at their pleasure, so many telephones as this order will prevent the defendants from using. There will be the usual undertaking in damages. This is, of course, till trial of action or further order.

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Mr. ASTON: That does not extend to their laying down any extension of their system, or introducing a new system.

Mr. JUSTICE KAY: I have limited it by the number of telephones which this prevents them using.

Mr. ASTON: Now using.

Mr. JUSTICE KAY: Yes.

Crampton v. Patent Investment Company (Limited).

In this action, which has occupied Mr. Justice Field, without a jury, for four or five days, the plaintiff, who is the patentee of certain improvements in and relating to electric bells and alarm clocks and apparatus to be used in connection therewith, sued the defendants, under section 32 of 46 and 47 Vic., cap. 57, to recover damages from them for having, in contravention of that section, threatened him with "legal proceedings, or liability in respect of any alleged manufacture, use, sale, or purchase" of a certain invention which he (the plaintiff) claimed in a certain electrical bell which he was at the time manufacturing and selling. The plaintiff pleaded that he had never used the defendants' invention as alleged, nor was his bell, in fact, an infringement upon the defendants' patent, or of any legal rights of the defendants. The plaintiff further alleged that the defendants' patent was bad for these reasons *inter alia*—(*a*) that the defendants were not the true and first inventors; (*b*) want of novelty; (*c*) non-utility; (*d*) ambiguity in specification and variation in provisional and final specification; (*e*) anticipation. The plaintiff further pleaded that the defendants would continue their threats until restrained by injunction; that the defendants had commenced an action against the plaintiff for infringement of their letters patent in October, 1886, but discontinued the same by notice in August, 1887. The defendants admitted that they had threatened the plaintiff and Messrs. Swete and Main (agents of the plaintiff) with legal proceedings for infringement, but denied that such threats were wrongful, and did not admit that the electric bells made by the plaintiff were made according to his alleged invention; that their patent was good and valid; that the bells which the plaintiff was manufacturing, and of which they complained, were an infringement of their legal rights; that in commencing their proceedings against the present plaintiff in the former action they had acted *bonâ fide*, without malice, and with reasonable and probable cause. On these pleas issue was joined.

Mr. E. E. Jenkins appeared for the plaintiff; and Mr. Rogers W. Wallace was for the defendants.

The evidence and arguments were chiefly of a technical character, and at the conclusion of the case

Mr. JUSTICE FIELD said that it had been conducted by both counsel with such skill and care that he was, notwithstanding its highly technical nature, in a position to decide it at once. Having pointed out that the object of the Legislature in enacting Section 32 of the Patent Law Amendment Act—under which this action was brought—was to protect deserving patentees from being harassed and oppressed by threats and vexatious actions by persons wrongfully claiming right to use their inventions, he said that the section gave the right to any such aggrieved person of recovering damages in an action against the person or persons so threatening him. It was that remedy which Mr. Christopher Crampton here wished to enforce. It was clear, his lordship observed, that the plaintiff claimed to be the inventor of Jensen's bell, and also that they had threatened him (Crampton) with legal proceedings, and, indeed, actually commenced an action against him (the present plaintiff) for infringement of their Jensen's bell. That action, however, was discontinued on terms which it was not necessary to refer to. It had been argued that the defendants had not used any threats within the true meaning of the section. Even if there was no authority upon that point he would have decided it, as he now did, in the defendants' favour. Now, were these threats justifiable? That depended upon whether or not the defendants had any legal rights to what they claimed. Referring to the Jensen bell (the defendants' patent) his Lordship said there could be no doubt that it was a very great improvement, and that the whole combination adopted by Jensen was of great utility, and proper subject matter for a patent. That being so, it seemed clear that the defendants, who were now admitted to be the patentees of Jensen's bell, had *primâ facie* legal rights in their patent. Referring to the mechanism of the different bells, the learned judge said it was obvious that Crampton and Jensen's bells were substantially the same, producing the same results by the same means; and Jensen's being the senior in date, Crampton's was, he said, an infringement of Jensen's *primâ facie* legal rights. But the plaintiff had attacked this *primâ facie* right, alleging on various grounds that their (the defendants') patent was invalid. First, it was said there was variation in the specifications. His lordship held that there was substantially none. Second, as to anticipation, he referred to the case of Cornish *v.* Kean (1 Web., R. 507) on that point, and held that there was not sufficient proof of anticipation. He also held that the defendants' patent was useful, new, and proper subject matter for a patent, and finally gave judgment for the defendants on the usual terms.

Avery v. The National Company for the Distribution of Electricity by Secondary Generators.

This was an application made on the 8th inst., in the Queen's Bench Division, before Mr. Baron Huddleston and Mr. Justice Charles, for a new trial of the case, which was tried on 10th April, resulting in a verdict for the defendant company. Judgment was again given for the company, leave for a fresh trial being refused.

PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

7,487. G. BINSWANGER and H. J. COATES. London. Improvements in electric switches. May 22, 1888.

7,519. E. G. KEMPE. London. Improved portable easy chargeable safety fluid battery. May 22, 1888.

7,522. E. J. HOUGHTON. London. Dynamo apparatus. May 22, 1888.

7,523. E. J. HOUGHTON. London. Means and apparatus for electric lighting. May 22, 1888.

7,530. E. R. CHITTENDEN and E. E. VAUGHTON. Kingston-on-Thames. A portable electric safety lamp. May 22, 1888.

7,536. B. WILCOX. London. Improvements in galvanic batteries (T. P. Whittier, United States). May 22, 1888.

7,541. W. P. THOMPSON. Liverpool. Improvements in electric machines (H. W. Spang, United States). May 22, 1888.

7,548. U. DIEULEVEULT. London. A floating telegraphic or telephonic station or apparatus for enabling ships at sea to communicate with one another or with the shore. May 22, 1888.

7,619. G. J. WEIR. Glasgow. A primary electric battery. May 24, 1888.

7,636. J. APPLETON, W. T. BURLEY and A. E. WILLIAMSON. London. Improvements in holders for electric incandescent lamps and shades. May 24, 1888.

7,655. R. E. B. CROMPTON. Chelmsford. Improvements in and connected with underground conductors of electricity. May 25, 1888.

7,679. J. G. SOWBERRY and C. J. CHUBB. London. Improvements in electric lamps. May 25, 1888.

7,692. C. K. FALKENSTINE and J. J. VARLEY. London. Improvements in the manufacture of screws, screw rivets, bolts, terminals, and other fittings used in connection with electrical appliances. May 25, 1888.

7,696. T. COAD. London. Improvements in incandescent electric safety lamps. May 25, 1888.

7,784. L. HOPPE and G. HOPPE. London. An electric motor for clocks, watches, and other similar apparatus. May 26, 1888.

7,750. J. DULAIT. London. Improvements in electric arc lamps. May 26, 1888.

7,761. C. B. BURDON. Tianmere. Improved method of applying electricity to a general system of traction. May 23, 1888.

7,805. H. J. ALLISON. London. Improvements in the method of, and apparatus for the production, transmission, and distribution of electric currents. (C. E. Tritts, United States.) May 29, 1888.

7,848. W. P. THOMPSON. Liverpool. Improvements in or relating to indicators for alternating electric currents. (G. Westinghouse, jun., United States.) May 29, 1888.

7,849. W. P. THOMPSON. Liverpool. Improvements in or relating to apparatus for detecting and locating faults in alternate electric circuits (G. Westinghouse, jun., United States). May 29, 1888.

7,850. W. P. THOMPSON. Liverpool. Improvements in or relating to alternate current electric distribution. (G. Westinghouse, jun., United States). May 29, 1888.

7,851. W. P. THOMPSON. Liverpool. Improvements in switches for electric circuits. (G. Westinghouse, jun., United States.) May 29, 1888.

7,852. W. P. THOMPSON. Liverpool. Improvements in or relating to electric circuits. (G. Westinghouse, United States.) May 29, 1888.

7,853. W. P. THOMPSON. Liverpool. Improvements in or relating to storage batteries. (C. D. P. Gibson, United States.) May 29, 1888.

7,876. B. WILCOX. London. Improvements in electric batteries. (B. A. Abakanowicz and A. d'Arsonval, France.) May 29, 1888.

7,091. J. J. HORNE. Dereham. Improvements in the construction of electro-medical and other magnets. May 30, 1888.

7,916. T. O'BRIEN. Manchester. Improvements in transmitting written or other characters, figures, drawings, plans or the like, and also indicating and recording the indications of registering instruments by electricity and in apparatus therefor. May 30, 1888.

7,924. A. J. BOULT. London. Improvements in or relating to electric apparatus for firing mines and the like. (G. Manet and C. Manet, France.) May 30, 1888.

7,977. H. G. MORRIS and P. G. SALOM. London. Improvements in the mode of filling secondary battery plates. May 31, 1888.

7,998. F. HOLMAN. London. Improvements in and relating to shades and reflectors for incandescent electric lamps. May 31, 1888.

8,039. A. LE CLERCQ and A. VANSTEENKISTE. Liverpool. Improvements in or relating to the transformation or conversion of electric currents. June 1, 1888.

8,062. F. KLEINER, London. A combined electrical time switch and electrometer. June 1, 1888.

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8,081. W. Rowbotham and W. Fox, Manchester. Improvements in and relating to electrical bells, indicators, and such like. June 4, 1888.

8,099. R. E. B. Crompton, J. F. Albright, and J. H. F. Soll. Chelmsford. Improvements connected with electrical hoists or cranes. June 4, 1888.

8,160. E. M. H. Andreoli, Brixton. Production by electricity of chlorine and its oxygenated compounds, and the utilisation thereof. June 4, 1888.

8,161. C. C. Nichols, of the firm of C. A. and H. Nichols. London. On behalf of the London Electric Bleaching Company. Bleaching paper pulp by electricity. June 4, 1888.

8,170. H. J. Allison. London. Improvements in governing devices for electric motors and circuits. (The Baxter Electric Manufacturing and Motor Company (Incorporated), United States.) June 5, 1888.

8,200. W. T. Goolden and H. W. Ravenshaw. London. Improvements in electrical transformers. June 5, 1888.

8,354. M. Leclanché. London. Improvements in the manufacture of depolarisers for primary or secondary electric batteries. June 7, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

Note.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

June 2, 1888.

7,865. F. George. Dursley. Improvements in dynamo-electric and electro-dynamic machines. May 31, 1887.

9,843. W. T. Goolden and S. Evershed. London. Compensating electric measuring instruments for temperature. July 13, 1887.

10,519. J. B. Petter. London. Improvements in posts, such as fencing, telegraph, direction, lamp and other similar posts. July 28, 1887.

10,606. L. Gerard. London. Improvements relating to the distribution, storage and regulation of electric currents. July 30, 1887.

10,748. A. Schanschieff. Gipsy Hill. Improvements in portable batteries for the production of electric light. August 4, 1887.

13,954. W. E Irish. London. Improvements in or appertaining to electrical railways. October 14, 1887.

1,851A. J. Y. Johnson. London. A sound conveying tube for telephones, graphophones, and like instruments. (The Volta Graphophone Company, Incorporated, United States.) February 7. *Note*:—This application having been originally included in No. 1,851, dated February 7, 1888, takes, under patents rule 23, that date.

4,524. W. J. S. Barber-Starkey. Manchester. Improvements in portable galvanic batteries. March 24, 1888.

6,237. A. Millar, Glasgow. Improvements in jars or cells for primary or secondary electric batteries. April 27, 1887.

6,416. L Hoppe and G. Hoppe, London. Improvements in galvanic elements. May 1, 1888.

6,481. H. H. Lake. London. Improvements relating to the electric transmission of power and to apparatus therefor. (N. Sesla, United States). May 1, 1888.

6,502. H. H. Lake, London. Improvements relating to the generation and distribution of electric currents and to apparatus therefor. (N. Sesla, United States). May 1, 1888.

June 9, 1888.

8,240. J. B. Hard and T. Wilson. London. Improvements in galvanic batteries. June 8, 1887.

8,500. R. S. Waring. London. Improvements in conduits for electric wires or cables. June 13, 1887.

8,701. J. Ross. Glasgow. Improvements in and relating to the production and application of electric energy for lighting or other purposes. June 16, 1887.

10,071. W. B. Sayers and W. H. Sturge. Birmingham. Improved fittings for electric incandescent lamps. July 19, 1887.

10,740. S. Mathis. London. Improvements in regulators for electric lamps. August 4, 1887.

14,346. A. P. Lundberg. London. An improved bell-pull electric-light switch. October 21, 1887.

15,703. J. Court. London. A galvanic battery for medical purposes November 16, 1887.

2,703. F. Hargrave. London. Improved means or apparatus for sounding at sea and elsewhere by electricity. February 23, 1888.

PATENTS SEALED.

June 1, 1888.

4,214. J. G. Alison. Birkenhead. Improvements in indicators or automatic telegraphic apparatus for indicating the direction and speed of motion of marine or other engines. (Partly by Edouard Lambinet, France.) March 21, 1887.

4,795. F. F. Lee. Sheffield. Direct motor wheel for the driving of carriages, dynamos, or other machinery. March 31, 1887.

5,862. W. Blenheim. Egham. Simultaneous driving of a number of clocks by magneto electricity. April 22, 1887.

5,958. A. M. Clark. London. Improvements in dynamo electric and magnetic machines. (L. Maiche, France.) April 23, 1887.

6,754. R. E. B. Crompton and J. Swinburne. Chelmsford. Improvements in and connected with dynamo electric machines. May 9, 1887.

6,917. W. M. Mordey and C. E. Webber. London. Improvements in electric transformers, induction coils, or inductional resistance coils. May 11, 1887.

6,987. A. Siemens. London. Improvements in electric arc lamps. May 12, 1887.

7,021. G. Scarlett. Liverpool. Improvements in electro-dynamic and dynamo-electric machines. May 13, 1887

15,056. J. A. Betts Clapham. An improved multiple electric cable. November 4, 1887.

16,032. W. Main. United States. Improvements in electromotors and dynamo electric machines. November 22, 1887.

506, C. M. Dorman and R. A. Smith. Manchester. Improvements in the construction of suspension fittings for incandescent electric lamps. January 12, 1888.

750. H. H. Lake. London. Improvements in and relating to electric railways and to vehicles for use thereon. (D. G. Weems, United States.) January 17, 1888.

June 8, 1888.

4,220. J. W. King. London. Improvements in instruments for measuring electric currents. March 21, 1887.

4,447. P. B. Elwell. Wolverhampton. A new or improved apparatus for measuring, indicating, and recording currents of electricity. March 25, 1887.

4,832. H. Leipmann. The Leipmann Carbon Company (Limited). London. Improvements in the manufacture and construction of carbon "plates" or electrodes for use in primary batteries, and for electro-metallurgical, electrolytical, and other electrical purposes. March 31, 1887.

3,097. B. M. Drake and J. M. Gorham. London. An improvement in holding the plates of secondary voltaic batteries. February 29, 1888.

SPECIFICATIONS PUBLISHED.

7,078, 1887. Williams, P., and Powles, W. Electrical indicators for gasholders, &c. (Price 8d.)

7,618, 1887. Mordey, W. M., and Webber, C. E. Electrical transformers. (Price 8d.)

7,857, 1887. Tudor, H. Registering meters for electric currents. (Price 8d.)

8,068, 1887. Bayley, H. Holders for incandescent electric lamps. (Price 8d.)

8,380, 1887. Lineff, A. L., and Jones, W. Operating tramcars by electricity. (Price 1s. 3d.)

8,433, 1887. Neale, F. W. Telephone apparatus. (Price 8d.)

9,011. 1887. Jones, E. Dynamo-electric generators, &c. (Price 8d.)

14,542, 1887. Sandwell, W. D. Electric motors. (Price 11d.)

14,622, 1887. Vaughton, E. E. Electric accumulator. (Price 8d.)

3,678, 1888. Olpherts, W. G. Electrical signalling on railways. (Price 8d.)

4,561, 1888. Brown, C. A. Battery jar. (Price 6d.)

7,829, 1887. Beck, W. H. (Cassagnes.) Automatic transmission of steno telegraphic signals. (Price 8d.)

7,834, 1887. Edmunds, H. Controlling, &c., electric currents. (Price 8d.)

8,214, 1887. Thompson, W. P. (Mauritius). Telephone systems. (Price 1s. 3d.)

9,256, 1887. Yuly, J. L., and Andrews, H. W. Regulating the speed of dynamos. (Price 8d.)

13,069, 1887. Van Rysselberghe, F. Harmonic telegraphy. (Price 11d.)

14,062, 1887. Pullar, E. Automatic medical electrical apparatus. (Price 8d.)

15,537, 1887. Paul, R. W. Electric switches. (Price 8d.)

17,047, 1887. King, F. Secondary batteries. (Price 8d.)

137, 1888. Pürthner, J. C. Producing induced electric currents. (Price 8d.)

3,075, 1888. Southey, A. W. Electric arc lamps. (Price 6d.)

3,215, 1888. Oldroyd, J. W. Electric incandescent lamps. (Price 6d.)

3,235, 1888. Miot, G. Multipolar dynamo-electric machines. (Price 8d.)

4,277, 1888. Boult, A. J. (M'Laughlin). Electro-mechanical movements. (Price 8d.)

4,929, 1888. Gillett, W. and Hazeltine, G. Magneto-electric generators. (Price 6d.)

1,363, 1882. Maxwell-Lyte, F. Secondary batteries. (Price 8d.) Second edition.

7,189. 1887. Akester, W. H. Secondary batteries. (Price 8d.)

8,206. 1887. Davies, D. H., and Tourtel, J. M. Producing electric light by insertion of coin. (Price 8d.)

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8,495. 1887. CLARK, A. M. (Berton). Electric lamps. (Price 1s. 1d.)

9,598, 1887. TIMMIS, I. A. Electrical apparatus for working railway signals. (Price 8d.)

738, 1888. SMART, H. R. Fittings for hydro-dynamic ventilating apparatus. (Price 8d.)

3,246, 1888. WALKER, F. Electrical lamp and projector, &c. (Price 8d.)

3,303, 1888. LEIGH, H. H. (Clerc). Registering the consumption of electrical energy. (Price 8d.)

4,362, 1882. GAULARD, L., and GIBBS, J. D. Distributing electricity. (Price 8d.) (Fourth edition).

6,809, 1887. ESHELBY, J. and E. Electric bell indicators. (Price 8d.)

6,918, 1887. GEDGE, W. E. (Claude). Telegraphy. (Price 1s. 3d.)

7,012, 1887. CHAPMAN, F. G., and others. Electric arc lamps. (Price 8d.)

9,829, 1887. STANLEY, T. Dynamo electric machines. (Price 8d.)

9,904, 1887. GRABAU, L. Insulating coatings for electrolytic apparatus. (Price 8d.)

10.195, 1887. HALL, J. P. Dynamo electric machines. (Price 11d.)

10,575, 1887. EMMOTT, W., and RIDER, J. H. Instruments for electric measurement. (Price 6d.)

15,717, 1887. RANDALL, C. A. Electrical date and time stamp. (Price 1s. 1d.)

COMPANIES' MEETINGS.

The Consolidated Telephone Construction and Maintenance Company (Limited).

The seventh annual ordinary general meeting of this Company was held at the Terminus Hotel, Cannon-street, on the 7th inst., under the presidency of Mr. C. L. W. FitzGerald.

The Secretary (Mr. CHARLES CURTOYS) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN: Gentlemen, the report which we have laid before you, as you will see by turning to the figures, shows available as the profit of the year the sum of £10,788. 7s. 4d., which, with the balance we brought forward from last year, of £1,695. 18s. 5d. amounts to the sum of £12,484. 5s. 9d. As you are aware, we have already paid an interim dividend at the rate of 5 per cent., and we now propose that we should write off the machinery and plant and the furniture the sum of £541. 6s. 3d., and also pursue the policy which we have always carried out—that of writing down the values of things to a certain extent. We propose to write a further sum of £2,000 off the item on the credit side of the balance-sheet under the head of "investments in telephone companies"—that is, off our shares in the Edison-Gower-Bell Telephone Company. We hold in that company 20,000 Preference shares of £1 each, and 15,000 Ordinary shares of £1 each. We have now reduced that item from £25,000 to £18,000. I will now go back to the expenses. The ordinary expenses for the year amount to, in round figures, about £200 less than those of last year. The legal expenses are a little less. We then come to an item which I do not like very much—"arrears of fees and special remuneration, Colonel Gouraud and costs—£952. 1s. 10d." That is in reality an item which should have been paid in the year 1883-1884 out of the profits that Colonel Gouraud had made himself; but, unfortunately, at that time, when Colonel Gouraud was chairman, there was not the money to pay the fees with. We have had to pay the fees, Colonel Gouraud having brought an action against the Board for those fees which were in arrear. Although we (the Company) had imagined that Colonel Gouraud, having sent round a circular to all the shareholders stating that he had resigned his fees, when it came to the trial the Court held that that circular was not sufficient evidence of Colonel Gouraud relinquishing his fees, and consequently they gave their decision against the Company. I now go a little lower, and there you find the sum of £175 which we have spent on the Belgian patents. We have up to this time spent £375 on that particular head, and of course you must not look on that money as lost yet, as that money is for the legal expenses of this patent trial, which we hope will bring this Company in a large sum of money should it result favourably. It is a very difficult matter for any one to say that it will result favourably; but so far, it has gone favourably. We then come to an item, "Return of capital," £139. 3s. 10d., which you will remember, was in return of capital last year. We have then a sum reserved for a claim in dispute and bad debts, and that claim has been settled for £100, and £20 the cost of the arbitration. We are therefore rather to the good there. I now come to the balance-sheet. Against the item capital expenditure, goodwill, patent rights, &c., stands the sum of £75,436. We have not deemed it necessary to write anything more off that this year, for the reason that we wrote off such a very large sum last year. Then comes "agency account, Austria." The sum invested in telephone exchanges, patent rights, &c., amounts in round figures to £127,245. That is, as you see, "contra'd" on the other side. It is of no importance in this balance-sheet, but I shall have something more to say on this head when we come to the extraordinary general meeting. Our plant and machinery now stands, after we have written off the sum we propose, at £4,740. 12s. We have written down that plant by about, roughly, £2,500, and I can safely say this—that the plant to-day is in the most efficient state, and that we go on improving our plant and at the same time write down its value. The stock of instruments, you will observe, is rather more, about £1,000; that is caused by our having taken over the stores of our late contractor. I do not know that I need make any further remarks about these other items. I have already spoken about the Edison-Gower-Bell Telephone Company. I will now go to the debit side, and there you see an item of sundry creditors and credit balances, £2,025. 7s. 10d. All this is pretty well paid off. I think we only owe really about £300. I think that that is fairly satisfactory. As you see by our Report, after writing off these various sums, we propose to pay you a further dividend of £2. 17s. per cent., which will make a total dividend of £5. 7s. per cent. I have already spoken to you on the subject of Colonel Gouraud's action for payment of his fees, and I regret to state that he has now, after waiting the whole four years, thought fit to commence an action against the Committee of Investigation on the ground that the reports published to you are libels on him. We are advised by our solicitor that those reports undoubtedly are privileged reports, and all I can say, as Chairman of that Committee, is that nothing could be further from our thoughts than libelling Colonel Gouraud. There is no object in libelling him. What we did try to do was to show from the minutes what we found there to the shareholders, and we put that in print. Whether Colonel Gouraud will proceed with the action I cannot tell. I have already spoken to you on the subject of the Edison-Gower-Bell patent action in Belgium. We none of us can say how that will end, but our solicitor is decidedly of opinion that we at all events have a very good case, having the same patent, which is the patent in England that governs all the telephone wires about us. I now come to a paragraph alluding to the Portuguese business. The Edison-Gower-Bell business in Portugal has been sold to a company called the Anglo-Portuguese Telephone Company, which has already issued one report, and I may say that it is of a decidedly favourable nature. I trust that this Anglo-Portuguese business, which has already a very considerable income, will some day or other return some dividend to the Edison-Gower-Bell Company, as they hold the shares, and that that Company will hand some of the profit on to us. The next paragraph relates to the manufacture of telephones. As you are aware, when we, the present Board, took over this business, there was a contractor. He was a very able man indeed, and undoubtedly he knew his business very thoroughly. That has gone on for four years, and we, on certain occurrences, determined that it would be for your interest that we should undertake the manufacture of telephones for ourselves. I am fortunate, I think, in now being able to say that my studies under this gentleman, the contractor, and my having been daily at the works, have enabled me to master the manufacture of these telephones sufficiently to be able to say that I can undertake the management of your business. I may say that since the contract was terminated, everything in connection with the work has gone on satisfactorily. I find no difficulty in it, and I trust—as I think any one must see—that we ought to make more profit than if we employed a third party who contracted to make the instruments at a fixed price. The next paragraph is one which I am sure the shareholders will be pleased to see—that is that all the telephone interests, the United Company and our Company—are working in harmony together, and no doubt, should this amalgamation alluded to in the Report take place—of which I think there is every probability—we shall see a very considerable advancement in the number of telephones ordered. I think anyone can understand that provided we could talk from London to Manchester, Liverpool, and Leeds, many people would have telephones who would not otherwise have them. That is my feeling. I believe that the fusion is likely to take place, and I think it will be a very good thing for all of us if it does. It will make us much stronger in regard to our relations towards the Government. I next come to what I consider one of the most satisfactory features of the whole of the report, and that is the progress of our subsidiary companies. You see the figures before you. The Telephone Company of Austria has increased by 245 subscribers and £1,801 in income, and the Anglo-Portuguese Company (late the Edison-Gower-Bell Telephone Company) has an increase of 130 subscribers and £994 in income. I was looking back to day to see the figures in 1884 of these companies. The figures of the Telephone Company of Austria were:—626 subscribers, with an income of £4,227; and those of the Edison-Gower-Bell Company were 603 subscribers, and an income of £4,000; Those figures make a total of 1,229 subscribers, and an income of £8,227; whereas now the totals in Austria and Portugal are 3,536 subscribers, with an income of £23,255. Further than that, we have at last made those two companies absolutely money-paying concerns; in other words, the Board and friends have found money for these Companies so that they should have some working capital, which they never had before. They are now both paying us cheques for all the goods we make for them. That, to my mind, is one of the most satisfactory things I have to tell you to-day. You will notice that Mr. Buckingham has joined the Board. Mr. Buckingham was one of the earliest gentlemen I spoke to about investigating the affairs of this company, and there is, I think, no one in England I would sooner have on the Board of this Company than Mr. Buckingham. He has already been of considerable service to your Company. If any shareholder has any question to ask me which I can answer I shall be pleased to do so before putting the motion for the adoption of the report and accounts. The motion I propose is:—

"That the statement of accounts and balance-sheet and the report of the Directors and auditors, as now submitted to the meeting, be received and adopted, and that a final dividend of £2. 17s. per cent. be paid, making with the interim dividend previously paid £5. 7s per cent. for the year ended March 31st, 1888."

Sir ALEXANDER ARMSTRONG, K.C.B.: I have much pleasure in seconding that. I can add nothing to the statement of the Chairman, which I am sure the meeting will consider satisfactory,

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A SHAREHOLDER: Will you answer a question before you put that? There is an item on the credit side of the balance-sheet, "Loans on security, £8,300." Will you tell me to whom that is lent, and on what kind of security?

The CHAIRMAN: It is lent to a firm of stockbrokers, and they gave us the usual Stock Exchange securities, which we can redeem from account to account.

The SHAREHOLDER: That is hardly the business of the Company.

The CHAIRMAN: You must lend your money to someone. Do you understand the difference in lending the money to a bank at 1 and 1½ per cent., and to a broker, from whom you get 2½ per cent? In the bank, too, you only have the security of the bank, but when you lend money on loan to brokers you have tangible securities.

Mr. A. E. GREEN (one of the auditors): The securities have been investigated by the auditors, and they are perfectly satisfied that you have tangible security.

The CHAIRMAN then put the motion in the usual way, and it was carried unanimously. Continuing, he said:—The next motion is the re-election of the Directors, and I propose

"*That Sir Alexander Armstrong, K.C.B., and A. H. Baker, Esq., be, and they are hereby, re-elected Directors of the Company.*"

Mr. PITT COBBETT: I think it would be in proper order if you proposed those two gentlemen separately.

The CHAIRMAN: Very well. Then I propose the re election of Sir Alexander Armstrong.

Mr. RICHARD VAN ZELLER seconded the motion, which was carried unanimously.

The CHAIRMAN: I have now to propose the re-election of Mr. A. H. Baker.

Mr. VAN ZELLER having seconded the motion.

Mr. PITT COBBETT said: It was at my instance that this business was put in this way. My object in asking that their re-election should be put separately was to have the opportunity of saying that it is not desirable, in the interests of the Company, that Mr. Baker should be reinstated in his position as a Director. Quite apart from the special conditions connected with Mr. Baker, I submit that it is not desirable that Stock Exchange gentlemen should be too largely represented on the Board of a company like this. I do not mean to say that we are not fortunate in having the present gentlemen on the Board, but I think it would be advantageous if shareholders took this opportunity of taking action in the direction I propose. I think it highly objectionable to elect any Director to whom any objection could be taken. The Company has suffered too much in days gone by to warrant its incurring further risk of the kind. I hold that it is not desirable that Mr. Baker should be re-elected, but that the nomination of a new Director be left in the hands of the Board.

Mr. WARD: I confess I am surprised at these remarks. Had they been raised at the time Mr. Baker was first proposed to the Board, I could, I think, have supported them, because I do not like as a rule Stock Exchange men to be on a Board, as there are certain objections to that course; but Mr. Baker has been on the Board for a considerable number of years, and as far as I know no objection has been made to him, or anything injurious said as to his character, or that his being on the Board is against the interests of the Company. I confess I am not prepared to hold up my hand against the re-election of a gentleman against whom the charges brought are so vague. If our friend had any charges to bring against a Director of this Company, he should, I think, state them openly, and not insinuate that there is anything against one individual. At all events, I am not prepared to take mere insinuation as a fact. I like something like truth when a charge is made against a man, showing that the charge is one which we ought to entertain.

The CHAIRMAN: I am rather astonished at the attack that has been made on Mr. Baker. So far as any gentleman saying that he does not think a member of the Stock Exchange is a good Director, I must say I cannot see it. I think that they are business men, most of them—as good men of business as any one else. That is my opinion. If the shareholders mean to say that a gentleman being on the Stock Exchange he will take advantage of the market to buy or sell the shares, then I reply that shareholders themselves are ready to take advantage of the market also. Mr. Baker is one of the gentlemen who came to the rescue of the Company for the shareholders. He has worked as hard as any man on the Board, and it seems to me a most surprising thing to say that he should not any longer be a member of the Board because certain things occurred in a club; because, after all, the Stock Exchange is a club. If anyone can tell us in what way the Company has suffered through Mr. Baker, let us have it out. Do you suppose that we have sold one single telephone less from what has happened to Mr. Baker? Do you suppose that the Telephone Company of Austria or the United Company have ordered one telephone less from us through that?

The SOLICITOR: Perhaps, gentlemen, before you deal further with this matter I should mention to you that under the 98th clause of the Articles of Association no person is eligible, unless recommended by the Directors or a retiring Director, unless his name is before the meeting by notice for seven days. It is the business of this meeting to re-elect Directors, and Mr. Baker's name is the only name before the meeting with which I can deal. Now, personally, let me say that Mr. Baker has been a most intimate personal friend of mine for 30 years. I do not think that the Stock Exchange incident has affected Mr. Baker in the least degree among those who have known him, who know him to be a man of the highest honour. I do not think it has affected him either in his business relations on the Stock Exchange, and I am sure that in the outside world he has had nothing but sympathy.

Mr. HUNTER: I wish to corroborate what the solicitor has said. If I desired to leave any business in the hands of an impartial honest man, I would leave it to Mr. Baker, who I know, as the Chairman has said, has been very instrumental in bringing the Company to the state it is now in.

Mr. BAKER: I was not unprepared for the remarks that have fallen from the gentleman in the corner (Mr. Pitt Cobbett), but I do not think that this is the place for me to vindicate myself. I can assure you I am not a man to come and ask for re-election if there was the smallest shadow of a black stain on me. I have been a member of the Stock Exchange for twenty-five years. You must bear in mind that the Stock Exchange Committee are an irresponsible body and can do as they like, and as long as you are a member of the Stock Exchange you must submit. The censure and what they chose to do with me was for a transaction entered into under the advice of my solicitor. I consider that the business transactions I ventured into were straight, business-like, and above board. I purposely chose to come here and seek re-election because when a body of gentlemen choose to pass resolutions which cannot be sustained in law, it is best to meet them face to face, to disclaim in every possible way that which has been sent round. I can assure the gentlemen who have spoken that had there been the smallest shadow of wrong against me, I should not have asked you to re-elect me. The Chairman has perfectly correctly stated that I and one of my colleagues on the right [referring to Mr. Grëwing] and the Chairman were the main instruments of bringing this Company from a state of chaos into what we may call a fairly satisfactory condition. I do not know what Mr. Pitt Cobbett's holding is, but I hold now and have held from the Company's existence about 4,000 shares. I think that many here will be perfectly satisfied to take me for what I am worth, and I shall decline to discuss my little episode any further.

The CHAIRMAN then put the motion in the usual way, and declared it carried with one dissentient.

Mr. BAKER: I am very much obliged to you for this continued mark of your approval, and I can assure you that in the future I shall endeavour to merit, as in the past, with my friends around the table that confidence which you have been good enough to bestow on me to-day.

A SHAREHOLDER: May I ask what this investment of £18,000 is—this asset of the Edison-Gower-Bell Telephone Company's shares.

The CHAIRMAN: That is one of the assets of the Company. We have 20,000 of the Preference and 15,000 of the Ordinary shares of that company.

The SHAREHOLDER: How is it that it is shown as an asset for £18,000, when there is no market for it?

The CHAIRMAN: There is no market for the shares of the Telephone Company of Austria, but they pay a dividend. Do you mean a Stock Exchange market?

The SHAREHOLDER: I do. Suppose we wanted to realise these shares, should we get £18,000 for them?

The CHAIRMAN: How can I say that? To show that we do not think this asset is as good as the shares of the Telephone Company of Austria we have written it down to-day by £2,000.

The SHAREHOLDER: Why not write it down to £5,000, as you have written it down to £18,000?

The CHAIRMAN: We must make the profits to do that. These companies' shares will gradually grow in value.

The SHAREHOLDER: If the Company were going to be wound up this asset might not realise £1,000.

The CHAIRMAN: I cannot really say what would happen in a winding up. We have saved the Company once from being wound up. Have you any Edison-Gower-Bell shares?

The SHAREHOLDER: No.

Mr. BUCKINGHAM: With reference to the question of the hon. proprietor, it is simply answered in this way. Many years ago, when this Company was formed, a large number of other companies were formed as kindred associations; and really the formation of those consisted of a mass of shares on paper. There were at that time a large number of them completely valueless. Many of the things handed over to this Board have, by judicious management—more particularly by that of the Chairman and three or four of my colleagues—become of value in the course of time, and they are daily becoming more valuable. This particular Edison-Gower-Bell asset is to my knowledge, as a new Director, the worst thing we have, but the chances are that in three or four years it may become valuable. Three or four years ago the River Plate shares were almost valueless, and now they have become valuable. As the Chairman says, there is no Stock Exchange quotation, but, nevertheless, there is a market for them. To sum up the whole, when these Directors took over this Company they took over a mass of paper belonging to certain subsidiary companies, which will, in due course, prove of some value to the Consolidated Company.

The CHAIRMAN: I have now to propose

"*That Mr. J. G. Griffiths, of the firm of Messrs. Deloitte, Dever, Griffiths and Co. be re-elected an auditor of the Company at the same remuneration as before.*"

A SHAREHOLDER: What is the remuneration?

The CHAIRMAN: Fifty guineas. That was fixed in 1884.

Mr. HENRY GREWING seconded the motion, which was carried.

Mr. GARDNER: I now propose the re-election of Mr. Green, and I should like to make an addition—that the remuneration of the auditors be the same in both cases. I understand that one of them gets fifty guineas, and the other half that amount.

The CHAIRMAN: Perfectly right. Mr. Griffiths makes a monthly audit. Mr. Green only audits the accounts. When you get a monthly audit you can see where you stand. That is the reason why Mr. Griffiths gets 50 guineas and Mr. Green 25 guineas.

It was then proposed, seconded, and carried,

"*That Mr. Arthur E. Green be re-elected an auditor of the Company, at the same remuneration as before.*"

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The SECRETARY then read the notice convening the extraordinary general meeting, at which it was intimated that the following resolution would be proposed as a special resolution :—

"*To terminate the management by this Company of the business now carried on by it in Austria for the Telephone Company of Austria (Limited), and for winding up such business.*"

The CHAIRMAN : I should like to say two or three words, as this is, perhaps, slightly confusing to some of the shareholders. There is in the balance-sheet a sum standing of £127,245. 11s. 10d. That is the amount that has been spent in Austria on the telephone business there. The reason that is put in the balance-sheet "Agency account—Austria," is this, that in the year 1882, when this concession was undertaken, a company called the Telephone Company of Austria was formed. The Consolidated Company had bought the concession, and they handed it on to the Telephone Company of Austria. By Austrian law, each company working a business in Austria has to be recognised by the State. The Austrian Government declined to recognise the Telephone Company of Austria—I believe mainly on the ground that there was no capital. The Consolidated Company they accepted as a company to work that business, with the result that the Consolidated Company did the work of the Telephone Company of Austria from that date up to 1885. In 1885 we, the Board of the Consolidated Company, thought it would be better for the Austrian Company to manage its own business. It has done so ever since, and the result of that is that we have at last got a recognition for this Telephone Company of Austria by the Austrian Government. This resolution is merely to enable the old Consolidated business, which has been practically defunct for three years, to be put an end to legally. There are no figures involved in it, and no payment of expenses or anything.

The SECRETARY then read a long list of resolutions for dealing with the proposal in question.

The CHAIRMAN : You have heard this long string of resolutions read to you. You will have them all put together, I presume. I beg to propose that they be accepted.

Mr. GREWING seconded the motion, which was declared carried unanimously.

The SOLICITOR : Before you leave, perhaps I should mention that there is a slight error in the notice sent out with respect to the confirmation of this resolution. There is a little ambiguity in the Articles of Association as to special resolutions and special business, and the Secretary has given you notice, as if this were a special resolution requiring confirmation. That is not so. It is special business, that cannot be transacted at an ordinary meeting ; but the present vote is quite sufficient.

The CHAIRMAN : That concludes the business of the meeting.

Mr. WARD : Do you intend to send a report of this meeting to the shareholders, because what has just now passed is very important, and I think that all the shareholders ought to know it ? I have now to propose a vote of thanks to the Chairman and Directors for the able manner, and I think the satisfactory manner, in which they have conducted the business of the Company in the past year.

Mr. GERMAINE seconded the motion, which was carried unanimously.

The CHAIRMAN : I am very much obliged to you. I think as to the suggestion of Mr. Ward that it is desirable that we should send round a report of the meeting, and it shall be done.

The proceedings then terminated.

Institute of Medical Electricity (Limited).

The first ordinary general meeting was held at Essex Hall, Essex-street, W.C., on 7th inst. Mr. W. Lant Carpenter was voted to the chair. He said that though the meeting was called in accordance with the requirements of the statute, they had but little to report, since they had been obliged to delay the opening of an establishment in London. This was mainly owing to certain negotiations with the Royal College of Physicians (which he hoped, however, would soon be satisfactorily completed), having reference to the appointment of medical officers to the institute. The Directors had given considerable attention to the business of the institute, having held sixteen meetings since the Company was registered. Mr. F. L. Rawson, M.S.T.E. and E., had joined the Board, and it had been unanimously decided that no Directors' fees would be accepted until a dividend of six per cent. per annum should have been declared.

The meeting cordially approved the action of the Directors with reference to the Royal College of Physicians, and a resolution was passed confirming an agreement provisionally entered into by the Board, whereby the institute acquires the business of the Electrified Rooms Company of Southsea. This had been carried on for more than a year, with the warm approval and support of above forty local medical men, upon a similar principle to that adopted by this institute, viz., that no electrical treatment is administered to any patient without the concurrence, and upon the prescription, either of his own medical man or of the medical officer of the institute.

NEW COMPANIES REGISTERED.

D'HUMY CABINET BATTERY SYNDICATE (LIMITED).—This company was registered on the 4th inst., with a capital of £15,000, in £250 shares, to acquire and work the invention patented by P. R. de F. D'Humy, for domestic electric lighting, called "The D'Humy Cabinet Battery." The subscribers are :—

	Shares.
James Davidson, 8, The Avenue, Upper Norwood	1
W. W. Prole, Croyde, Devon	1
J. Johnstone, 14, Manor-place, Paddington-green	1
F. D'Humy, C.E., 2, Carlton-mansions, Clapham-rise	1
J. T. Browne, C.E., 32, Rue Baudin, Paris	1
B. H. Hertslet, Belle Vue House, Richmond	1
F. B. Lidstone, 58, Warwick-rd., South Kensington, land agent	1

Registered without special articles.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 8th, 1888, were £4,311.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 8th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,606.

RE SHACKLETON HALLETT.—The case of this bankrupt came before Mr. Registrar Hazlitt on the 9th inst. The bankrupt, a barrister, of Hare-court, Temple, has practised since 1864, and in 1882 purchased the business of William Elmore, electrical engineer, and afterwards established the Electric Company at a cost of about £10,000, which he partially borrowed. He sold the business about 1884, including certain patents, to a company named "William Elmore (Limited)," his share of the consideration being about £33,000 in shares and cash. The company is now in liquidation, and the present value of the shares uncertain. He attributes his failure chiefly to that circumstance and to losses by money lent. The unsecured liabilities are returned at £1,947. 8s. 9d. and assets *nil*. The first meeting of creditors is fixed for this day (Friday).

PATENT

SILICIUM BRONZE AND SILICIUM COPPER WIRE.

The best for overhead Telephone and Telegraph Lines,

AND ALL ELECTRICAL PURPOSES.

Hard Drawn High Conductivity Copper Wire.

ROLLED AND DRAWN

PHOSPHOR BRONZE.

PHOSPHOR BRONZE

BEARINGS, BUSHES,

AND OTHER PARTS OF

ELECTRICAL MACHINERY.

SOLE PROPRIETORS of the British, Indian and Colonial Patents,

THE PHOSPHOR BRONZE COMPANY (Limited),

87, Sumner Street, Southwark, London, S.E.

WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, June 13, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending June 13, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	36½ 37½	3 11 6	Jan., Apr., July, Oct.	37	36
2,614,820	Stock	10/0	Do. Preferred	60½ 61½	4 9 2	,, ,,	62	60
2,614,820	Stock	nil.	Do. Deferred	11½ 12	...	February	11½	11
130,000	£10	3/0	Brazilian Submarine	12⅝ 12⅝	4 15 0	Mar., June, Oct., Dec.	12⅜	12⅜
16,000	10	8/0	Cuba Submarine	13 13½	5 18 9	February and August	13⅜	...
6,000	10	10/0	Do. Preference	18½ 19½	5 2 6	,, ,,	...	..
12,931	5	2½%	Direct Spanish (£4 paid)	3½ 4	8 10 0	March & September	...	...
6,000	5	5/0	Do. Preference	8½ 9½	5 5 3	April and October	9⅜	9
60,710	20	2/0	Direct United States	8⅜ 8⅝	4 11 6	Jan., Apr., July, Oct.	8½	8⅜
380,000	10	2/6	Eastern	11½ 12	4 11 9	,, ,,	12	11½
70,000	10	3/0	Do. 6 per Cent. Preference	14½ 15	3 19 0	,, ,,	15	14⅜
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	...	...
250,000	10	5/6	Eastern Extension	12⅝ 13⅛	4 19 3	Jan., Apr., July, Oct.	13⅛	12⅞
22,050	10	8/3	German Union Telegraph and Trust	9 9¼	7 7 4	January and March	...	...
179,177	10	2/0	Globe Telegraph and Trust	5¾ 6	5 4 3	Jan., Apr., July, Oct.	5 1/16	5½
178,992	10	3/0	Do. 6 per Cent. Preference	13¾ 14	4 5 0	,, ,,	13 15/16	13⅝
150,000	10	7½% '87	Great Northern	14 14½	5 6 3	Jan., July, and April	14¼	13⅞
17,000	25	37/6	Indo-European	36 38	6 11 9	April and October	...	...
38,948	10	3%	London Platino Brazilian	5¾ 6¼	...	May and November	...	...
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	...	...
338,225	Stock	15½%	Submarine	140 150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America	6 6½	8 0 0	January and July	6 7/16	6¼
150,000	100	8%	Do. Debentures	112 117	6 16 2	June and December	...	...
88,321	10	nil.	West India and Panama	⅞ 1⅛	...	...	1 1/16	...
34,563	10	*10/0	Do. 1st Preference	10½ 11	8 12 8	April and October	10⅝	...
45,181	15	9/0	Western Brazilian	9⅞ 10⅛	6 2 9	March & September	10 3/16	10⅛
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	⅝ ¾	5 0 0	Yearly	⅝	...
220,000	£1	...	Oriental (11s. paid)	¼ ⅜	...	...	...	...
80,000	5	5/0	United	14¼ 14½	4 6 8	June and December	15⅛	14 5/16
50,000	5	2/6	United River Plate	5 5⅛	...	April and October	5 1/16	5 3/16
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb. '86	Anglo-American Brush (£4 paid)	2½ 3	...	...	...	...
23,692	5	nil.	Do. (fully paid)	3½ 4	...	February & August	3½	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2 2¼	...	...	2⅜	...
312,000	½	5% '86	Maxim-Weston	1/16 2/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39½ 40½	5 18 4	March and July	40¼	39¼
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 3	February & August	17¼	16 13/16

* On account of arrears of dividends.

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

BOARD OF DIRECTORS.

The Right Hon. Sir H. J. SELWIN-IBBETSON, P.C., Bart., M.P., *Chairman.*
LORD CLAUD J. HAMILTON, M.P., *Deputy Chairman.*

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ERNEST NOEL, Esq.
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J. DENISON PENDER, Esq.
The Right Hon. LORD SUDELEY, P.C., F.R.S.
LEOPOLD SALOMONS, Esq.
JOHN C. SALT, Esq.
C. A. WHITMORE, Esq., M.P.

Offices—**WINCHESTER HOUSE, OLD BROAD STREET, LONDON, E.C.**

The principal objects of the Corporation are :—

1. Performing the duties of Trustee, Executor and Administrator.
2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the duties of the family solicitor.

The Corporation acts as Trustees for the Debenture Holders in Public Companies.

For terms, &c., application should be made to the General Manager at the Company's Office.

GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 527.—Vol. XXI. FRIDAY, JUNE 22, 1888. Price 4d.

NOTES.

Very little consideration has yet been given—in this country, at any rate—to the question of electric traction on a series or constant current circuit. In America, as our readers will probably recollect, this principle has been adopted and worked out by Mr. S. H. Short. A description of the method will be found in *The Electrician* of April 29, 1887. Since that date, however, we believe that important improvements have been effected, and we have also reason to believe that the system will shortly be brought more prominently before English electricians and engineers. Under these circumstances additional interest is imparted to the paragraph in the letter of our New York correspondent in the present issue, in which he summarises the statements made in a recent controversy between Mr. Short and Mr. Sprague. The discussion would have been more instructive, perhaps, if each of these gentlemen had been less eager to depreciate the methods of his rival. It is questionable, for instance, whether Mr. Short has any right to say that Mr. Sprague would find it "practically impossible" to run 30 cars at once on the parallel system. Still less do we think that Mr. Sprague is justified in asserting that Mr. Short would require 2,450 horse-power to operate a line which he himself works with only 200 horse-power. However, these are questions upon which, as we have hinted already, we may shortly have an opportunity of forming a more definite opinion. Meanwhile, whatever other merits or demerits may be ascribed to Mr. Short's system, it is interesting to note that it possesses this highly important feature, namely, that the conductors are completely insulated throughout the greater portion of their length. In this respect it resembles the system with which Mr. Lineff has recently obtained such good results on the West Metropolitan Tramway.

In our issue of April 27 last we gave an illustration taken from a photograph of the clothes of a labourer (now in the possession of the Royal College of Surgeons) which were completely stripped from the body of a man by a flash of lightning, the man himself sustaining no personal injury. An almost identical case is now reported from America. The particulars will be found in a Note further on, taken from the *Scientific American*. That journal also gives an engraving taken from a photograph of the clothing, which has been reduced to the same condition of rags and tatters as in the earlier instance. Unfortunately, in this case the victim sustained severe injuries, from which he took some months to recover. It seems reasonable to suppose that in each of these cases the clothing had been soaked through by the rain, and thus formed a better conductor than the body; possibly there may also have been a condensing action between the adjacent layers which occasioned the disruptive effects.

Apropos of this subject we publish to-day the first of the two lectures recently delivered by Dr. Oliver Lodge before the Society of Arts, on the protection of buildings from lightning. We have previously commented upon the extreme value and interest of these lectures, and we have referred briefly to some of the remarkable experiments with which they were accompanied (*Electrician*, March 23, 1888). The text of the lectures has not hitherto been available pending their publication in the *Journal* of the Society. We may add that we have learnt with pleasure that it is probable that the lectures will eventually be republished in book form, with considerable extensions.

The fertility of Mr. Edison's inventiveness, and the zeal with which his patents were planted in every part of Europe, as well as in his native land, appear to have resulted rather disastrously in one or two instances. A test case, and one which will determine a great number of other important suits now pending, has just been decided against him in the United States Circuit Court, on the ground that his Austrian patent having expired some years ago the American patent was thereupon extinguished. About a dozen of the Edison patents relating to dynamos and incandescent lamps are affected by this decision. Some of the points are fundamental; and, according to information reaching us from the States, the manufacture of incandescent lamps is there practically thrown open to the public. But the final stage of litigation has probably not yet been reached.

The report furnished by Messrs. Alabaster, Gatehouse and Co. upon the Weymersch battery (the text of which will be found further on), justifies the belief that the depolarising fluid discovered by M. Weymersch is capable in a zinc-carbon battery of giving results of a very remarkable character. With a discharge of about 10 amperes, equal to a current density in the cell of 0·12 ampere per square inch, it was found that the E.M.F., current, internal resistance, and temperature of the cells remained practically unaltered during a period of 31 hours, after which the test was discontinued. Still more remarkable is the fact that the consumption of zinc is not more than 10 per cent. in excess of the equivalent of the electrical energy evolved. A battery capable of giving such results as these in ordinary

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practice would be a very valuable addition to our resources for laboratory work, and even perhaps for electric lighting on the smallest scale and under circumstances where the frequent handling of acids is unobjectionable. We must, however, be permitted to add that we see no reason whatever to believe that the advent of this cell portends a revolution in domestic electric lighting, or that the invention possesses any extravagant value as a financial investment. We shall hope to find that the proprietors of the patent are content to rely upon the genuine merits of the invention to win the position to which it is legitimately entitled without enlisting the meretricious aid of the prospectus maker and the company monger, with abnormal ideas as to the capital required for its exploitation.

SHAREHOLDERS in the Maxim-Weston Company have so much cause for lamentation that nobody will begrudge them the amusement they tried to get out of the proceedings at its meeting last Friday. But for the assurance of the Chairman that the conduct of Mr. WATT towards Mr. SWABY was the "funniest thing in the City," and the laughter which followed the recital, we should have failed to see where the fun came in. If, however, the Mark Tapleys of the City can be jolly under such depressing circumstances, it is about the only consolation left them. The Committee of Investigation, as a last resort, propose to augment the directorate which has dwindled down to two persons, neither of whom inspires perfect confidence. When the five new directors are elected a lively time may be expected for them. At present Mr. HUGH WATT and Mr. LOUIS SWABY are the couple installed as caretakers of the Maxim-Weston property; and the master-mind in this situation being Mr. WATT, poor Mr. SWABY is alternately kicked out and restored to favour, according as he coquets with the shareholders or resumes allegiance to his better half. Meanwhile we notice that advertisements are appearing in the daily papers concerning the "*celebrated* Watt arc lamp and dynamo machine." Celebrated, in a sense, they certainly are likely to become, but it is nevertheless difficult to find anyone who can explain what they are celebrated for just at present.

THE new "Technical Instruction Bill" which has just been circulated in the House of Commons is a great improvement on the one proposed and withdrawn last year. Although excluding the teaching of any particular trade or industry, the present Bill accepts the term "manual instruction," including instruction in the use of tools and modelling in clay, wood, or other materials, instead of limiting the term technical instruction to those branches of instruction for which grants are awarded by the Science and Art Department. The proposal for putting the question to public vote has been dropped; and each board or district is to be empowered to adopt the system forthwith on the passing of the Bill; one condition, or rather restriction, being, however, that the expenditure on technical instruction as above defined shall not in any one year exceed a rate of 1d. in the pound. Perhaps the most valuable improvement is that which extends, under certain conditions, the provisions of the Bill to voluntary schools, in which, as a matter of fact, about 40 per cent. of the national education is conducted.

IN reference to the device for effecting telephonic communication between ships at anchor and the shore, which was described in our last issue, our attention has since been drawn to a communication made to a contemporary journal by Mr. F. HIGGINS in December, 1881, in which substantially the same device is described. The idea of terminating the submarine cable at a fixed buoy, and carrying thence a smaller line to the ship, is common to the two schemes. Mr. HIGGINS was, however, chiefly concerned with the permanent connection of lightships, and he proposed that when the ship had a single mast the line should be carried from a drum upon the deck up a channel in the side of the mast and over a swivel pulley at the top, passing thence to a light mast fixed upon the buoy. When the ship had more than one mast Mr. HIGGINS proposed to mount the drum upon a rail running round the ship, so that it could be shifted by hand as the vessel swung with the tide. For temporary connections it would appear from Mr. TODD'S letter that it is only found necessary to pay out some slack wire. If the wire breaks between the ship and the buoy very little mischief is done.

MR. P. DELANY having recently suggested that electric light linemen might to some extent be protected from shocks by wearing metallic wristlets and anklets connected together by a flexible wire worn under the coat sleeve, Mr. C. W. S. CRAWLEY and Mr. H. NALDER have made some measurements of the relative resistance of the two paths thus opened to the current. These will be found further on. It must be observed that the device cannot be of any value unless it should prove that the resistance from the interior of the wrists through the epidermis (that is to say, *two* thicknesses of skin) is less than that through the arms and across the chest. Mr. DELANY expressly stated that he had made no experiments upon this point, and much as we should have liked to believe that his plan would prove efficacious, it did not seem very likely that the above conditions would hold good. The result of the experiments—made, of course, with low voltages—seems to bear out the conclusion that when the current has once entered through the skin of the hand, and has to make exit by the other hand, it finds a path of lower resistance through the body than through the skin of the two wrists, even when the latter is well moistened. We are open to receive further evidence on this point; but meanwhile it seems necessary to deprecate the use of this device in actual practice with high tensions, lest it should lead to a feeling of false security, and so directly tend to increased danger. Meanwhile, the electrical industries, both in this country and in America, may well be congratulated on the remarkable brevity of the list of fatalities which they have occasioned. We very much doubt whether an equivalent amount of energy has ever been employed in any known form for an equal length of time with so few victims.

THE following paragraph appeared yesterday in all the leading daily papers:—"The Council of the British Association of Medical Electricians have appointed Mr. C. B. HARNESS, consulting medical electrician, President of the Association." The day previously an advertisement of the "Electropathic Belt" filled a whole page in the *Daily Telegraph*. Mr. HARNESS has

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thus far successfully defied the efforts which have been made to awaken the public mind to a sense of the true character of his pretensions. Not even the admirable and thorough *exposé* which appeared some little while ago in the columns of our contemporary the *Electrical Review* has had any perceptible effect. It has always appeared to us, however, that this is far more a question for the medical than for the electrical profession, and while we can quite understand that, as a general rule, the medical press prefer to treat advertising quacks with silent contempt, yet, when it comes to the foundation of a regularly organised school of quackery, we venture to think that the time has arrived when the representatives of the legitimate profession should depart from their usual attitude of reserve.

A CORRESPONDENT, writing from Rangoon, sends us a cutting from the Calcutta correspondence of the *Rangoon Gazette*, from which we gather not only that the wealthier natives of India are awaking to the advantages of the electric light, but also that English electricians in India are threatened with native competition. In the case before us, however, the results were of a singularly unhappy character, and are not at all calculated to inspire confidence in native talent. The fact that the armature of a dynamo may be driven round either by a steam engine or by means of a sufficiently powerful battery has evidently impressed itself upon the native mind, but his technical education has not yet proceeded far enough to enable him to discriminate between the two cases, or when one should be used in preference to the other. Original ideas are also entertained with regard to the most suitable means of support for primary cells. However, we had better let the *Rangoon Gazette* tell its own story:—"A wealthy native gentleman, on the occasion of some marriage festivities last Tuesday, contracted with a native electrician for the illumination of his house. A large dynamo was set up, *and in place of an engine to work it, eighty Grove's cells were used.* The cells were placed upon a tucktaposh (native bedstead), *which was raised on coolies' heads, relays of coolies being employed in supporting the platform.* They were engaged for three hours, and the result was that eight of the men were seriously affected by inhaling the fumes of the nitrous oxide gas given off by the cells. Two died on Wednesday and six others are in the hospital in a more or less critical condition. Why such a dangerous and foolish method was observed is not clear." The end of the story is too tragic and pitiful to make fun of, but we should like to have been told how the lights worked, and also *why* the cells were placed on the heads of coolies. Was it for the look of the thing, or to prevent other people from smelling at them, or to let the current flow down-hill to the dynamo?

Vienna.—We understand that the Anglo-American Brush Corporation has obtained a concession for the establishment of a central lighting station in Vienna.

Omnibus Lighting.—Some fifty cars belonging to the London General Omnibus Company have been fitted by way of experiment with incandescent lamps, run off small secondary batteries.

Indian Telegraphs.—A Reuter's telegram from Bombay states that, owing to the fall in exchange, the rates for foreign telegrams to Europe will be increased by three annas a word on the 1st of July.

The Electric Lighting Act (1882) Amendment Bill.—This Bill was read a third time in the House of Commons on Thursday, June 14th, and on Monday, June 18th, the Commons' amendments were agreed to by the Lords.

Evora, Portugal.—The Lisbon papers state that a contract for lighting the town of Evora by electricity has just been sanctioned without discussion in the House of Peers. Evora is a town of 100,000 inhabitants, in the Province of Alemtejo.

Electrical Automatic Machines.—We are informed that the Nightingale Automatic Electrical Machine Company (Limited) have placed an order for 500 machines with the Vulcan Manufacturing Company, electrical engineers, Rocliffe-street, Islington, N.

Society of Telegraph-Engineers and Electricians: The President's Conversazione.—Invitations have been issued by the President of this Society and Mrs. Graves to a conversazione at the Royal Institute of Painters in Water Colours, 191, Piccadilly, on the 10th July, at 9 p.m.

Kensington.—Messrs. Verity and Sons have just completed an installation of the electric light at the Kensington Parish Church. The chancel is lighted by means of thirty 16 candle-power lamps, and there are 200 lamps of the same size in the nave. The current is supplied by "The Kensington Court Electric Lighting Company."

Berlin.—The Berliner Electricitätswerke has issued the following tariff for the supply of motive power from central stations. The tariff is based upon a utilisation of not less than 3,000 hours per annum:—

Horse-power	1.	2.	3.	5.	8.	12.
Price per hour in shillings	0·38	0·72	1·05	1·7	2·64	3·98

The Electric Light in Trains.—The example set by the London, Brighton and South Coast and the Great Northern Railway Companies in trying the electric light in a few of their trains is, we believe, to be followed by the Midland. But while it has been applied by the Great Northern and Brighton to trains which are rarely broken up, we believe the Midland will endeavour to make each coach carry its own lighting power. Some of the Great Northern Company's trains which run over the Metropolitan lines have lately been fitted with Mr. Radcliffe's arrangement of dynamos, accumulators, and gearing.

Forthcoming Exhibition at Cologne.—An Exhibition will be opened in Cologne in September in connection with the sixty-first meeting of the German Scientists and Physicians, and the preparations are already well advanced. Applications for space must be made before June 30th, and all exhibits sent in by September 1st. There will be no charge to exhibitors for space or unpacking or repacking. Any article may be sold, but must not be removed before the close of the Exhibition. We understand that over 100 firms have already announced their intention of exhibiting, including a considerable number of English.

Bath.—A private meeting of the principal citizens of Bath (who are also the largest consumers of gas in the city) was held at the Grand Pump Room Hotel, on the 15th inst., when it was decided to take at once the necessary steps for the formation of a local company to supply Bath with the electric light for private and public use. It was decided to send in a tender to the corporation for the lighting by arc lamps of a central area, at a price that would pay 5 per cent. upon the capital employed. Mr. Massingham, who was present,

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promised to find £5,000 of the capital required, and also to assist the company in other ways.

Lighting of the ss. "Inanda."—Messrs. J. T. Rennie, Son and Co.'s new cargo and passenger steamship "Inanda" (London and Natal) has recently been supplied with sixty-five electric lights of 16 candle-power each. The current is supplied by a "Castle" dynamo, driven direct at 280 revolutions by a 6 horse-power (nom.) engine, supplied by Messrs. Tangye Bros., of Birmingham. The vessel is wired throughout with single lead and a "ship" return. The vessel also carries three cargo lanterns over each hatchway, with Sunbeam lamps of 200 candle-power each. The work has been carried out by Messrs. J. H. Holmes and Co., of 17, Coleman-street, and Newcastle-on-Tyne, under the superintendence of Mr. S. Crouch.

H.M. Telegraph Ship "Monarch."—Death of Captain Draper.—We regret to learn that the captain of the Government Telegraph Ship "Monarch," Mr. Draper, died of bronchitis, with which he was attacked while engaged in the recent cable-laying operations for the Post Office in the North Channel. Captain Draper expired on Sunday, the 3rd inst., at Belfast, where he had been landed for medical aid on the Friday previous. The deceased captain was 51 years of age, and had been in command of the "Monarch" since she was launched in 1883. He had previously commanded the "Dacia," and was a thoroughly experienced and careful navigator. His loss is greatly lamented by all who knew him.

Derby.—One of the principal features of the Industrial Exhibition, which has been held in Derby during the past fortnight, was the electric light exhibit of Messrs. John Davis and Son, of that town. The dynamo, which was a 4-unit "Castle" machine, was driven by a 3 horse-power "Stockport" engine, and the lamps exhibited comprised—one 2,000 candle-power "Castle" arc lamp; one 400 candle-power "Castle" arc lamp; one 400 candle-power "Sunbeam" incandescent, as well as some Edison-Swan 16 candle-power incandescents. The local gas company had offered reduced terms to the Exhibition on condition that no electric light should be allowed in the main hall, so that the lamps were confined to the entrance.

Perpignan.—The town of Perpignan will shortly be provided with a central lighting station. The town theatre is to be lit by 273 incandescent lamps of 10, 16 and 20 candle-power, at a contract price of 33fr. for each performance, which seems a remarkably low figure. Consumers having at least a three-months' agreement are charged 4 centimes per lamp-hour for a 10 candle-power lamp, 6 centimes per hour for a 16 candle-power lamp, and 7 centimes per hour for a 20 candle-power lamp. The consumption will be measured by meter if customers wish it. The renewal of the lamps has to be paid for in addition to this at the rate of 50 centimes per lamp per month, and the rent of the meters varies from 50 centimes to 3 francs 50 centimes a month, according to its size. The work is to be undertaken by M. Larny.

Edinburgh Town Council and the Electric Light.—At a meeting of the Edinburgh Town Council held on the 19th inst., the Town Clerk read a letter from the secretary of the Anglo-American Brush Electric Lighting Corporation with regard to the conditions imposed by the Town Council for permission to lay their conductors under the street for the electric lighting of Princes-street. The company thought that to enable them to go to the expense of laying conductors in the streets the contract should be for a period of not less than seven years, and representing that the rate proposed was too high, especially in view of the fact that they might not have a full demand for the first few years, and suggesting that the price should be reduced to 6d. per yard, or adjusted to a sliding scale. The matter was remitted to the Streets and Buildings Committee.

The Nordenfelt Torpedo.—A trial of the Nordenfelt electrically controlled torpedo took place on the Thames at Erith on Friday last in the presence of a number of naval and military authorities, foreign as well as English. The new torpedo measures 35ft., with a maximum diameter of 29in., its shape being that called cigar. Charged for action it weighs 6,200lb., its equipment consisting of 300lb. of explosive, which can be increased to 500lb., 120 electric storage cells, a motor weighing 780lb., and 3,000 yards of cable, which is played out as the boat travels. It is driven by a screw propeller and steered by a balanced rudder, the speed being 14½ knots. This weapon is intended for harbour or coast defence, and requires no prepared base to operate from, a small boat towing it to any required position, from which it can be electrically controlled and manœuvred in any direction and at any range within the limits of its cable, and exploded when its object is reached. The trial on Friday was entirely satisfactory. The electrical details have not been fully disclosed.

Electric Launches on the Thames.—We mentioned some time since that Messrs. Immisch and Co. proposed to establish a series of stations on the River Thames, by which current might be obtained for charging accumulators on electric launches. The first of these stations has now been completed on board a hulk which is at present moored in the river a little below Kew. On Saturday last Messrs. Immisch and Co. invited a party of friends to visit this station, and to make a trial trip in an electric launch, which has just been completed for service at this station. Previous to starting up the river the ceremony of christening the launch was performed by Mrs. Immisch, and the boat received the name of "Malden." A landing was effected at Eel Pie Island, where the company were entertained at dinner, and in the evening the party returned to the charging station, after an extremely successful and a very pleasant trip. We shall shortly give further technical details of the arrangements adopted.

The Copper Syndicate.—An American paper says that the French syndicate is not satisfied with binding the leading producers of copper throughout the world in a three years' contract not to sell under a certain figure, supposed to be 13c., but has now made contracts with copper consumers. In this way it hopes to protect both parties with a cast-iron rate which is remunerative to all parties. Referring to this last operation of the French syndicate, a contemporary says:—"The contract is for between £30,000,000 and £40,000,000 at 16·50c. The terms were originally for six months, but it is believed it has since been changed to four months; it is certainly not less than the latter. The syndicate agrees not to allow the price to decline below 16·50c. The consumers, on their part, can purchase what copper they want for consumption, but cannot resell upon the market, and as all ingots, cakes and bars are stamped, they can easily be traced, and the party found reselling can be held liable under the contract."

The Committee of the Royal Meteorological Society on Thunderstorms.—At a meeting of this Society, held on Wednesday evening, the 20th instant, the first report of the thunderstorm committee was read. This report deals with the photographs of lightning flashes, some 60 in number, which have been received by the Society. From the evidence now obtained it appears that lightning assumes various typical forms, under conditions which are at present unknown. The committee consider that the lightning flashes may be arranged

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under the following types:—1. Stream. 2. Sinuous. 3. Ramified. 4. Meandering. 5. Beaded or chapletted. 6. Ribbon lightning. In one of the photographs there is a *dark* flash of the same character as the bright flashes, but the committee defer offering any explanation of the same until they get further examples of dark flashes. As the thunderstorm season is now coming on, the committee propose to publish their report at once, along with some reproductions of the photographs by the autotype process, in order that observers may be prepared to notice the various forms of lightning.

Incandescent Lamp Experiments.—At a recent meeting of the Société Française de Physique, M. Mascart described some interesting experiments which he had carried out with a view of determining how far incandescent lamps might be a source of danger when in the immediate vicinity of inflammable materials. Some 32 candle-power incandescent lamps were tightly enveloped in cloth, others in wadding, with the gummed surface removed, and others, again, were placed in the folds of some old stage scenery; in no case was there any charring or undue heating. An extra thick cotton hood placed over a 32 candle-power lamp became charred wherever it was in contact with the globe after ten minutes had elapsed. A 32 candle-power lamp which was surrounded by a black silk hood and then by a black velvet one, set the latter burning gradually in six minutes. In another experiment two lamps were enveloped respectively in black and white wadding, from which the gummed surface had *not* been removed, and in two minutes charring commenced, both lamps burst, and the wrappings were set alight. Finally a 300 candle-power lamp was laid against some old scenery; in a minute and a-half the scenery began to char where the globe touched it, and slowly burnt without flame.

Acid or Resin for Wire Joints.—Our Boston contemporary *Modern Light and Heat* contains the following letter on the use of acid as a flux in soldering electric light wires. The writer is an inspector of the Boston Fire Underwriters' Union:—"I am often asked why I prefer acid to resin to solder joints in electric light wires, and, with your kind permission, should like to answer through your valuable medium. I do not prefer it, but think that we get better results from acid than resin. It is safe to say that only one out of ten knows how to make a good joint with resin, or if they do know they will not take the trouble. You, of course, know, as do many others, that the secret of joints made from resin is a perfectly clean surface. This, of course, requires some care, while with acid, if the wire has any oil or grease, or any of the insulation which the linemen have failed to scrape off, the acid will do the work which the workmen (by name, but not by nature) have failed to do. I have learned from experience that the wires eaten off by acid are so few that the danger of fire from such cases is less than those from poor joints with resin. I hope that some time in the future we shall have men that we can depend on to make joints with resin."

Catalogue of the Consolidated Telephone Construction and Maintenance Company.—The illustrated catalogue of the Consolidated Telephone Construction and Maintenance Company affords a tolerably complete exhibition of the telephonic appliances in use in this country. There was a period when the Patent Offices in this and other countries were reaping large revenues from the unceasing "invention" of "improvements" in telephonic apparatus, but owing, chiefly no doubt to the firm grip with which the holders of the Bell and Edison patents have maintained their hold upon the fundamental principles of telephony, the appliances at present in the market bear no traces of outside influence, the only surviving exceptions being those earliest in the field, such as Gower, Blake, and Hunnings. In view of the fact that the instruments made by the Consolidated Company are unquestionably efficient, to a degree approaching perfection, the fact is an instructive one. Several forms of switch-boards are illustrated in this catalogue which are well adapted for exchanges of moderate size, and are much cheaper than the "Multiple" board, though for installations of 1,000 subscribers and upwards nothing else has yet proved equal to the "Multiple." The Consolidated Company also make a good many specialities in the way of divers' and mining telephones, &c.

The Westinghouse Company and a New Incandescent Lamp.—The following statement appears in the *American Engineer*: M. de Routhamsky, secretary of the Russian Legation to the United States, was recently in Pittsburg, and spent several hours in consultation with Mr. George Westinghouse, jun., and other members of the Allegheny County Electric Light Company. In explanation of his errand he said: "I came here on behalf of a fellow-countryman, for whom I have just concluded an important contract with Mr. Westinghouse relating to incandescent lamps. My countryman has made a discovery which will probably have a greater influence on electric lighting than any of previous years. I am not at liberty to give the details of my transaction here to-day, but I will say this much, that the discovery relates to a filament to be used in incandescent lamps that is capable of standing so high a temperature that from two to four times as much light can be secured from a given expenditure of power as has been claimed by the Westinghouse and Edison Companies. The lamps which are supplied with those filaments will give more light for the horse-power than two arc lamps, and I think it is reasonable to look forward to the gradual displacement of the arc light. I think the effect on electric lighting will be very marked, as it will at once double the capacity of existing plants and will save 10 per cent. in fuel, which has all along been about one-third of the cost of operating."

Lighting of the Langham Hotel.—This magnificent building in Portland-place, which forms one of the finest hotels in Europe, has just been lighted throughout by electric light. Towards the end of last year the directors determined upon carrying out this important work, and requested some of the leading firms to send in tenders and give a detailed scheme as to how the work would be carried out, together with samples of all electrical apparatus proposed to be used, as well as designs of electroliers, pendants, brackets, or other devices proposed for lighting the different rooms throughout the building. It was eventually resolved to place the work in the hands of Messrs. B. Verity and Sons, of King-street, Covent Garden. The coffee room, which is the finest room in the building, is lighted by four rows of brass pendants, with large crackled glass shades, the inner row having three lamps, and the outer row two lamps each, making in all eighty lamps of sixteen candle-power. Next in importance comes the drawing or general sitting room, which is lighted by four handsome ormolu chandeliers in the style of Louis Seize, with crackled glass shades, the tops of the chandeliers having a star of gas jets for use in the event of a failure in the electric light. The same system is carried out in the ladies' room, gentlemen's writing room, smoking and billiard rooms, &c. The bed rooms are lighted throughout with one or more lamps according to size, as well as the private sitting rooms, these being lighted with electroliers of a neat and pretty design. In the whole of these rooms and also in the bed rooms the switches for controlling the light are placed by the

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side of the doors and have printed instructions over them as to their use in English, German, and French. The corridors are provided with pierced brass canopies and glass shades, suspended by crimson silk cords; also all the lavatories, &c., are lighted in a similar manner, together with all the kitchens, serving rooms, pantries, &c. The current is taken from the Grosvenor Gallery central station in Bond-street. The transformers, of which there are eight, are placed in a specially constructed building in the yard at the rear of the hotel, and the secondary cables are run from thence to the different floors. Altogether there are at the present time 1,400 lights; the whole of the cables and wires (of which there are many miles) have been manufactured especially for the purpose, as have also the different switches, safety fuses, electroliers, pendants, &c. The whole of the work has been completed in four months, and, considering the substantial character of the work, it constitutes one of the quickest jobs on record. The works were carried out under the direction of Mr. J. Elwin Coles, the manager, and also Mr. J. G. S. Cunnington, the electrical engineer, of B. Verity and Sons.

A Remarkable Escape from Lightning.—The *Scientific American* contains a letter from Mr. John De Motte, of De Pauw University, which furnishes the second instance on record of a man having his clothes destroyed by lightning without fatal results to himself:—"The narrowest escape from death by lightning of which I have ever heard came to my knowledge while lecturing a few weeks ago at the Florida Chautauqua. The drug store, which is used as a post-office by the good people of De Funiak, stands between the railroad station and their beautiful little lake. At the time to which I refer it was 'protected' by a common-sized twisted copper-band lightning rod, with iron core, fastened to the house by glass insulators in the old-fashioned way. Several other houses in the town were 'rodded' in the same way; but after this one was so badly shattered they were torn off by their owners, 'to lessen their chances of getting struck, you know,' they explained. About a hundred feet back of the post-office stood two fine specimens of the tall pines which grow so abundantly in that region. On the afternoon of the 18th of last August, at about one o'clock, a number of boys and men had collected under the post-office porch, thinking, on account of the lightning rod, that they would be safe from the lightning, which was playing rather freely from an only partially cloud-covered sky. Among them was John Chisholm, a merchant of De Funiak, who was sitting about half way between the corner post of the porch and the nearest window. The lightning struck the two high pines, and, after shattering their tops, leaped to the rod, completely melting its points, and then, running along the comb of the roof to the gable and down a corner, demolished that portion of the building. Mr. Chisholm's only recollection of the stroke is a sensation like that of a heavy blast of hot air striking him between the shoulders. He was thrown forward upon his face and taken up for dead. His shoes and trousers were left looking very much as if they had been attacked by an army of hungry rats. How a man could have his clothes chewed off from him by lightning in that style and still live is a mystery. His shirt was torn entirely in two. His body was badly blistered, especially from the knees down. Becoming conscious, he experienced a terrible feeling of suffocation and 'heartache, as though it would burst.' He remained helpless for four months, suffering terribly from an aching in the bones and stinging sensation, 'as though a thousand needles were being stuck all over my body.' Now, after a lapse of over nine months, Mr. Chisholm has gradually recovered the use of his limbs, only suffering from an occasional violent involuntary jerk in the back. Several others sitting near were, of course, more or less shaken up. Dr. Allred caught a part of Mr. Chisholm's charge in his foot, and went on crutches for some days."

The Melbourne Centennial International Exhibition—The arrangements for the lighting of the building of this Exhibition with electricity are well under way. The Australasian Electric Light, Power, and Storage Company hold the contract for the exhibition building and the main annexes, and they are following closely on the heels of the builders and the decorators. The whole of the leads for the arc lights have been fixed, and are ready for the lamps. To give some idea of the magnitude of this part of the work, it may be stated that about 27 miles of leads have been used. To the casual observer, however, very little of them can be seen, care having been taken to keep them out of sight as much as possible, and to avoid ugly festooning of the wires. The installation is being carried out under the personal supervision of Mr. R. E. Fletcher, the company's electrical engineer, who also carried out the lighting of the Adelaide Jubilee International Exhibition last year. The Brush arc and Victoria incandescent dynamos and lamps are used throughout. The lighting of the Melbourne Exhibition will exceed anything of the kind that has hitherto been attempted in our own country. The contract is for 825 10-ampere Brush arc lamps and 2,000 16 candle-power incandescent lamps, with the necessary dynamo machines, conductors, fittings, &c. There will be 37 Brush dynamos, each capable of supplying current to 23 Brush arc lamps, and 7 Brush-Victoria dynamos, each supplying current to 350 Swan incandescent lamps. Power for driving the machines will be supplied by six horizontal engines, coupled in pairs, each pair capable of giving about 500 horse-power. Steam for these engines will be supplied from 12 boilers. Every precaution is being taken against a failure of the light. The countershaft is divided into several sections, and any of the dynamos or engines can be stopped without interference with the others. The arc lamps will be arranged so that no two lamps supplied with current from the same machine come together. Half the lights could be extinguished without causing any serious inconvenience, as the buildings would still be better illuminated than with gas. In the main building, the dome, naves, and transepts will be lighted with Brush arc lamps, and the picture galleries, wine cellars, the space under the galleries in the main hall, the aquarium, retiring rooms, offices, &c., will be lighted with incandescent lamps. In the annexes the Brush arc lamp will also be employed. The total area to be lighted is as follows:—Arc lighting, 943,135 square feet of floor space, or about 1,144ft. per lamp; incandescent lighting, 119,000 square feet floor space, about 58 square feet per lamp. The seven incandescent dynamos are compound-wound and will be joined up in parallel. This makes practically one machine of the seven, the work being distributed evenly amongst them all, but with the advantage that one or two of the machines could be disconnected from the circuit in a few seconds if necessary. There is every prospect of the electric light being ready five or six weeks before the opening of the Exhibition, provided the engines and boilers, which are being made by various firms in Melbourne, can be supplied in time, of which there seems to be every probability. Messrs. Ganz and Co. are to light up the reception rooms with about 290 incandescent lamps of 16 candle-power, and the armament court and part of the machinery annexe, covering about 30,000 square feet of space, with 30 arc lamps, the whole of which will be worked by Zipernowski-Déri transformers. Messrs. W. H. Masters and Co. have made an offer to light the western machinery annexe with 78 arc lamps of 2,000 candle-power, but the contract has not been let.

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UNIPOLAR INDUCTION.—III.

BY G. W. DE TUNZELMANN, B.SC.

(Continued from page 171.)

The first to employ an electro-magnet to exhibit the phenonema of unipolar induction was E. Hoppe, whose apparatus is described in a Paper published by him in Vol. XXVIII. of Wiedemann's *Annalen*, 1886.

In a Paper published in the *Sitzungsberichte der Wiener Akademie* in July of the same year, Exner and Czermak described some experiments made by them in which they also used an electro-magnet.

Their apparatus consisted of a cylindrical bar of soft iron, one half of which was surrounded by a magnetising helix, and the other by a metallic jacket. When the ends of the jacket were connected with a galvanometer, the results obtained were similar to those obtained with Fessel's apparatus, with which it was practically identical. These two physicists then investigated the current in the jacket without using a fixed conductor. As it was impossible to use a galvanometer for this purpose, they devised the plan of connecting the ends of the jacket with the axis of rotation through a silver voltameter placed inside the jacket, and rotating with it. The induction current produced in the jacket caused polarisation in the voltameter, and this polarisation was tested without stopping the rotation by disconnecting the terminals of the voltameter from the ends of the jacket and placing them in connection with the terminals of a galvanometer, when the polarisation produced a momentary deflection of considerable amount in the galvanometer, and a smaller permanent deflection.

In one experiment the electro-magnet was rotated at a constant speed, while the jacket remained at rest, and at the end of a quarter of a minute the polarisation was tested and gave a swing of 145 scale divisions. The jacket was then made to rotate at the same speed and for the same time, when a swing of 143 scale divisions was obtained, so that the two results were as nearly identical as could possibly be expected. When the magnet and the jacket were rotated together, the swing obtained was only 0·8 of a scale division, so that there was practically no effect.

The ends of the jacket were then connected directly through the voltameter by means of a wire, and it was found that no current was produced when the jacket and the wire rotated together about the magnet, or when the magnet was rotated while the jacket and wire remained at rest.

All the experiments which we have described will be found to be very simply explained by the law of electro-magnetic induction, discovered by Faraday, that *the total E.M.F. induced in a closed circuit moving relatively to a magnetic field is equal to the rate of decrease in the number of lines of force which pass through the circuit*, provided we make the assumption that the system of lines of force, or the magnetic field of a magnet, rotates with it.

In our next article we shall consider the physical meaning of this assumption.

In order to understand clearly the application of this law to the different experiments which have been described, it may be well to recall some properties of magnetic lines of force which are summed up in the law of induction just stated.

A line of force is a vector quantity—that is to say, if it is turned end for end, its action is reversed. The positive direction is usually taken to be the direction in which a free north pole would tend to move along a line of force.

As a line of force passes through a closed circuit from the outside to the inside, or *vice versâ*, it sets up an E.M.F. along the circuit.

If the line of force passes from the inside to the outside of the circuit the E.M.F. produced is such as to cause a current passing round the circuit in the direction of the hands of a watch placed so that the positive direction of the line of force passes through the watch from the face to the back.

It follows from the vector nature of the lines of force that if a positive and a negative line pass through the circuit in the same direction, the currents produced will be in opposite directions, so that the total current will be zero. When, therefore, we speak of lines of force crossing the circuit continuously in the some direction, we mean that the lines are all of the same sign, and that they all pass either from the inside to the outside of the circuit, or *vice versa*.

It is clear that when a magnet having its axis fixed is made to revolve relatively to a fixed external circuit, no current can be produced, for the number of lines of force which pass into the circuit during any given time must be equal to the number which pass out of it during the same time. In other words, every line of force will cut the circuit twice in opposite directions.

When the terminals of a fixed circuit are connected with the two poles of a magnet revolving about its axis, it is also clear that no current will be produced, because for every positive line of force, coming from the north pole of the magnet, which crosses the circuit in a given direction, a negative line of force coming from the south pole of the magnet will cross it in the same direction.

In the experiment of Fig. 1 the disc C is continuously cutting the lines of force in the same direction, and no lines of force are cut in the opposite direction, so an E.M.F. will be produced acting along the radius of the disc.

In the experiments Figs. 2 to 8 the central portion of the magnet itself takes the place of the disc, and the reason that the strongest current is produced when contact is made near the centre of the magnet is that in that case a larger number of lines of force cut the circuit as the magnet revolves relatively to it.

In the experiments Figs. 10 and 11 the number of lines of force crossing the circuit in one direction is greater than the number crossing it in the other, and therefore a current is produced.

With respect to the experiments in which a jacket is used, it will be convenient to summarise the results already obtained.

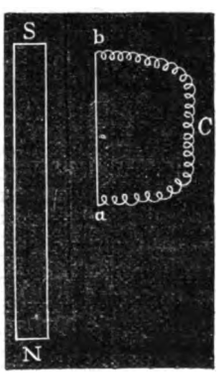

FIG. 12.

Let N S (Fig. 12) be a cylindrical magnet, which may be either a permanent steel magnet or an electro-magnet. Let *a b* be the section in the plane of the paper of a metallic jacket surrounding, and concentric with, the axis of the magnet. Let *a c b* be a metallic wire with its ends in contact with the upper and lower edges of the jacket respectively. The results obtained may then all be included under one of the following heads :—

1. If the jacket only rotates a current is set up round *a c b*, which is reversed in direction when the direction of rotation is reversed.

The current is produced by the lines of force crossing the jacket continuously in the same direction, while no lines of force cross the rest of the circuit.

2. If the magnet and the jacket rotate together a current is obtained of the same strength and in the same direction as before, due to the lines of force crossing the wire *a c b*, while the jacket remains, relatively to them, at rest.

3. If the magnet rotates while the jacket and wire remain at rest there will be no current, for as the lines of force cross both portions of the circuit in the same direction there is neither increase nor decrease in the total number passing through the circuit, and therefore no E.M.F. round the circuit.

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4. If the magnet remains at rest while the jacket and the wire rotate together there will be no current, the relative motions being the same as in case 3.

5. If the magnet and the wire rotate with the same angular velocity while the jacket remains at rest a current will be produced by the lines of force crossing the jacket.

6. If the wire *a b c* is removed and the edges of the jacket are joined to the axis, then if the magnet is made to rotate while the jacket is at rest, or if the jacket is made to rotate while the magnet remains at rest, a current will be produced by the lines of force crossing the jacket continuously in the same direction.

(To be continued.)

THE PROTECTION OF BUILDINGS FROM LIGHTNING.*

BY DR. OLIVER LODGE.

One hundred and fifty years ago the nature of lightning was unknown. Several persons surmised that it had some connection with the phenomena excited in a piece of glass tube when rubbing it, phenomena which were called electric; but no proof of the connection was attempted. The proof that lightning was, in fact, nothing but a large electric spark was given, as you know, in 1751, by that marvellously comprehensive and commonsense genius, the Philadelphia printer, Benjamin Franklin.

This great man, a statesman of the first magnitude, might have made one of the first experimental philosophers, had he lived in quieter times instead of having to take a prominent part in the Declaration of Independence and in the great American War. A space of some twelve years limits his active devotion to electrical matters, but in that time he acquired a masterly grip of the subject, expressing himself very accurately and precisely concerning electrical theory, his statement of which is far superior to a great deal that has quite lately passed current in text-books; indeed, it is only now becoming capable of improvement through the labour and the inspiration of some of the still greater giants of our own day.

From the time that Franklin flew his kite at Philadelphia and ascertained beyond cavil the true nature of lightning, from that time to the present the protection of buildings and ships from its destructive agency has been mainly a matter of detail and application of the laws of eletricity so far as they were known.

For a long time the erection of lightning conductors was opposed by the religious world as heretical and impious. But, first in some Protestant provinces in Germany, and later in France and England, the use of the heretical rods gradually extended. The extension of their use in England and their application to ships were greatly aided by the labours of their enthusiastic worker, Sir W. Snow Harris. Their extension in our South African colonies, where violent thunderstorms are frequent, is largely due to the influence of the late Dr. Mann, in whose honour this course of lectures has been established. Anyone who has read or heard Dr. Mann's contributions to the *Journal* of the Society of Arts,† must have been struck, not only with his keen interest and enthusiasm, but also with his grasp of fundamental principles, his open-minded receptive attitude to new controvertible views, and the thoroughly practical and business-like way in which he handled the subject.

Concerning the origin of atmospheric electricity I have not much to say. It seems to me probably due to friction, like Armstrong's hydro-electric machine. Faraday showed that the exciting cause in that apparatus of Armstrong's was the friction of water spray driven by steam over the solid surface of the jet; so also I picture winds in the atmosphere driving the spray of mist against rock and ice surfaces, and so gradually producing a certain difference of potential between the upper layers of the atmosphere and the surface of the earth.

I have spoken as if I thought the friction had to be between mist globules and solid matter. It seems doubtful whether friction against air will suffice to render water electric. If it is efficient, then it is well to notice that, though there is no finite slip between bodies and the common air through which they move, yet this does not apply to rarefied air. The viscosity of rare air is as great as that of dense, but the slip of solids through it is another matter. In rare air there is an actual slip at the surface, and accordingly the *apparent* viscosity of rare air, as observed by the settling of dust or the falling of a feather in a vacuum, is less than in air at common pressure. It may be, therefore, that the finite slip of mist or dust-particle through the upper layers of the atmosphere is one effective cause of atmospheric electrification, and after a spell of dry weather there is liable to be an accumulation of electricity, because it has had no recent opportunity of escape.

In the polar regions electrical discharges are mainly silent, or brush-like, giving the fantastic forms of aurora. But in our latitude these silent discharges in the upper semi-conducting rarefied layers of atmosphere are seldom visible. We see the effect in another form. The electrification gets occasionally conducted down by clouds into the lower and denser layers of atmosphere. By the aggregation of small globules into great ones the potential is enormously raised, until in the lower atmosphere they flash either into each other or into the earth, and the strain is partially relieved.

It is important to note that clouds appear to play only a secondary part in the phenomena. The upper regions of atmosphere are at a different potential from the earth—cloud or no cloud. Clouds are able to conduct it down towards the earth, and thick dense clouds are therefore the usual prelude to a thunderstorm.

The way in which the coalescence of small charged globules into larger globules is competent to raise their potential enormously is well understood, and I need not dwell upon it;* but the converse operation, or the tendency to coalescence of globules produced by feeble electrical charges in their neighbourhood, is not so well known, and I proceed to show the very simple experiment described by Lord Rayleigh, with a water-jet and sealing-wax.

A vertical jet about one-twentieth of an inch in diameter and three or four feet high does best, but almost any fairly vertical jet of clean water will serve. The drops fall as a scattered shower like fine rain until a stick of excited sealing-wax is held a yard or two away; they then instantly collect into large globules and fall as a thunder shower.

We have now to think of ourselves as living always between the coatings of a large condenser or Leyden jar, the upper coating the sky, the under coating the earth; the common air is the dielectric between. Ordinarily the sparking distance is far too great. Every now and then portions of the upper coating protrude down as clouds, and we are then liable to a disruptive discharge. Some square miles of cloud and some square miles of land are the two coatings, and the interval of separation need not be extremely great. If the cloud and the earth were perfect conductors, all this great area would be relieved in a single flash of awful size; but, fortunately, the conduction of cloud is a slow process, and it usually takes a good many flashes from different parts to remove its charge.

The total maximum energy of a given area of cloud at a given height from the earth is easily estimated, for it is well known that as soon as the electric tension of air reaches the limit of about half a gramme wt. per square centimetre, disruption occurs. Supposing it all equally on the verge of giving way, the energy of the dielectric per cubic centimetre is therefore $\frac{981}{2}$ ergs, and per cubic mile is $\frac{4{,}110 \times 10^2}{2 \times 3 \times 10^7}$ foot-tons = 70,000,000 foot-tons.

Given, then, the whole area of cloud facing the earth, and its height when on the point of discharging at every point, and you have the number of cubic miles of strained dielectric, and an approximation to the energy of the storm, at the rate of 70,000,000 foot-tons per cubic mile.

The potential needed to give a spark a mile long is so enormous† that the quantity of electricity required to give this energy need not be very great; $2{,}176 \times 10^8$ electrostatic units of quantity per square mile would give a bursting tension. Now, $2{\cdot}176 \times 10^{11}$ electrostatic units is just about 70 coulombs, or not enough to decompose one-hundredth of a gramme (1-7th of a grain) of water.† Faraday stated this, but it is often disbelieved.

As to the cause of the curious V-shaped troughs or depressions and horizontal whirls that are often found associated with thunderstorms, I have no suggestion to offer; but on those heads I may refer to Mr. Abercromby's recent little book on the "Weather" (Int. Sci. Series, 1887).

Thinking now of a cloud and of the earth under it as forming the two coats of a Leyden jar, in the dielectrics of which houses and people exist, we have now to consider what determines a discharge, and what happens when the discharge occurs. The maximum tension which air can stand is $\frac{1}{2}$ gramme weight per square centimetre. At whatever point the electric tension rises to this value smash goes the air. The breakage need not amount to a flash, it must give way along a great length to cause a flash; if the break is only local nothing more than a brush or fizz need be seen. But when a flash does occur it must be the weakest spot that gives way first— the place of maximum tension—and this is commonly on the smallest knob or surface which rears itself into the space between the dielectrics.

If there be a number of small knobs or points the glows and

* Lecture I. of the "Mann Lectures," delivered before the Society of Arts, March 10th, 1888.

† *Journal* of the Society of Arts, April 30, 1875, and March 15, 1878.

* See a lecture on "Thunderstorms" by Prof. Tait, in *Nature*, August, 1880.

† The difference of potential for a spark a mile long, between flat plates, is roughly 16×10^7 electrostatic units.

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brushes become so numerous that the tension is greatly relieved, and the whole of a moderate thunder cloud might be discharged in this way without the least violence. This is by far the best way of protecting anything from lightning; do not let the lightning flash occur if you can possibly avoid it. But one cannot always prevent it, even by a myriad of points. A good deal more might be done in this direction than is done, but still, sometimes a cloud will descend so quickly, or it will have such a tremendous store of energy to get rid of, that no points are sufficiently rapid for the work, and crash it all comes at once. One specially noteworthy case when points are no protection occurs when one cloud sparks into another, and thence to the ground; or, in general, whenever electric strain is thrown quite suddenly upon a layer of air. (See Lecture II. for details.)

When a flash occurs a considerable area is relieved of strain, and the rush of electricity along the cloud and along the ground towards the line of flash sets up a state of things very encouraging to another or secondary flash or flashes practically simultaneous with the first.

One consequence of this is known as the back stroke or return stroke. It was studied by Lord Mahon, and depicted in his work, "Principles of Electricity," published in 1780. Professor Tyndall has made it extremely well known, so that a reference to it is made in almost every elementary science school in the country.

But the popular account of the matter is, I believe, very inadequate. It says the man's electrical condition is disturbed by the inductive action of the cloud, and that on the cloud being discharged the man's original condition is restored; the passage of the induced charge from his hat to the ground being enough to kill him.

Now the shock that a man could get that way is but feeble; it is only twice what he would get if completely isolated and exposed to inductive action. The amount of charge stored up in a man's hat is not great; the electric tension is more likely to pull his hat off than its release is likely to do him any damage.

I do not deny the existence of this static return shock, but I assert it to be impotently feeble. One can feel all there is to feel by holding a hat near an electric machine till nearly bursting tension, and then discharging the machine. There is no special object in waiting for a thunderstorm.

There is more in the "return stroke" than a mere recovery from statical disturbance of equilibrium. It is a matter to which I must return at some length next week.

Now proceed to the kind of damage done when a building is struck, and to the customary and orthodox modes of protecting them from the effects of the flash when it does occur, as well as if possible of warding off the flash altogether by silent discharge. The two main destructive aspects of a lightning flash are—(1) its disruptive or expanding or exploding violence; (2) its heat.

The heating effect is more to be dreaded when the flash is slow and much resisted; the bursting effect when conducted well except at a few places. A noteworthy though obvious thing is, that the energy of the discharge must be got rid of somehow. The question is, how best to distribute it. It is no use trying to hocus-pocus the energy out of existence by saying you will conduct the charge to earth quite easily and quietly.

The disruptive effect is well shown by the effect of lightning on trees. It is as if every cell were burst by the expansion in the path of the discharge. The effect on conductors is, however, just as marked. Here are five specimens of wires deflagrated on glass by a Leyden jar discharge—gold, silver, copper, iron, and platinum; each has its characteristic trace, by which it can easily be recognised.

[A number of pictures of damage done to buildings and ships by lightning were here thrown upon the screen. They are mostly contained either in Mr. Anderson's work on "Lightning Conductors," or in Mr. Tomlinson's on the "Thunderstorm," or in both.]

St. George's, Leicester, is a curious case, for the rod of the vane conducted the flash half-way down the spire, when it blew a ring of stones out, and so dropped the top half of the spire neatly inside the bottom half, making a tremendous smash, carrying away all the floors of the tower, and beating in the foundation-arch.

Ships may have a mast utterly destroyed and split to pieces—thick iron hoops binding the mast being rent asunder and flung about by the force of the expansion; or the heat of the flash may ignite the sails or some other combustible matter.

Now take a few examples of buildings or ships more or less protected by conductors. Some of these examples are very instructive as calling attention to the vagaries and unexpected behaviour of powerful flashes. It is these vagaries which I consider have been hitherto unexplained, and it is precisely these to which I wish to direct your special attention.

I shall hope to show next week how closely and completely they can be illustrated by laboratory experiments, and I believe that it is to a neglect and misunderstanding of these phenomena that so many of the partial failures of conductors have been due.

For that conductors often fail is undeniable. It is customary to say that they are not properly made, or that there was a faulty joint, or that there was a bad earth. A bad earth is the favourite excuse. A good earth is a good thing undoubtedly, and one cannot well have too much of it; but for a flash to leave a fine thick copper conductor on a tall chimney while still high up, and begin knocking holes in the brickwork in order to make use of the soot or the smoke or some bolts or other miserable conductors of that sort, because it is not satisfied with the moderate allowance of earth provided for it at the bottom, is evidence either of simple perverseness or else of something more deep-seated and not yet properly called attention to.

If the earth is bad, the flash can show its displeasure when it gets there by tossing it about and boring holes into it, and breaking water and gas mains; but at least it might leave the top and middle of the chimney alone—it might wait till it got to the badly-conducting place before doing the damage. Yet it is notorious that on high chimneys a flash often refuses to follow a thoroughly good conductor more than a quarter or half-way down, but takes every opportunity of jumping out of it and doing damage.* Why is this? Well, that is the main question I shall attempt to answer in this course.

It may be said that the effect of the bad earth is to make the whole path so highly resisting that the discharge necessarily declines to take it. Well, if that were so, it need not have come into the conductor at all. It is supposed with one breath to strike the conductor because it affords an easy path to earth, and with the next it is said to leave the conductor, because after all it finds it a bad one.

Besides it need not be so very particular about a little resistance; it has already come through, say, half a mile of clear air, it might manage a few feet of dry soil. It strikes violently through the air, enters the conductor, and begins to go quietly. Why does it not continue to go quietly till it gets to the bottom of the good conductor, and *then* begin displaying its vigour by boring holes below, as it has done above? Why should one end have to be so persistently cockered up? Why not insist upon having not only a good "earth," but also a good "sky"?

Let me repeat a good earth is a good thing, and it is not possible to have too much of it, except on the score of expense, but even if it were so good an earth that it might be almost called a heaven, it would not stop the tendency to side flash. One would be still liable to spittings out from conductors, especially from tall stout ones, as I shall hope to clearly show next time. However bad an earth may be, it can hardly be worse than one afforded by soot, and bricks, and yards of air.

My position at present is that an earth is desirable to prevent damage to pipes, foundations, and other things buried therein. But that, *so far as getting rid of the flash is concerned*, it ought to suffice if the conductor was cut off level with, or even a foot or two above, the ground. It would knock things about in jumping the rest of the way, but it should not be expected to leave the conductor until it gets to the break, any more than it should be expected to take the conductor half way down instead of at the top. It is true it sometimes *does* partially take the conductor at the middle, just as it sometimes partially leaves it at the middle, but I say that it is not to be expected to do either of these things on ordinarily accepted principles. There are some differences between the behaviour of positive and negative electricity, but none of such extent as will explain the extraordinary difference between the two or three points pointing skywards and the extensive roots advocated at the other end.

Take these examples now. A house where the lightning, having struck the conductor, flashes off from it in two places to get to a roof gutter and a distant water-butt. Here is a ship where the lightning is striking in two places at once, the top of the mast and the yardarm. In the next it is striking at the top of the conductor, and also at a point on deck, and at two places on land as well. This is a most instructive example. I have little doubt that the three are echoes or reverberations of the main flash, and excited by it; not excited by induction as in a coil, still less by mere static return, but by a surging or momentum of electricity, of which I have more to say. The next diagram shows the ship "Conway" capitally protected, except as to its flagstaff. The water was seen to be luminous in conducting away this flash from the sides of the ship. Here is the arrangement by Snow Harris of conductors able to accomplish this protection—simple and effective. A ship is an easy thing to protect, provided you realise that every mast and every spar is liable to be struck. If you protect the masts you may chance the spars if you like; but you are not to think of areas of protection; all such ideas are perfectly illusory.

[Figures of certain houses with elaborate conductors were shown.]

Nothing projecting upwards is left unspiked, and the earths are thorough. These appear to be examples of excellent, though certainly expensive, protection.

If these house were powder magazines we should have to be more

* For an example of the entire failure of a brass rod, 1in. in diameter, *see* Anderson's book, p. 137. For cases of capricious leaving of a conductor for such things as safes and fowling-pieces, *see* pp. 250 and 273.

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careful still and make a more critical examination ; but as ordinary houses they are safe so long as the conductors are in decent condition.

Now rapidly run over ordinary good orthodox conductors. First, the sky end. Points are good, as explained ; but platinum points are liable to be melted. The best points are cones of copper, not too sharp, and thickly gilt. Gold is better than platinum in being just as durable and much better conducting, and therefore less liable to melt. Many points are better than one, especially as some are apt to get fused and blunted by some discharge ; others may still remain sharp.

True, anything will act as a point when the tension rises high enough ; but the great thing is to keep down these dangerous tensions if anyway possible. So soon as a knob begins to emit brushes the sparking point cannot be far distant ; but sharp points will glow and reduce the strain far before the sparking point.

Perhaps the best protected building in the world is the Hôtel de Ville at Brussels, the hobby of M. Melsens. The whole system used in this building is excellent and theoretically perfect, so far as I know, in every respect ; but it is not cheap, and some people might perhaps hold that it was not artistic.

As for the main conductors, one finds rod, rope, and ribbon. The plan most approved perhaps by the Lightning-Rod Conference is this copper-tape, which is very nice, neat, and flexible, and free from joints.

Two important matters to be thought of in connection with the conductor are—that it shall not corrode away in places, and shall not be stolen. Another point that must not be overlooked in fixing up any length of conductor is that it is liable to expand and contract. An allowance must be left for this. When it is remembered that it is liable to be exposed to the full glare of the sun, backed up sometimes by a kitchen chimney behind, and then again at another time exposed to the coldest nights, a range of 100° Centigrade is not excessive.

I once rigged up some copper rod battery conductors of substantial thickness between two walls, and one morning after a frost found one snapped clean in half by the contraction. This would be a bad thing to happen to a lightning conductor ; so either bends must be left in the rope when put up, or else special compensators must be introduced at intervals.

The allowance for copper is 1 in 500 ; say an inch in every 40 feet. The best place for a compensator is just above the holdfast, so that it will have to support no weight. A bight or bend in a flexible rope answers every purpose, but bends should not be made too sharp, or the discharge will jump across instead of going round. That is a thing to be remembered. Flexible conductors are very convenient, but their convenience must not be abused. Always take them as straight as possible. Lightning has no time to go round circles—it will jump across sooner. Why should it not be let to jump across ? Well, because it burns the conductor. That is the real objection to bad joints—the extra heat ; a sort of arc produced there, and the liability to fusing and destruction of the conductor at these parts. There is, moreover, some danger from fire.

Now about the earth end. We have had examples of good earths already. Here is a cheap one advocated by Dr. Mann : wire rope opened out into a brush, and the two ends of another short bit, similarly treated, spliced across the first. Two of the fuzzed out ends make contact with deep soil, one with the surface soil, so that one or other is pretty sure to reach moisture.

The whole conductor introduced into the Cape by Dr. Mann, is simple, cheap, and admirable for cottage purposes and for emigrants. Squatters in the States, or Canada, or at the Cape, are far more liable to thunderstorms than we are in this country, and they should certainly rig up one of these homely things. A bit of iron fencing rope will do, with both ends fuzzed out, one supported by a tube fixed to the chimney, the other sunk deep into moist ground, or swamp if available.

In towns, where there are water or gas mains anywhere near the terminus of a lightning conductor, they should always be connected to it ; and this mainly for their own protection. For if they be not connected, the lightning will not scruple to still make use of them if it chooses, and having to jump across a yard or two of bad conductor on the way, it can easily knock a hole in them or melt them, instead of getting to them quietly.

It must be understood that what I say of the mains underground does not apply to the pipes in a house. To connect lead water pipes with a lightning-conductor might possibly lead to their being melted ; but to connect the house gas-pipe with a conductor is a most dangerous proceeding. The neighbourhood of gas-pipes in a house must be scrupulously avoided. The more it is connected to the mains underground the better, but one does not want lightning rushing along compo-pipes, picking out all the bad joints, and lighting all the gas there. In so far as a house contains escaping gas, or weak gas-pipes, it must be treated like a powder magazine, and great care be taken. A ridiculously minute spark may ignite gas without being noticed, the hole in the pipe may quietly enlarge, and the house be burnt down. A considerable amount of damage has been done in this way. So soon as Swan lamps are in universal use, lightning may occasionally play havoc with their filaments and fuse a few cut-outs, but it will not find the leads easily combustible or capable of burning the house down.

Whether it be gas or electric light, however, lightning should, if possible, ke kept out of the house-leads—not only because of the danger it may do at joints and insulations, but because the gas-brackets and chandeliers are usually conveniently suspended over desks and near arm-chairs, just where an unsuspecting person's head is likely to be ; and a spark to one's head is unsafe.

Hitherto I have spoken of the orthodox system of protection, the gather up and carry away system. But, as you know, there is another system suggested by Clerk Maxwell, the birdcage or meat safe principle. In a banker's strong room you are absolutely safe. Even if it were struck nothing could get at you. In a birdcage, or in armour, you are moderately safe. I should not care to try armour myself ; the joints might get unpleasantly hot and explosive. And even the birdcage, if struck by a big enough flash, might get melted. A melted patch on one's protective armour would be extremely disagreeable. Sometimes one is told to get thoroughly wet through instead of seeking shelter in a thunderstorm ; but it is a question whether a stroke is more unpleasant than rheumatic fever.

However, a sufficiently stout and closely-meshed cage or netting all over a house will undoubtedly make all inside perfectly safe. Only, if that is all the defence, you must not step outside, or touch the netting while outside, for fear of a shock. It would be unpleasant, when you reached home out of a storm, to find it so highly charged as to knock you down directly you tried to go in. An earth connection is necessary as well.

A wire netting all over the house, a good earth connection to it at several points, and a plentiful supply of that barbed wire which serves so abominably well for fences stuck all over the roof, and you have an admirable system of defence.

Now let us see how far most people agree, and where they begin to branch out and differ. The old and amusing political controversy between knobs and points has disappeared. Points to the sky are recognised as correct ; only I wish to advocate more of them, any number of them, rows of them, like barbed wire—not necessarily at all prominent—along ridges and eaves. For a point has not a very great discharging capacity. It takes several points to discharge readily all the electricity set in motion by a moderately-sized Voss or Wimshurst machine ; hence, if you want to neutralise a thunder cloud, three points are not so effective as 3,000.

No need, however, for great spikes and ugly tridents, so painful to the architect. Let the lightning come to you, do not go to meet it. Protect all your ridges and pinnacles, not only the highest, and you will be far safer than if you built yourself a factory chimney to support your conductor upon. At present the immediate neighbourhood of a factory chimney or steeple is not a safeguard, but a source of mild danger. But no one need believe this till after my next lecture, and not then if the experiments fail.

Next, as to the conductor. Should it be iron or should it be copper ? Should it be insulated from the building, or should it be connected with all the metal it contains ? These are questions at present in dispute. The Lightning-Rod Conference approves copper, though not putting it specially and strongly before iron. Durability is its main recommendation. Under all circumstances I am not sure whether it is more durable than galvanised iron. Mr. Preece has great experience of wires in chemical and all other districts, and I believe he upholds iron. Franklin and the Americans to this day prefer iron. Certainly it is much cheaper, and not so easy to melt. We will consider the question, and, I think, come to a definite conclusion next week.

Also the question about connecting up the conductors to all metal masses, roofs, girders, balconies, water gutters, &c. ; we had better leave that open too. Nearly everyone condemns insulators, but one eminent authority, M. Callaud, advocates caution and circumspection in what things you connect and what you do not connect. He points out, for instance, that if you connect up a balcony to the conductor, a person standing thereon may become one of its striking terminals. I must say I agree with him. Some there are who advocate connecting *both* ends of a roof gutter, or other such nearly closed contour, and not only one end. I decidedly agree with this also, for reasons which next week I will make abundantly clear. On this point I have, in fact, no doubt.

As regards the shape of the conductor, whether rod or ribbon ? Many experiments have been made, notably some by Mr. Preece on the discharge of Dr. De la Rue's battery through conductors of various sectional shapes, to see if extent of periphery matters. Hitherto the results have been negative. We may conclude, I think, that it does not matter much as regards liability to be deflagrated. But theory clearly points to the fact that a bundle of detached wires is electrically better than a solid rod of the same weight per foot, in every respect except durability. But durability is an essential feature. No shape can be considered satisfactory which aids corrosion. One thing is obvious ; plenty of surface

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encourages cooling, and slightly diminishes danger of melting. Its other much more important advantages we will consider later.

Lastly, the "earth" and its testing. An earth is necessary, or you will have your foundations knocked about and your garden ploughed up. A good earth is desirable. A few tons of coke with the conductor coiled up amongst it is a well-known and satisfactory plan if the soil be permanently damp. A bag of salt might, perhaps, be buried with it to keep it damp throughout, or rain water may be led there. Often, however, the most violent thunderstorms occur after a spell of fine weather, and the soil is likely to be dry. It is the best, therefore, to run your conductor pretty deep, and there make earth.

It is all very well to connect the conductors to water-mains if near, but if they are far off or non-existent it is no use; and in no case, in my opinion, should they be used as sole earths. Certainly not gas-mains. In dry weather they are not earthed at all well, and a strong charge may then surge up and down them and light somebody else's gas in the most surprising way. It does not often happen, but it may happen in sandy soil after dry weather. Always there should be a good deep earth—a well if possible, a boring if not—and the conductor be led down into it. If it likes to make a disturbance when it has to leave the conductor a long way down, no one need grumble. It cannot do much harm there. There is, of course, no magic in water, unless it forms a large continuous sheet. An isolated puddle in a rock, such as has been used before now for a lighthouse, is no earth at all. A thoroughly good earth is really a geological question; and for an important building a geological specialist should be consulted.

An occasional test of an earth, in ordinary weather, is no real security as to what may happen after a long-continued drought. It would be easy to arrange a plan whereby just raising a handle shall give sufficient information as to the state of the earth, without any skilled operator. To this end two earths should be provided, quite independent of each other (one a water-main, for instance, the other a ton of coke), and they should be connected, first to each other and then to the conductor, by a substantial copper band. Now, let the band connecting the two earths pass through some covered outhouse, and have a well overlapping junction of two flat areas pressed together by a spring, but capable of being raised on or off the other by pulling at a handle or a rope. A galvanometer indicator and Leclanché cell, permanently connected so as to send a current between the two earths directly the handle is raised, will show by its deflection the state of conductivity of the two earths. Very likely the two earths themselves will suffice to give the necessary current without an auxiliary battery.

There is this to be said, however. If a building is so situated, either on high sandy ground or on an impervious rock, that a decent earth is very difficult to get, then, at least, the house is not likely to make a better earth than the conductor. That is a weak point in the excuse so often made concerning an accident to a protected building, that the earth was not sufficiently good. It can very seldom be shown that the earth, apparently chosen in preference, was any better; often it was obviously worse.

It is a superstition to place much reliance on the testing of conductors with a galvanometer and Wheatstone bridge. A galvanometer and Wheatstone bridge are powerless to answer many important questions. A Leclanché cell can no more point out what path lightning will take than a trickle down a hill-side will fix you the path of an avalanche. The one is turned aside by every trivial obstacle, and really chooses the line of least resistance; the other crashes through all obstacles, and practically makes its own path. A flash strikes a house at one corner, rushes apparently part way down the conductor, then flashes off sideways to a roof-gutter, sends forks down all the spouts, and knocks a lot of bricks out. Another branch bangs through a wall in order to run aimlessly along some bell-wires, and then out through a window-frame, and down a spade or something propped up against the wall to earth. The lightning tester comes with his galvanometer and Leclanché cell, and reports that the earth of the conductor has 100 ohms resistance; and the accident is therefore accounted for. But how much resistance would he have found in the paths which the lightning seemed to choose in preference to the 100 ohms? Something more like a 1,000,000 probably. Or, perhaps, there is a bad joint in the conductor somewhere, the parts being separated by one-sixteenth of an inch. But why should it prefer to jump several yards, and knock holes in walls and windows, rather than jump one-sixteenth of an inch? No; the galvanometer, and Wheatstone's bridge, and Ohm's law, and conductivity, are simply not in it.

Something has been left out of consideration, and something very important, too; and until that something is fully taken into account no satisfactory and undeniable security can be guaranteed.

That something is inertia—electrical inertia.

Suppose you have a pipe or U-tube full of water, used as perpetual overflow to a cistern, and you want it to be equal to all demands. You test it, and find it perfectly easy to pour the water either way; both ends are perfectly open; the pipe is a good conductor. Then comes some one and hits the stagnant water in your pipe a tremendous blow with a hammer, bursts the pipe, and scatters the water all about. That is what lightning does to your lightning conductor and to the electricity in it. It is no great push, it is a terrific blow.

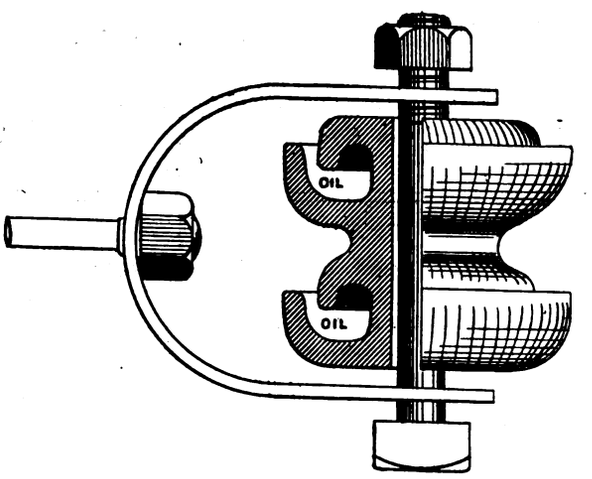
Conductivity is not what you want; widening the pipe is no remedy. There is a something you want; there is a remedy. The remedy is elasticity—electric "capacity." You must reduce the electrical inertia (or self-induction) of your conductor as much as possible, and you must increase its electric elasticity (or capacity) wherever convenient. These are matters concerning which I have many experiments to show next week.

The lecturer exhibited a photograph of Sanderson's climbing ladder for chimneys, which had been kindly lent by Messrs. Richard Anderson and Co. He read (as requested) a letter from Mr. W. McGregor, advocating the formation of a society for the protection of life and property from lightning. And he called attention to a suggestion of the Hon. R. Abercromby's, at the Manchester Meeting of the British Association last year, that a systematic observation and record of thunderstorms should be undertaken, so as to gain a knowledge of the distinct types of storm, and the modes of circulation of air which accompany them.

He further desired to express his obligation to the following books, for many details and examples of damage done, and of current methods of protection:—"Lightning Conductors," by R. Anderson, third edition, revised by Dr. Mann (Spon). "The Thunderstorm," by C. Tomlinson, F.R.S. (S.P.C.K.). "Report of the Lightning-Rod Conference," edited by G. J. Symons, F.R.S. (Spon). An extensive list of memoirs on the subject is contained both in this Report and in Anderson's book. Dr. Mann's Paper in the *Journal* of the Society of Arts, 1875 and 1878.

AN OIL INSULATOR FOR SHACKLES.

We illustrate herewith a form of fluid insulator adapted for shackles, which has been designed by Mr. F. Higgins, and is used on the lines of the Exchange Telegraph Company. The sketch needs very little description. It will be seen that there are two oil cups, and that externally the shackle is of much the usual form. Since the use of fluid insulators was first introduced by Messrs. Johnson and Phillips, their great value in cases where high insulation is required, or where exceptional difficulties are met with in maintaining insulation, has been repeatedly recognised. For over-house electric light wires some use has already been made of this form of insulator, and for such a purpose Mr. Higgins's shackle will often be very useful.



MEETINGS OF SCIENTIFIC SOCIETIES.

SATURDAY, June 23rd.

PHYSICAL SOCIETY.

8 p.m. Note on "Continuous Current Transformers." By Prof. S. P. THOMPSON, D.Sc.

WEDNESDAY, June 27th.

SOCIETY OF ARTS.

4 p.m. Annual General Meeting.

SOUTH OF ENGLAND TELEPHONE COMPANY (LIMITED).—The directors of this company, at their meeting to-day, decided to recommend a dividend of ½ per cent. on the Ordinary share capital for the year ended 30th April last, placing £500 to a reserve fund, and carrying forward £1,115. 0s. 8d. The dividends on the Preference Shares have already been paid.

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The Electrician.

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THE ELECTRIC LIGHTING ACT AMENDMENT BILL.

In the House of Lords on Monday last the Commons' amendments to Lord THURLOW's Bill for amending the Electric Lighting Act of 1882 were agreed to, and by the time these lines are in print the measure, as now amended, will probably be the law of the land. The draughtsman of the original Act, departing from the usual phraseology in such documents, applied the term "undertakers" to those persons who, in similar relations, had previously been described as "promoters." Whether this was a happy inspiration or an unintentional prophecy, certain it is that a funereal aspect has clung to the Act ever since its promulgation, the undertakers undertaking nothing except to bury it in oblivion so soon as its real character was understood. For a few brief weeks after the passing of Mr. CHAMBERLAIN's Act applications for licenses and provisional orders poured in upon the Board of Trade with quite unexpected abundance; but long before the bye-laws under which they were to be granted had been drawn up every one of these applications had been withdrawn, or the projects with which they were connected virtually abandoned. The interval of six years which has elapsed since then has made no change in the disposition of the undertakers, not one of whom has attempted to exhume the Act from its unhonoured grave. On the contrary, in every succeeding year the demand for an amended Act, or, in other words, a radically different Act, grew stronger; and this has at last resulted in the legislative concession which we are able to announce to-day.

The question here naturally arises—What shall we do with it now that we have got the amendment so long desired? On the whole, we may say that comparatively little interest has been taken in the matter by the electric lighting companies, whom we prefer to call promoters, the chief anxiety being manifested by the general public and the newspapers which represent their views. This is a hopeful sign, for it indicates, on the one hand, that the demand for the electric light has become too strong for the legislative obstacles thrown in its way; and, on

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the other, that the business of electric lighting is being carried on successfully in spite of and without the help of any legislation whatsoever. We have always thought that the discipline of these years of free competition would operate beneficially on the industry, and we are still of this opinion, whatever may follow from the passing of Lord THURLOW's Bill. That Bill, as it stands, although a great improvement on its predecessor, is by no means wholly satisfactory, and the time which has been occupied in doing without it has proved that if they are not acceptable to the investing public the provisions of the Bill can be dispensed with without serious hindrance to the trade. It is probable, however, that in many instances they will be taken up with alacrity. There is abundance of capital awaiting investment; there is a considerable demand for the electric light; and with the experience gained during the period of probation there is no reason to doubt that the terms offered under the new Act will attract investors and prove fairly remunerative.

Some of the more glaring objections incidental to the original Act arose out of the regulations which the Board of Trade was empowered to frame for its administration. The absurdity of some of these rules was pointed out by Mr. T. H. BLAKESELEY soon after they were issued; and it is hardly necessary to add that they have never been put in force, nor ever will be. Some damaging criticisms had been made by the Secretary of the Edison Company earlier in the year following the passing of the Act, on the restrictions as to the lamps to be used and the manner in which the consumer was to be charged. The companies were left no option; and as lamps were capable of great improvement, Mr. ARNOLD WHITE not inaptly described the Act as one for the perpetuation of bad lamps. He also pointed out the inadequacy of the inspection proposed by the Board of Trade in the supposed interest of the consumers, the companies at that time being of opinion that the inspector should examine and test the light supplied, and not the methods employed for supplying it. Probably on these and a number of other points which were taken exception to at the time, the Board of Trade, as well as the electrical engineering profession, have learnt a great deal since then, and we shall expect that the regulations under which the Act of 1888 will be administered may at least be workable or be capable of becoming so. When these preliminaries have been adjusted, there will probably be little delay in applying for provisional orders on the part of local companies, many of which will no doubt be formed to employ special systems identified with well-known firms. We do not suppose that these firms will become promoters under the Act on their own account to any large extent. The lessons of 1880-2 ought to be sufficient safeguard against the unnecessary assumption of speculative risks, at any rate so long as a safe and fairly extensive business can be done in the manufacture and erection of plant.

As regards the municipalities, it is probable they will largely avail themselves of the option afforded them by the Bill, and the confidence which the passing of it will naturally inspire. The Local Government Bill, if it survives the ordeal it is now undergoing, will also contribute to this result by increasing the powers and responsibilities of the local authorities. The original Electric Lighting Act was no favourite with the municipal bodies. As we remarked soon after it was passed, the Act conflicted with their most cherished views of local self-government, the whole power of the local authorities in regard to the supply of electricity being transferred by a side-wind of legislation to the political Secretary of the Board of Trade. A strong remonstrance from provincial local bodies was made at the time; and it is not to be supposed that with the virtual independence they will enjoy under Mr. RITCHIE's Bill they will long submit to the dictation of the Board over which he now presides. Under the old Act it was possible to compel the local authorities to adopt the electric light by the threat of granting a license to an outsider. The outsider, as things happened, did not present himself; but even if the same power is retained in the new Act, the Board of Trade will be slow to exercise it, and the local authorities will be none the less likely to look kindly on the electric light for being perfectly free to adopt it or not as they please. They were distinctly hostile to Mr. CHAMBERLAIN's Bill; so far as we can learn they are, on the whole, by no means unfriendly towards Lord THURLOW's. Naturally they did not at first approve of the terms of purchase in the amended Act; but, so soon as they discovered that they must have this or nothing, their opposition was withdrawn.

DELANY'S SAFETY DEVICE FOR LINEMEN.

BY C. W. S. CRAWLEY AND H. NALDER.

A short time ago Mr. Delany read a Paper before the American Institute of Electrical Engineers on the protection of the human body from dangerous currents, and suggested the use of metallic wristlets and anklets, all four of which were to be joined by a wire. Thinking it would be well to determine how far this method really afforded protection, we recently made a few rough experiments on the subject. Round each wrist was wrapped a strip of tinfoil 7·5 cm. wide, and this was bound on with a piece of copper wire; the wrists were well wetted with salt water, and an exceptionally good contact was thus obtained. The palms of the hands were placed on metal plates in earthenware dishes, which were then filled with water containing common salt, so that the palms of the hands were wetted but not the backs. The hands were kept as still as possible the whole time on the metal plates, so as to avoid any variation of surface, and therefore of resistance, and switches were arranged so that the current could be put on to either the metal plates or the wristlets.

It was required to measure the following:—x the resistance of the body apart from skin resistance, y the skin resistance of a hand, and z the skin resistance of a wrist. The measurements were made by a delicate voltmeter used as an ammeter. Used in this way its constant came out ·05 milliampere per degree, the total E.M.F. applied being measured by another voltmeter. The first E.M.F. used was 18 5 volts. Four measurements were taken—

(*a*) Left hand to right hand,
(*b*) Left hand to right wrist,
(*c*) Left hand to left wrist,
(*d*) Left wrist to right wrist,

the resistances in these cases being respectively $x+2y$, $x+y+z$, $y+z$, $x+2z$, from which, of course, it is easy to get the values required, the last measurement being taken merely as a check. Five sets of readings were taken with 18·5 volts, and five more with 11 volts. The hand resistance, as might be expected, fell considerably with time, beginning with 1,000 and falling to 395; z, however, rose from 770 to 1,165, which may be accounted for by the skin drying to some extent under the wristlets, though when the latter were taken off the skin was still found to be very appreciably damp. In each set of experiments the measurements were taken as quickly as possible one after the other, so as to prevent change during the set. The mean values found, with 18·5 and 11 volts respectively, were $x=675$ and 930 ohms, $y=695$ and 470 ohms, $z=785$ and 1,035 ohms. Bringing these figures to bear on what would occur in practice it comes to this: the current enters at the hands and gets through to the inner tissues; arriving at the wrists it has two paths open to it, one through the body, with a resistance of about 800 ohms, the other through the short-circuiting wire + twice the skin resistance of the wrist (or $2y$), which is somewhere between 1,600 and 2,000 ohms—that is, it would at best only relieve the body of about $\frac{1}{3}$ the current; while in actual practice, with the skin comparatively dry, we should be sorry to trust to it to do as much as this.

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One further negative result may be mentioned: with 18 volts, and the current on the two hands, the reading was 179 degrees; the two wristlets were then metallically joined together, and the current only rose to 180°, or 9 milliamperes. This last result, though obviously not consonant with the resistances measured, was observed several times.

THE MINIMUM POINT OF CHANGE OF POTENTIAL OF A VOLTAIC COUPLE.*

BY DR. G. GORE, F.R.S.

In a previous communication on "The Effect of Chlorine on the Electromotive Force of a Voltaic Couple" (Roy. Soc. *Proc.*, May 3, 1888) I described a phenomenon which I now venture to term the "Minimum Point of Change of Potential of a Voltaic Couple." In that description a "thermo-electric pile" is mentioned as having been used for the purpose of balancing the electromotive force of the couple, whilst finding the "minimum point of change." As very few persons possess a thermo-electric pile suitable for the purpose, I have devised and employed the following arrangement, by means of which the use of the pile may be dispensed with.

Take a voltaic couple, composed of an unamalgamated strip or stout wire of zinc or magnesium (the latter is usually the best), and a small sheet of platinum immersed in distilled water; balance its electric potential through an ordinary galvanometer by that of a precisely similar couple composed of portions of the same specimens of the same metals, immersed the same moment as the other pair in a separate quantity of the same water, and gradually add to one of the two cells sufficiently small and known quantities of an adequately weak solution of known strength in a portion of the same water, of the substance to be used, until the balance is upset, and take note of the proportions of the substance and of water then contained in that cell. It is more easy to successively dilute than to successively strengthen the solutions, and thus arrive at the "minimum point." The method is a little less accurate than the one in which a thermopile is employed.

By means of this method, using a couple composed of magnesium-platinum in distilled water, I have found the following "minimum points of change of voltaic potential" in solutions of potassic chloride, potassic chlorate, hydrochloric acid, and chlorine. I selected these substances because they were representative ones suitable to yield results for comparison, and because they gave extreme and intermediate magnitudes of the effect. The results are compared with those obtained with a Mg + Pt couple and the thermopile.

Potassic Chloride KCl.—Solution at 18°C., "minimum point" lay between 1 part in 3,875 and 4,650 parts of water, and by the aid of the thermopile, with the solution at 17°C., "minimum point" between 1 in 3,875 and 4,305.

Potassic Chlorate $KClO_3$.—Solution at 19°C., "minimum point" between 1 in 4,650 and 5,166, and with the pile, solution at 18°C., between 1 in 4,920 and 5,470.

Hydrochloric Acid HCl.—Solution at 17°C., "minimum point" between 1 in 516,666 and 664,285, and by the aid of the pile, solution at 19°C., between 1 in 516,666 and 574,074.

Chlorine Cl.—Solution at 18° C., "minimum point" between 1 in 15,656,500,000 and 19,565,210,000, and with the pile, solution at 12·5° C., between 1 in 17,000 millions and 17,612 millions.

The results show the great degree of delicacy of each method, and the extremely large difference of proportion of different substances required to upset the balance. The two methods agree.

By employing a great variety of dissolved substances I have found that nearly every such substance has a minimum proportion, below which it has no apparent effect upon the electromotive force of a Mg Pt or Zn Pt couple in distilled water; and this proportion appears to be a constant number, dependent only upon very simple conditions, viz., unchanging composition of the voltaic couple and liquid, a uniform temperature, and employing the same galvanometer. The apparently constant numbers thus obtained may probably be used as tests of the purity or of the uniformity of composition of dissolved substances.

The "minimum point" and degree of sensitiveness varies with—1st, the chemical composition of the liquid; 2nd, the kind of positive metal; 3rd, to a less degree with the kind of negative metal; 4th, the temperature at the surface of the positive metal, and at that of the negative one; and 5th, with the kind of galvanometer employed.

The order of the degree of sensitiveness or magnitude of the "minimum point" is manifestly related to that of degree of chemical energy of the liquid, and, therefore, also to the atomic and molecular weights of the dissolved substances, and to the ordinary chemical groups of halogens. With certain exceptions, it is also distinctly related to the amounts of chemical heat. The greater the degree of free chemical energy of the dissolved substance, and the greater its action upon the positive metal, the smaller the proportion of it required to upset the balance. The proportion necessary for this purpose probably represents a fixed amount of voltaic energy in all cases, viz., the amount necessary to overcome the mechanical inertia of the needle of the particular galvanometer employed.

As the "minimum point" of a chemically active substance dissolved in water is usually much altered by adding almost any soluble substance to the mixture, measurements of that point in a number of liquids at a given temperature with the same voltaic pair and galvanometer, will probably throw some light upon the state of combination and degree of chemical freedom of substances dissolved in water.

* Paper read before the Royal Society, June 14, 1888. Abstract.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER IX.—*Magnetic Fields.*

(Continued from page 148.)

114. *Action of a Magnetic Field on a Magnet.*—It has been mentioned before that when a magnetic needle suspended or pivoted about its centre is placed in a magnetic field, it immediately sets itself in the direction of the lines of force in that field—that is, the direction of its own internal lines coincides with the direction of the lines of the field at the point where it is suspended. It is important to understand fully this action, as it immediately concerns the cause of the movement of galvanometer needles when the field by which they are surrounded is altered by starting a current in the coils.

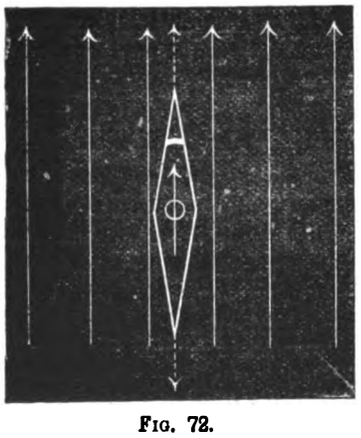

FIG. 72.

Let us consider a horizontally suspended magnetic needle free to move in a horizontal plane in the uniform magnetic field of the earth. It will set itself with its marked or north end towards the north pole of the earth, as in Fig. 72, where the straight lines represent the uniform lines of force of the earth's horizontal field H, and the arrow inside the magnet represents the direction of its own internal lines of magnetisa-

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tion. The force acting at each end of the needle keeping it at rest in this position is equal to the product of H into the strength of the needle pole, which we call m; that is, the force at each end of the needle is equal to H m. This force is shown in dotted arrows at each end of the needle, and it will be seen that when the needle is in this position (the meridian) there is no *turning* force exerted on it. But now, if we turn the needle through a right angle, as in Fig. 73,

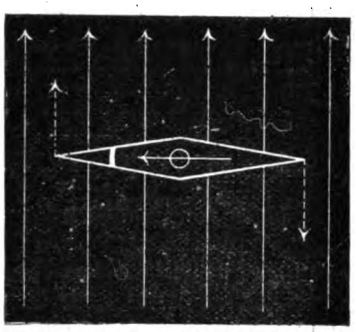

FIG. 73.

we shall have to exert some force to keep it there; in other words, the force H m at each end is now tending to turn it back to the meridian.

115. "*Moment*" *of a Force.*—The capability of a force to produce movement, or turning about a centre, is termed the "*moment*" of that force. The moment of a force about a point is the product of that force into its perpendicular distance from the point—that is, the distance from the point to where the force is applied must be reckoned along a line perpendicular to the direction of the force. To make this clear let us take a rigid bar, A B, capable of turning about its centre, C, at one end of which a force equal to F lbs. is pulling (Fig. 74) in a direction making an angle of a degrees with the bar. Let the bar be L feet long; the length A C will then be $\frac{L}{2}$ feet. Draw C D perpendicular to the direction of the force. The "moment" of the force about the point C is then—

F × perpendicular C D.

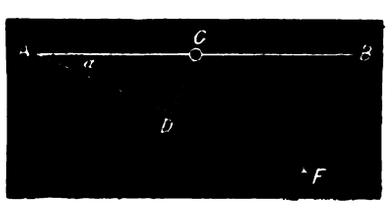

FIG. 74.

Now we can find the length of C D by a simple trigonometrical ratio. (It may be mentioned here that the only trigonometrical functions of angles made use of in these papers will be the three most frequently met with—viz., the sine, the cosine, and the tangent. The student should familiarise himself with these simple functions of angles. A table of natural sines and tangents will be required for reference. The cosine of an angle may be found from a table of sines by subtracting the angle from 90 and taking the sine of the remaining angle.) Now we have the ratio $\frac{CD}{AC} = \text{sine } a$; and therefore

$$CD = AC \sin a = \frac{L}{2} \sin a \text{ (feet)};$$

whence the moment of the force is equal to

$$F \times \frac{L}{2} \sin a \text{ (pound-feet)}.$$

For example, if F = 10lbs. and L = 10ft., and the angle = 30°, we have moment of $F = 10 \times \frac{10}{2} \times \frac{1}{2} = 25$ pound-feet (where sin $30° = \frac{1}{2}$).

It should be observed here that since sin $90° = 1$ and sin $0° = 0$ the moment of F is $\frac{FL}{2}$ when the force acts at right angles to the bar, and is *nil* when acting in the direction of the length of the bar. Hence a given force acts at the greatest advantage as regards turning a lever, or, in other words, its moment is greatest, when it acts at right angles to the direction of length of the lever. When we, for instance, exert force ourselves in order to move a heavy lever, such as the opening or closing of the gates of a river lock, we instinctively use our strength to the best advantage by pushing at the extreme end of the lever and at right angles to it. Taking the above figures with the force acting at 90deg., the moment of F becomes

$$\frac{10 \times 10}{2} = 50 \text{pound-feet.}$$

Suppose, now, that an equal force, parallel to the first, acts at the other end, B, of the lever (Fig. 75), so as to turn it round in the *same* direction about the centre C. Drop the line C D′ perpendicular to the direction of the force, as before. Then $\frac{CD'}{CB} = \sin a$, or $CD' = \frac{L}{2} \sin a$ (angle C B D′ $= a$), and therefore the moment of the force F acting at B is

$$\frac{FL}{2} \sin a,$$

which is the same as the moment of the force acting at A.

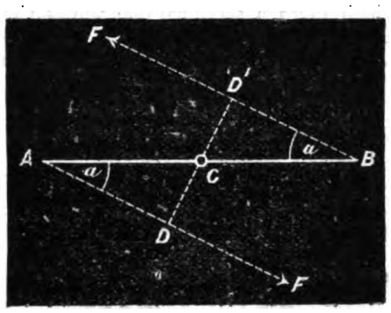

FIG. 75.

Now, as both these forces tend to turn the lever the *same* way round we must *add* their moments to obtain the moment of the two together, and as their moments are equal the moment of the two will be twice that of one—that is,

$$2\left(\frac{FL}{2} \sin a\right) = FL \sin a.$$

For example, with equal forces of 10lb. each, acting at each end of the lever at an angle of 30deg., the moment of the two forces combined is

$$10 \times 10 \times \tfrac{1}{2} = 50 \text{ pound-feet.}$$

If the forces were acting at right angles to the lever, as in Fig. 76, the combined moment would be simply

$$FL = 10 \times 10 = 100 \text{ pound-feet.}$$

(To be continued.)

"INFLUENCE MACHINES, FROM 1788 TO 1888."*

BY PROF. S. P. THOMPSON.

(Continued from page 183.)

Almost at the very same time, and quite in ignorance that any other inventions of this kind were going on, there were a series of beautiful machines brought out by Sir William Thomson. In 1867 or 1868 he was at work upon some of these. There is one shown here at Fig. 15. The field-plate in this machine is in the form of a metal box; there are two of these, one on either side of the rotating armature. The latter has carriers upon it, and there is a pair of neutralising springs to touch these carriers while they are under influence, and other springs, or brushes, to receive the charges that were brought round. You have all the same parts of the organism as existed in Belli's and in Varley's machines, only you have them arranged a little more scientifically. Sir William Thom-

* A Paper read before the Society of Telegraph-Engineers on May 31st, 1888.

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son expressly draws attention, I think, to the spring contact, and he also speaks subsequently (this is a point I confess I do not quite understand) of the great power of Holtz's machine as being due to the absence of the metallic carriers which he himself and others had been employing. This machine Sir William devised to serve as a "replenisher" for his quadrant electrometer, though very soon the more compact form of replenisher, with two narrow brass strips as carriers (Fig. 16), was substituted for that with the disc armature. The model here, 11in. in height, is a self-charging machine, differing only in size from the actual electometer replenisher. It was constructed by my assistant, Mr. Rousseau.

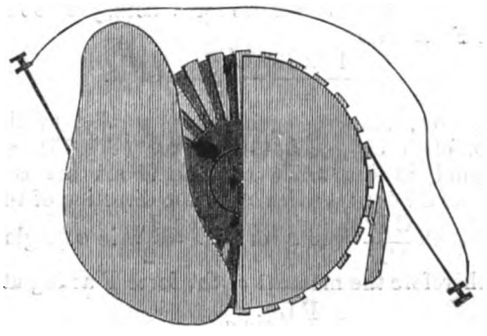

Fig. 15.—Sir W. Thomson's Replenisher (disc form).

In Fig. 17, which gives a sectional diagram of the replenisher, F F are the field plates, C C the carriers, $n\,n$ the neutralising brushes, and $a\,a$ the appropriating brushes, which receive the

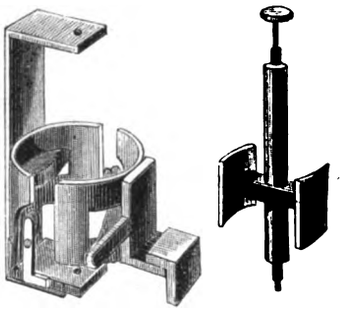

Fig. 16.—Sir W. Thomson's Replenisher, used in his Quadrant Electrometer.

charges as they come round on the carriers. I think, however, I shall do a very great injustice to Sir William Thomson if I let you imagine that that was his only machine. He has been kind enough to lend me for exhibition here two other

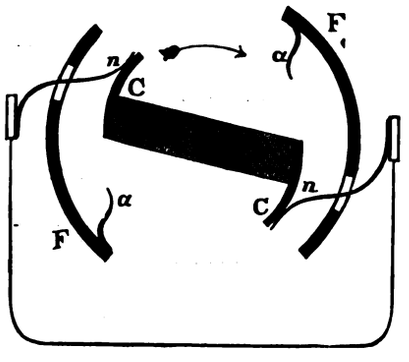

Fig. 17.

machines. They are interesting as being machines with rotating carriers and multiple field-plates, of a pattern which he devised for electrifying the ink vessel of the siphon recorder. I do not know whether these two actual instruments were early or late in the history of development, but they are very interesting—particularly interesting to me, inasmuch as they carry out an analogy which I have often dwelt upon between the influence machine and the dynamo. The lower field-plate is in position here underneath; the upper field-plate is a sort of cover to the machine—it has been removed so that you can see the armature. Now, from each row of the various sectors of the armature there comes out (insulated, of course) a metal pin. These metal pins stand out at the end like the parallel bars of the commutator of a dynamo—in fact, this is the commutator of the machine; and there are two pairs of metallic brushes, which rest on these commutator bars and take up

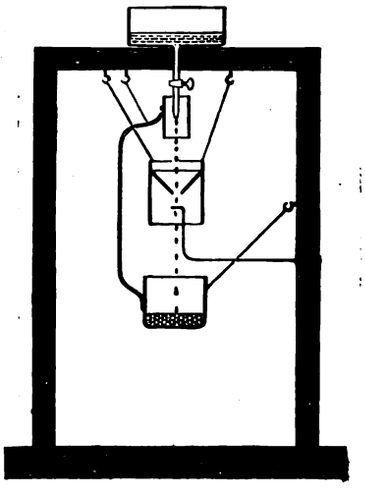

Fig. 18.—Modified Water-dropping Influence Machine.

the discharge just exactly as the brushes of the dynamo do. You can hardly have a more beautiful instrument on which to trace out the analogy between the influence machine and the dynamo. This

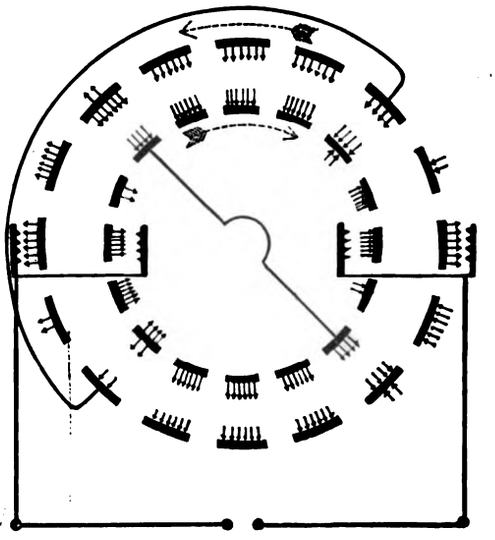

Fig. 19.—Diagram of Action of a Wimshurst Machine.

machine, known, I believe, as the "mouse-mill," and the "replenisher," and the "potential equaliser" are, however, not nearly

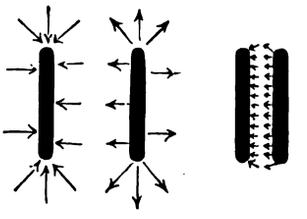

Fig. 20. Fig. 21.

all of Sir William's influence machines. There is one in which, without any rotation or any parts to rotate, he employed exactly all these principles—the touching of a carrier under influence and the reciprocal action from positive to negative. I have a rough model here of this most curious instrument. It looks very unlike the other instruments; it is the "water dropper." Here are two cylinders, and water might be arranged to drop in drops from nozzles through the cylinders; if the cylinders are electrified the drops will, in the act of dropping from the nozzles, be virtually touched while they are under influence. They thus drop through

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the cylinders electrified with charges opposite in sign to those of the cylinders through which they respectively fall. The drops which fall through the positive cylinder give up their negative charges to increase that on the negative cylinder, while those that fall through the negative cylinder acquire positive charges which go to increase that on the positive cylinder. There are also some Leyden jars to stand thus and receive the accumulated charges. A few months ago I thought it might be convenient to simplify the pattern somewhat, and here is a much more portable form of Sir William Thomson's water-dropper which I have described in the *Philosophical Magazine* (Fig. 18). The water drops here through a cylinder at the top into a second cylinder, and then it drops from this, being touched in the act of dropping, by a wire underneath, while under influence, into a third, a mere can to catch the water, and which is connected metallically to the top cylinder. The insulation is effected by means of well-paraffined silk strings supporting the cylinder and the can.

Meantime improvements came about in other directions. The difficulties that were found in the construction of Holtz's machines led to various suggestions in detail. In 1886 Prof. Morton, of New York, proposed to replace the Holtz plate, with its windows, by pieces of glass coming up from four sides. Similarly, about 1881, when Mr. Wimshurst was thinking of the problem of the influence machine, it occurred to him that the best way to make those windows in the Holtz machine was to take two separate pieces of glass and fix them a little apart from one another, with the paper field-plates pasted on behind. That, indeed, was the beginning of Mr. Wimshurst's researches. His first step was to adopt this small improvement. There is here a small 12-plate Holtz machine devised at that time by Mr. Wimshurst on this plan. Then certain things suggested to his mind that it would be better to make both plates go round, and to make them go round in opposite directions. That idea was soon put into shape, and we have here the original machine exactly as it was the day that it was completed—a pattern which has hardly been altered even in the most recent of Mr. Wimshurst's machines. The two discs are driven in opposite directions. There are two sets of neutralising brushes going across diagonally front and back opposite quadrants, and there is a pair of discharging knobs. This machine charged itself the first time it was tried, and now charges itself as I turn the handle. From time to time other patterns embodying the same idea have been produced. Mr. Wimshurst has kindly lent me a machine with two rotating cylinders, one inside the other, a pattern which has lately been made up differently with ebonite cylinders.* I have here a larger machine, by Mr. Wimshurst, which he has kindly lent me. It has four pairs of rotating plates. There is no trouble about exciting this kind of machine ; it excites itself with a very small number of turns of the handle. Now, it has occurred to me that it may be useful to have a somewhat different method of representing the facts than has hitherto been common. The method of representing the action of a machine by drawings such as depict the parts as sections of a cylinder is due to Bertin. I have used it here in a diagram, in explaining Clarke's gas lighter for example. It has occurred to me that it was better to have some kind of a drawing in which one would be able to study, not simply the charges on the surfaces of the conductors or the conducting parts, but also the action in the space between ; because, after all, that is the really important thing. Therefore I have devised a diagram (Fig. 19) to represent the facts of the distribution development of the charges in a Wimshurst machine. Those two circles of black marks represent the two sets of metallic sectors or carriers on the two rotating plates ; each plate, front and back, has its set of carriers. Here they are represented as one being outside the other, and as this is drawn the inner set must be considered as going round right-handedly and the outer set as going round left-handedly. Now, consider what would be the result if a sector at any point possessed a positive charge. It will exercise an influence all round it. You will have lines of electric force proceeding from it into the field. I have not attempted to draw these lines, but I have attempted to suggest them. If you have an insulated charged conductor in the middle of a space its electric lines may be considered as radiating out in all directions. If you have a disc charged—say, positively—from every unit of the charge on its surface there will go out lines of electric force in different directions. Suppose you have a negatively-charged plate, you will also have lines coming in from different directions. In Fig. 20 I suggest that there are two insulated metal discs, seen edgeways, one charged negatively, the other positively, at some distance apart. The charges are distributed most strongly at the edges of the discs, but also to some extent on their flat surfaces. In Fig. 21 the same two discs are represented as having now been put close together, with the result that their charges now act strongly upon one another, nearly all the lines of electric force being concentrated across the intervening layer of non-conducting air or glass. You have these positive and negative charges attracting one another, and accumulating on the two surfaces which are nearest together, the electric forces acting across the dielectric, which lies between.

I have chosen to represent the positive units by drawing arrows with their heads proceeding out from the surface, and the negative charges are represented by the arrow heads turned with the head inwards towards the charged surface.

Now, in the Wimshurst machine, to which this diagram with its two circles relates, some of the metal carriers are charged positively, others negatively. Consider the carrier on the back (or outer) set positively charged, and situated on the left at 45 degrees above the horizontal diameter. Opposite this positively-charged sector there is a metallic sector in the front (or inner) set, going across from left to right. As it passes it comes into contact with a brush of fine wires on the end of the diagonal conductor. This neutralising brush touches it while under influence. As a consequence there would be electric displacement taking place across that dielectric, and this metal plate will become negatively charged. As all the front (inner) sectors pass this point they go on over the top negatively charged, whilst for precisely analogous reasons the back (outer) sectors behind them on the right come over the top positively charged ; they have been touched by the other neutralising brush while under the influence of the negative charges on the front (inner) sectors. The sectors of each set, while acting as carriers of their own respective charges, act also as field-plates to influence the carriers of the other set. Further, while the positively and negatively-charged carriers are passing one another, their charges attract one another, and there would occur sparks across between them if it were not for the plates of glass which separate them. As each carrier comes up to be touched by the neutralising brush, there will be a rush of electricity down that conductor to the other

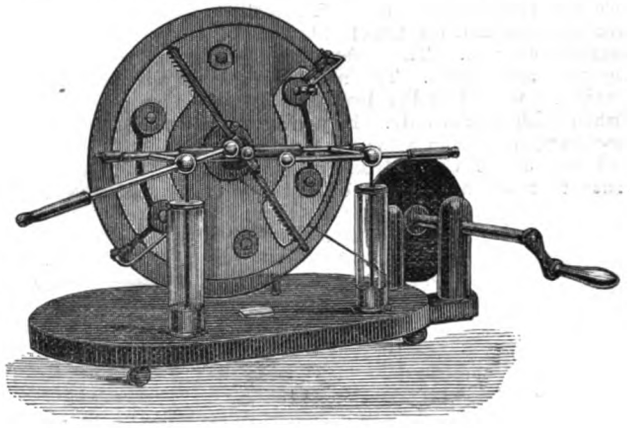

FIG. 22.—Voss Machine.

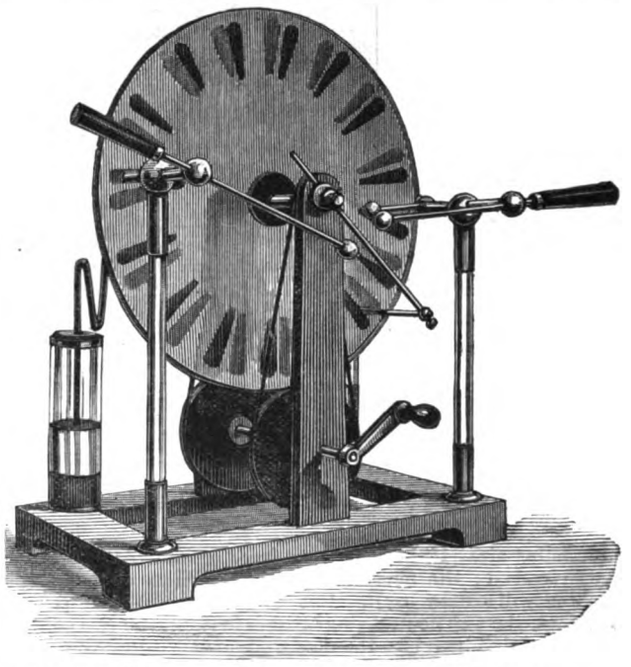

FIG. 23.—Wimshurst Machine (Harvey and Peak's form).

* See *The Electrician*, May 18th, 1888, p. 45.

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end, where a similar action, but of opposite sign, is taking place. I have drawn my diagram as though each (back) carrier coming over the top from right to left brought a charge of 6 units of positive charge. Each carrier of the front (inner) set, as it passes under the neutralising brush at 45° above the horizontal on the left, is considered as having electricity driven out of it by the influence of these positive charges, and as being left in a state of negative charge to the amount of 6 negative units. In the lower half of the machine similar actions are going on, with the result that the positive charges are brought to the left side of the machine by both discs, whilst negative charges are brought by both discs to the right side. A pair of discharging combs face the two discs on the left side to receive the surplus positive charges, and on the right there is a pair to receive the negative charges. These combs are connected to the discharging rods and knobs. The neutralising rods are, as I have said, furnished with metallic brushes, the discharging rods are furnished with combs only. If you have only combs, as in Holtz's machines, and as in some of Varley's machines, those machines will not excite themselves. You require an initial charge in order to make a sufficient effect to produce a discharge across the same sign, and they will of course repel one another. Now, here is a piece of apparatus made by Mr. Wimshurst, which enables me to show you this in the most beautiful way. It is simply the mechanism of a machine with two plates, and with diagonal neutralising rods, furnished with brushes, front and back; but there are no discharging rods or combs. These discs are made, not of glass, but of that rather vague substitute *dermatine*, a composition of india-rubber, and I do not know what other materials, flexible, closely resembling leather. If I excite this machine the discs actually bend towards one another top and bottom, but bulge out away from one another on the right and left. Here is another form of Wimshurst's machine (Fig. 23), kindly lent for exhibition by Messrs. Harvey and Peak, who have themselves introduced some small but not unimportant improvements in the details of mounting the discs on the driving pulleys and in the form of brush holders. I will now invite your attention to this very large machine with twelve plates (Fig. 24), constructed and exhibited here to-night by Mr. Wimshurst. When I left it at six o'clock the handle was tied up, and it has not been moved since; it has been tied up all day. Therefore, there is no possibility of its having had any recent charge. I want you to see that this machine will excite itself, and I ask you

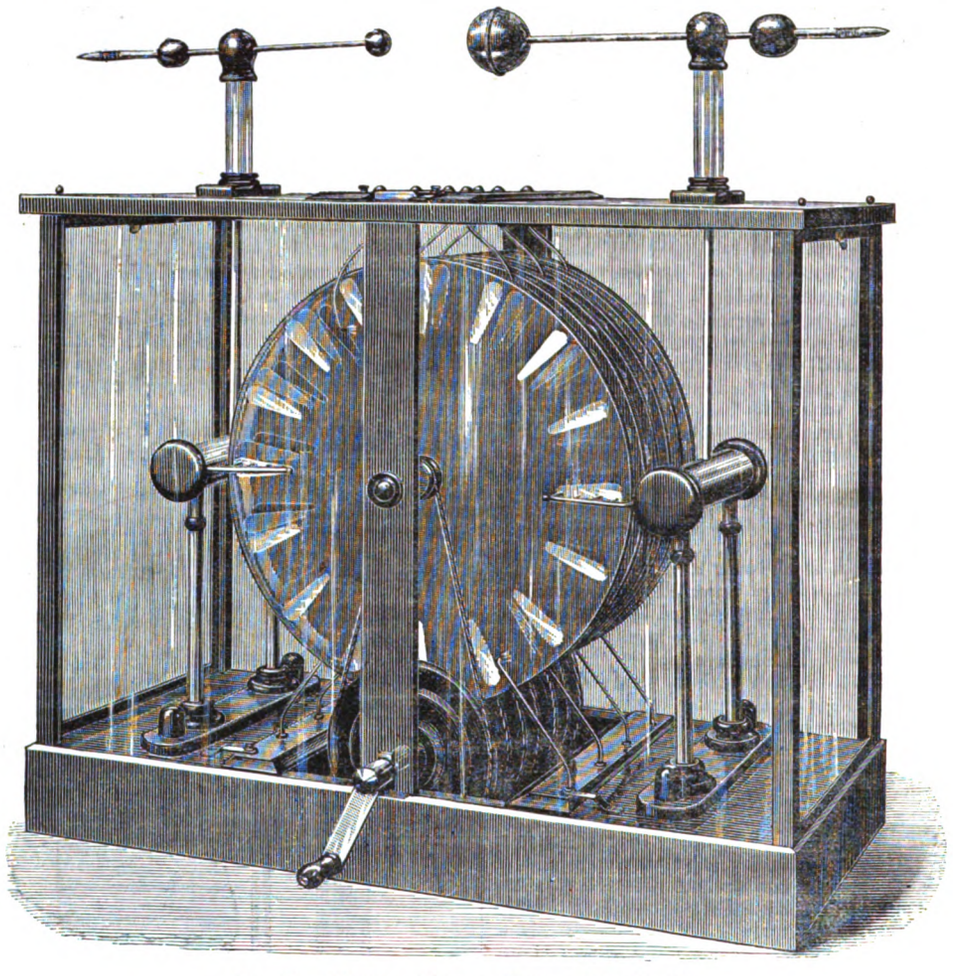

FIG. 24.—Wimshurst's large Twelve-plate Machine.

intervening air. If, however, you have brushes actually touching at the ends of the neutralising parts, then as a general rule the machine will excite itself. But if you have all the parts of the machines, the two neutralising brushes in front, the two neutralising brushes behind, and also the discharging apparatus, all made with brushes, the machine may excite itself; but then something else will happen. If you touch one of the discharging apparatuses so as to take a great discharge from one side, you are discharging through a metallic circuit, and you do more than you intend to do: you will probably reverse the machine in the very act of taking the discharge. You, therefore, ought not to have brushes, but combs, on the discharging part of the apparatus; and in all the recent examples of Mr. Wimshurst's machines—and for that matter I think in the latest Voss machines (Fig. 22), too—you will find that while the neutralising apparatus is provided with brushes, the discharging apparatus is provided with combs. I have already pointed out that in the region at the top, the two sets of carriers acquire charges of opposite sign, which attract one another. The same thing is true of the region at the bottom, but the respective signs are reversed. But at the sides, right or left, the charges of the two plates are of the to notice with what an extremely small amount of turning the machine does excite itself. I will take this very admirable electroscope and connect it on, and then I will turn as slowly as I can. You are to tell me when the machine excites itself. [Prof. Thompson here experimented with the machine, which had strongly excited itself when the handle had been slowly moved through about $\frac{1}{10}$ of a single revolution.] There is not much doubt about the power of that machine to excite itself; in fact, those machines, made as they are with good metallic connections for the two neutralising circuits that constitute the real working part of the machine, never fail to excite themselves. [Mr. Wimshurst here assisted Prof. Thompson in experimenting with the machine. Fig. 25 gives in reduced size a photograph of some of the sparks discharged from this most powerful machine.]

My account of influence machines would not be complete if I did not mention a most pregnant little paragraph in Maxwell's "Electricity," wherein that celebrated physicist proposed a form of influence machine (which, so far as I know, has never been made) having a device for avoiding the loss of energy that there necessarily is in the fact of internal sparks occurring in the machine.

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This he proposed to effect by adding certain supplemental conductors, which entirely obviated, at any rate in theory, the occurrence of internal sparks, and which therefore would add to the efficiency of the machine. Further, my summary of this subject would not be by any means complete (I propose to add it in my printed paper), without reference to the more theoretical researches of Rossetti, of Righi, and of Kohlrausch, and others upon the yield of these machines, and upon their internal resistance. The electromotive force of any given one of these machines is practically constant, no matter what their velocity; but the internal resistance decreases as the velocity increases, once more showing that a moving charge of electricity on a succession of moving charges

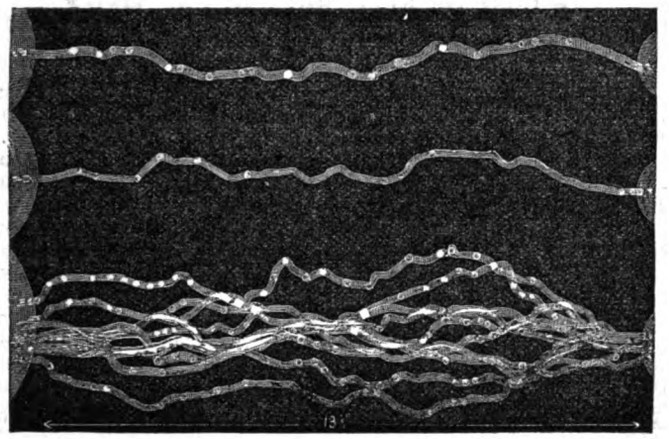

FIG. 25.—Photographs of Sparks from a Wimshurst Machine.

of electricity is the equivalent of a current. This is a topic which one might with advantage pursue a good deal further. There are also some rather interesting researches made by Bouchotte upon a small machine as to the actual work done in the machine in turning it; the torque between the two plates being measured at the same time as the velocity, and so the actual work done in the machine is measured. Time also fails me to tell of the experiments made by Poggendorff, by Holtz himself, and by Christiansen on the reversibility of the functions of the machine, how it can be made to act as a motor, receiving currents from another machine and revolving. Also my account would not be complete if I did not refer to two of the commercial applications of this very interesting scientific instrument. I mean first of all the suggestion of Prof. Lodge that such instruments should be used for collecting dust, smoke, and fog, and in that way dissipating them; and, secondly, the gaslighters which have been made on this very principle. I presume that was not in Nicholson's idea, inasmuch as there was no gas to light in his days. Some years ago Mr. Molison took out a patent for a form of influence-machine, in which he proposed a fixed disc and a movable disc, the movable disc being

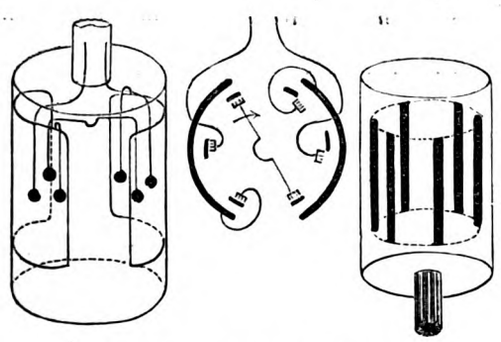

FIG. 26.—Clarke's Gas-lighter.

weighted so that you could swirl it round; but this in the more modern machine has been replaced by a little spring trigger, which actuates a small machine. There is one of them here opened to show how the trigger sets the disc in rotation. Then even before Molison's had come by any means to its present efficient form, Clarke had produced a form of gas lighter with which many of us are familiar (Fig. 26). The internal structure of this is, I may say, almost identical with that of Sir William Thomson's replenisher. There are two tin-foil field-plates, and there is a rotating cylinder of ebonite, which has eight pieces of metal foil upon it to serve as carriers. The essential parts are these two field-plates, the set of carriers on the rotating armature, a pair of neutralising brushes fixed to a cross conductor, and a pair of little appropriating brushes—if you will let me call them so—that take the induced charges as they come over and give them to the field-plates, and give them their accumulated charges. Last of all, there are a pair of discharging wires, connected through the stem of the instrument to the sparking tip, here.

Prof. Thompson exhibited a few other miscellaneous pieces of apparatus, and a discussion followed which will be given in our next week's issue.

(To be concluded.)

PHYSICAL SOCIETY.

At the meeting of this Society, held on the 9th inst., Dr. A. H. FISON described a

"Method of Comparing Very Unequal Capacities."

One of the coatings of each of the condensers to be compared is earth connected, and also connected with one end, A, of a resistance of 20,000 to 30,000 ohms, through which a current is maintained by means of a constant battery. The smaller condenser is charged to the difference of potential existing between the ends A B of the resistance, and is then discharged into the larger one. This operation is repeated a large number of times. The insulated coatings are then joined through a galvanometer, with a point, C, between A and B, C being adjusted so that on completing the galvanometer circuit after n operations there is no deflection.

Let C_1 and C_2 be the capacities of the large and small condenser respectively, R_a and R_b the resistances between C and A, and between C and B respectively, then the ratio of C_2 to C_1 is given by the equation

$$\left(1+\frac{C_2}{C_1}\right)=\frac{R_a}{R_b}.$$

As some time is necessarily occupied by the operations it is impossible to determine in this manner the relation between the instantaneous capacities, and they are therefore compared at a definite time after electrification.

The operations of charging and discharging the small condenser are effected by means of a specially constructed rotating key, which repeats the double operation ten times at each revolution. An automatic arrangement is provided for throwing the key out of action after a pre-determined number of revolutions. The author has used the method for comparing the capacity of a small air condenser with that of an ordinary micro-farad condenser. The capacity of the air condenser was calculated electro-statically, and a calculated correction for the edges was applied. The capacity of the larger was measured electro-magnetically by means of a ballistic galvanometer, and the result of the comparison by the above method gave for b the value $2{\cdot}965\times10^{10}$ centimetres per second, after applying a correction for the capacity of the rotating key.

The author states that under favourable conditions capacities of as high a ratio as 10,000 to 1 can be compared by this method with an error of not more than 0·25 per cent.

Prof. AYRTON pointed out that a similar method had been employed by Prof. Perry and himself, and was described in their Paper on "The Specific Inductive Capacity of Gases." They had, however, abandoned the method on account of the difficulties which they encountered from leakage and absorption. He considered, therefore, that the interest of the Paper consisted in the description of the rotating key, which might very possibly overcome the difficulty due to leakage. In their instrument they had not used any device of the kind. The edge correction would be of interest if it were found that it could be applied with accuracy.

New Electric Lantern.

Mr. LANT CARPENTER exhibited a new form of lantern which had recently been built by Mr. W. C. Hughes, of Dalston. The body, which is made of mahogany, is in the form of a hexagonal prism, and is capable of rotation about a vertical axis.

The adjacent sides are provided respectively with—(1) a lantern microscope, with a very complete set of condensing lenses and objectives, a polariscope, and various adjuncts not often used in connection with lantern microscopes; (2) an ordinary projecting arrangement for lantern slides; (3) an arrangement for the projection of spectra, the prisms being carried on a small table sliding upon rails which also support the projecting lenses. The source of light employed is a modified form of the Brockie-Pell arc lamp.

Prof. S. P. THOMPSON considered that Mr. Carpenter had been judicious in his selection of the Brockie-Pell lamp, which was greatly preferable to the Belfast lamp, which he had himself used for a similar purpose, as in addition to being a focussing lamp, it had the important advantage of having a magnetic governor which was of such a construction as to work equally well when supplied

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with a constant current or with a current at constant difference of potential.

Prof. A. W. RÜCKER then read a note by Prof. T. E. THORPE and himself on

"Some Additions to the Kew Magnetometer."

In the Kew magnetometer the direction of the geographical meridian is determined by means of a small mirror in which an image of the sun is formed. When using the instrument in the field it is of the utmost importance to have this mirror in perfect adjustment.

The axis is made horizontal by means of a riding level. The plane of the mirror is made parallel to the axis by adjusting it until the image of the cross wires formed in the mirror is unchanged in position when the mirror is inverted in its bearings.

The plane of the mirror is made perpendicular to the axis of the telescope by making the cross wires and their image coincide.

In their recent magnetic survey of Great Britain and Ireland, the authors experienced so much difficulty in making these adjustments in the field that they usually adjusted the mirror from time to time indoors by means of a plumb line, or by observations on some convenient external object.

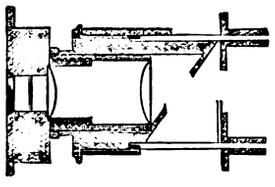

FIG. 1.

In order to eliminate errors of adjustment, the authors always, when possible, took four sets of observations of the sun, reversing the mirror in its bearings, and taking observations both with the observer facing the sun and with his back to it.

On cloudy days the sun frequently does not remain in view long enough to allow these four observations to be taken, and there is often no neighbouring object of sufficient elevation to be used for purposes of correction, and it is then necessary to trust to the previous adjustment. It was found that the mirror was not put out of adjustment to any considerable extent in moving the instrument from place to place; but it was, nevertheless, much more satisfactory to be able to test the adjustment in the field.

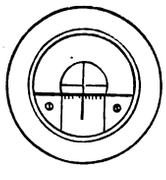

FIG. 2.

The method by the image of the cross wires was difficult to employ on cloudy days, as the light admitted through the aperture in the side of the telescope near the cross wires was insufficient, and even on bright days it was found desirable to envelope the observer's head and the instrument in a dark cloth, which was difficult in a high wind.

To overcome this difficulty the authors have made some additions to the instrument. A polished platinum mirror, with a hole in its centre, is fixed between the eyepiece and the cross wires at an angle of 45deg. with the axis of the telescope as shown in Fig. 1, and by this means when the aperture in the side of the telescope is directed towards a bright portion of the sky a considerable amount of light is reflected on to the cross wires.

To exclude extraneous light a brass tube is fixed between the mirror and the telescope by means of a support fitting into the three holes provided to fix the magnet-box in position. If the background reflects much light a small blackened metal screen, weighted with lead, is placed on the small horizontal circle which carries the mirror, and it can be removed without in any way affecting the adjustment.

It is in some cases impossible to take the back observations, or the sun may be so uncertain that it is desirable to take observations without waiting to adjust the mirror. In order to determine the error introduced the authors place a fine scale engraved on ivory (Fig. 2) in the plane of the cross wires, and determine the angular deviation of the mirror which produces a given displacement in the image of the cross wires on the scale, so that the error of the mirror can be subsequently determined by reading the displacement of the image on the scale. A series of observations taken with the mirror in good and in bad adjustment respectively, the latter being subsequently corrected by this method, were found to give closely concordant results.

The Rev. Father PERRY said that though the authors had described their improvements as small ones, he considered them to be improvements of the greatest value. He had experienced similar difficulties in using the Kew magnetometer, and had frequently found it necessary to use a theodolite instead of the mirror, and it was very inconvenient to be obliged to carry a theodolite in addition to the other instruments.

THE COST OF ELECTRIC ARC LIGHTING.*

BY C. M. KELLER.

It is evident that electricity as an illuminant has entered the lighting field to stay; therefore the cost of its production is of no small import to those who are engaged in the manufacture of gas. In presenting this Paper it is our purpose to show from tests the cost of electric light, in order that all interested may at least be enabled to figure upon it intelligently.

The time is coming when most all street lighting, in the larger cities as well as smaller, will be done by electricity, and it can be furnished by the manufacturers of gas at less cost than any new corporation or by the city itself.

It would be impossible to state the cost of electric light in every locality, as the price of fuel and labour varies as much as in the manufacture of gas, and the increased quantity made decreases the cost of manufacture; for instance, excluding material, the same amount of labour required to make 10,000 cubic feet of gas per day would as readily make 30,000 cubic feet. For like reason the same amount of labour required for a 50-light plant will maintain a 100-light plant. The nearer the machine to its maximum load the less power required per lamp—that is, a 50-light 2,000 candle-power American machine, with one light, requires 20·5 horse-power; the same machine with 25 lights 28·38 horse-power, or 1·13 horse-power per lamp; and with the maximum load, 50 lights, 46·36 horse-power, or ·925 horse-power per lamp.

Many manufacturers of electrical apparatus create a wrong impression in the minds of purchasers by under-estimating the amount of power required to run a dynamo, the power at the machine *only* being taken into consideration and *not* the power of the engine; thus a 50-light machine is rated from 35 to 38 horse-power when it requires 40 to 50 horse-power.

I will state here that the company which I represent has in operation two systems, the Thomson-Houston and the American, a 50-light plant of each, and a separate engine for each machine. After the establishment of a plant the most important thing to be considered is the fuel, which is the cheapest and best adapted for the work to be accomplished. In order to ascertain this, tests were made on October 19th, 20th, and 21st with 79 lamps each night, as follows:—

	No. Lamps.
City circuit all night (12 hours)	49
9:30 o'clock commercial circuit (4½ hours)	18
11 o'clock ,, ,, (6 hours)	12
	79

On the night of the 19th we consumed 6,600lb. of Indiana nut and slack coal at $1.30 per ton, amounting to $4.29; the 20th, 200 cubic feet of tan bark at 50 cents per 100 cubic feet, and 3,200lb. Pittsburg lump coal at $2.50 per ton, amounting to $5.00; the 21st, 4,160lb. Pittsburg coal at $2.50 per ton, amounting to $5.20; from which it will be seen that Indiana nut and slack at the prices named is the cheapest, also that one ton of Pittsburg lump is equal to 1½ ton of Indiana nut and slack coal.

We will now proceed to itemise the actual expenses incurred by an all-night run (12 hours) on a 50lb. Thomson-Houston machine running forty-eight street lights, viz.:—

4,500lb. Ind. nut and slack coal, at $1.30 per ton	$2.93
Engineer, one night, at $50.00 per month	1.67
Trimmer, one day, at $40.00 per month	1.33
Superintendent or electrician, one day, at $50.00 per month	1.66
Waste, &c., one day, at $20.00 per year	05
Water rent, one day, at $40.00 per year	11
96 prs. carbons, at $18.50 per month	1.78
One pint cylinder oil, at 60c. per gallon	07
One quart engine and dynamo oil, at 50c. per gallon	13
One day repairs on machine and lamps,, including globes, at $120.40 per year	33
One day taxes on 50-light plant, assessed at $5,000, at 2¼ per cent.	31
One day interest on 50-light plant ($10,000), at 6 per cent.	1.67
Making a total of	$12.04

* A Paper read before the Western Gas Association of America.

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Or 2·508 cents per lamp; but since most all street lighting is done by moon calendar, it is necessary to make an estimate of a six-hour run, the average time per night, viz. :—

2,600lb. Ind. nut and slack coal, at $1.30 per ton	$1.69
Engineer, one night, at $50.00 per month	1.67
Superintendent or electrician, one night, at $50.00 per month	1.67
Trimmer, one day, at $40.00 per month	1.33
48 pairs of carbons, at $18 50 per m.	89
Waste, &c., at $20.00 per year	05
Water rent, at $40.00 per year	11
Half-pint cylinder oil, at 60c. per gallon	04
One pint engine and dynamo oil, at 50c. per gallon	05
One day repairs on machine and lamps, including globes, at $120.00 per year	33
One day taxes on 50-light plant, assessed at $5,000, at 2¼ per cent.	31
One day interest on 50 light plant ($10,000), at 6 per cent.	1.67
Making a total of	$9.82

Or 20·45 cents per lamp.

Both of the foregoing tables refer only to street lighting, and any corporation engaging in street lighting alone will find this to be the expense incurred for either all night or moon calendar lighting.

We will now turn our attention to commercial lighting; for this purpose we use a 50-light American machine.

Expense incurred for 48 commercial lights on a six-hour run :—

2,300lb. Ind. nut and slack coal, at $1.30 per ton	$1.50
Engineer and trimmer, one day, at $50.00 per month	1.67
Supt. or electrician, one day, at $50.00 per month	1.67
Waste, &c., one day, at $20.00 per year	05
Water rent, at $40.00 per year	11
48 prs. carbons, at $18.50 per month	89
Half-pint cylinder oil, at 60c. per gallon	04
One pint engine and dynamo oil, at 50c. per gallon	06
Wheeling coal and removing ashes, at $2 per week	29
One day repairs on machine and lamps, including globes, at $63.40 per year	18
One day taxes on 50-light plant assessed at $5,000.00, at 2¼ per cent.	31
One day interest on 50-light plant ($3,000), at 6 per cent.	1.33
Making a total of	$8.10

Or 16·87 cents per lamp.

We have had in our city an average of about 35 commercial lights, and the only difference in maintaining them and the full number (30 lights) is in the amount of fuel and the number of carbons consumed.

These estimates have been made separately, on independent 50-light plants; but combining the two as a 100-light plant, the cost of maintaining 83 lamps on a six-hour run is :—

4,500lb. Ind. nut and slack coal, at $1.30 per ton	$2.93
Engineer, one night, at $50.00 per month	1.67
Supt. or electrician, one night, at $50.00 per month	1.67
Trimmer, one day, at $40.00 per month	1.33
Waste, &c., one day, at $20.00 per year	05
Water rent, one day, at $40.00 per year	11
Wheeling coal and removing ashes, at $2.00 per week	29
83 pairs carbons, at $18.50 per month	1.54
One pint cylinder oil, at 60c. per gallon	07
One quart engine and dynamo oil, at 50c. per gallon	13
One day repairs on machine and lamps, including globes, at $167.95 per year	46
One day taxes on 100-light plant assessed at $8,000, at 2¼ per cent.	50
One day interest on 100 light ($5,000), at 6 per cent.	2.50
Making a total of	13.25

Or 15·96 cents per lamp.

The above is the cost of running forty-eight street lights and thirty-five commercial lights for the first six hours of the night, when it is necessary for us to fire two boilers, which require 1,200lb. of coal to raise steam, or 600lb. for each boiler; now, if the commercial lights were lit in the fore part of the night, as usual, and the street lights not until ten or eleven o'clock, then the firing of one boiler would suffice, thus saving 600lb. of coal in the night run.

In all of the tests it has been shown the amount of Indiana nut and slack coal required per horse-power to be 6½lb., that is, after steam is raised, or with Pittsburg lump coal one-third less, 4·34lb. per horse-power.

It must be borne in mind that nothing has been allowed for depreciation on plant, burning of armatures, repairs on boilers, or accidents of any kind; you will also observe that commercial lighting is more profitable than street lighting, as it requires less labour, the engineer of a 50-light plant performing the duties of a trimmer; also that the circuit is shorter, consequently less resistance and attention.

In reference to the two systems, the Thomson-Houston and the American, no difference in the quantity, quality or steadiness of the light can be detected, as each carry a current of 9·6 amperes, but in regard to the cost of maintaining, there is a vast amount of difference in favour of the American. We have operated the Thomson-Houston system for 15 months to April 1st, 1888; repairs on same for 48 lamps and machine have been $150.50, or $120.40 for one year; making $2.51 per lamp. Three lamps fell accidentally and were broken, repairs on same $21.46, making an additional expense of 44½ cents per lamp.

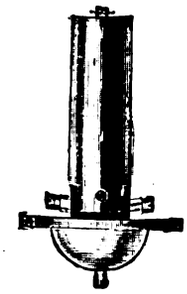
We have operated the American system one year to April 1st, 1888, repairs on same with an average of 35 lamps, $47.55, or $1.36 per lamp, showing a difference of $1.15 per lamp between the two systems, in favour of the American.

We have tested both systems in an impartial manner, by exchanging circuits—that is, by throwing the Thomson-Houston machine on the American circuit, and the American machine on the Thomson-Houston circuit, with fifty and twenty-five lamps; in every instance we find the American system requires the least power, is less expensive in the way of repairs, &c., requires less attention; and these we think are the most important points to be considered.

A gas company can operate a gas and electric plant combined advantageously, as in most cases it requires no purchase of real estate, no additional office rent or clerical force; the salary of the superintendent for the two combined would be less than if operated separately; all steam fitting and pipe work can be done at cost, the coke, breeze, and waste fuel from the gas works can be utilised, and the consumer furnished with either gas or electricity, and thus avoid the necessity of fighting opposing companies with low-priced gas.

BURGLAR ALARM WINDOW AND DOOR CONTACT.

For some time past a reliable burglar alarm contact for the protection of windows and doors has been greatly needed which will not be affected by damp or badly-fitting sashes. The contact illustrated in the adjoining figure is easily fixed in the bottom of the frame; by means of a centre-bit a hole is bored in the sash to fit over the projection, which effectually prevents any water from getting into the contact, and also prevents the possibility of a burglar stopping its action, which he can often do in the usual pattern by



means of a knife. The circuit is completed by means of a washer, making a rubbing contact on two springs. This contact is supplied by Messrs. J. T. Mayfield and Co., of 35A, Queen Victoria-street.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June 9th*, 1888.

Our Patent Office has been kept quite busy lately issuing patents relating to electricity, and especially for the utilisation of alternating currents. During the week ended May 29 no fewer than 69 electrical patents were issued, and of these about one half were assigned to the Westinghouse Company by Messrs. H. M. Byllesby, O. B. Shallenberger, P. Lange, and others, who are, I believe, in the service of the company. These patents relate to a number of details, such as circuit-controlling apparatus, indicators, meters, synchronising devices, methods for combining the alternating-current and storage-battery systems, and the like. One patent of seeming novelty is that issued to Mr. C. E. Fritts, whose work in connection with selenium cells two or three years back may not be forgotten by your readers. Mr. Fritts proposes to utilise alternating currents for lighting and power in connection with condensers. The idea of Mr. Fritts seems to be, if one may guess at the meaning of some of the language in the patent, that by the use of condensers he obtains at least three or four times the result from the same current as would be obtained without them. This, of course, would be an enor-

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mous saving, but, so far, no evidence has been adduced to prove either that the condensers themselves could be given a current capacity equal to the heavy work involved, or that they would operate on a sort of perpetual-motion principle, so that the current which served the lamps in one section of his line would serve half-a-dozen other sections equally as well. Yet another patent which deserves mention is that which has been granted to Camille A. Faure, and assigned by him to the Electrical Accumulator Company. The important claim of this patent is in the method of preparing secondary battery plates, consisting in applying to the plates or supports an active material in the form of a paste prior to immersion in the battery fluid. It has been generally understood that Mr. Brush held a patent of about the same nature, granted to him some three years ago. That being the case, it looks as if there were some contradictory views or actions in the Patent Office to be reconciled.

Speaking of alternating currents reminds me that reports from Boston tell of the active preparations being made for business by the Thomson Welding Company. This company was organised not long ago with strong backing, and is about to put its welding machines on the market. The company has a factory at Lynn, close to the big electric light works of the Thomson-Houston Electric Company. It is said that the welding machines will be sold, but that the company will collect a royalty for all welds that are made. Upon each machine will be placed a meter, which, it is said, will not register unless the weld is complete. There can be no doubt of the practical nature of this latest electrical application, and we shall probably soon hear of the general introduction of this machine.

The cable operators have, for a long time, looked down with a feeling of scorn upon their brothers at the ordinary Morse key, as the working of the latter has been regarded as a very simple matter. But the Morse operator may now hold up his head, for a device has just been brought out in which cable signals are transmitted, practically from an ordinary Morse key. The manner in which this is accomplished has been solved by Mr. P. B. Delany, whose synchronous system of telegraphy is familiar to you by its use in the Postal Telegraph system. As is well known, in the production of signals by the double-key method, many letters require reversed signals and the sending of opposite charges into the cable, thus swinging the syphon alternately above and below the centre line. This alternate charging reduces the speed of the cable, for if a short time only is allowed to elapse between, the outline of the curve does not become clearly defined, and the record flattens out to a straight line. Mr. Delany is working on the plan of transmitting Morse characters by a regularly reversed current of uniform duration. This is accomplished by means of a special construction of the key, together with an automatic device which allows the battery to be in connection with the cable only for a definite time, independent of the period of time during which the key is depressed by the operator. With this arrangement, when the key is depressed it first meets the contact which puts the battery to line, but at the very next instant meets another contact which operates an automatic device that breaks the circuit of the line. Therefore, as long as the key is held down, the negative battery cannot go to line; and hence, if the key be held down for the time represented by a dash, the instrument at the other line will so record it; *i.e.*, in the case of the siphon recorder, the siphon will remain deflected. Now, when the key is raised it makes contact at the back stop, sends the negative current into the cable, and the next instant it makes another contact that again breaks the circuit of the cable. Or, in other words, when the key is pressed down, a current of one polarity is sent; if it is immediately lifted up, a current of positive polarity is sent, lasting for the short time between the downward and upward movement, and forming the dot. If the key be depressed for a continued period the dash is formed; not by the passage of a long impulse of current, but because the positive polarity which terminates each signal has been deferred until the key is lifted up. Thus one current is the beginning of all signals, the other is the ending; the time between the beginning and the end determines whether the signal is a dot or a dash. The record made by this system on a cable one thousand miles long, and having 13,000 ohms resistance and a capacity of 900 microfarads, showed up with the utmost clearness, notwithstanding the fact that one half the number of cells with which the cable is ordinarily worked were available. About a year ago Mr. Delany experimented with this system in England, when on a visit there, and developed a speed of thirty words a minute over an underground cable having 7,000 ohms resistance and 90 microfarads capacity.

Mr. Edison publishes in this month's issue of the *North American Review* a very interesting article on his perfected phonograph. In this article he describes the manner in which the idea of the phonograph first came to him, and in which he worked it out, and he takes occasion to pay his respects rather satirically to those who have during the past ten years undertaken to improve his apparatus by re-inventing it for him, and then claiming it for themselves. The reason why he has let his great invention languish for so long a time is that his system of electric lighting has required all his inventive ability and directive energy, and even yet stands in need of new work in order to keep up with the demands of the times. The article gives an account of the various uses to which the phonograph can be put, and promises a speedy realisation of all of them. Mr. Edison is still working away at some of the details of the instrument, and in the meantime has it in every-day service, all the letters which leave his laboratory being, it is said, phonographically dictated. At any rate, I am told that they bear a little rubber stamp to that effect. I spoke just above about the details of the Edison lighting system. Through imperfections in one of these minor points, a couple of fires have occurred recently in central stations, but I think that hereafter the danger will be avoided. Considerable damage was done last week to one of the stations in Boston by a fire which occurred in one of the equaliser boxes. The station at Fall River suffered not long since in a similar way. These accidents point to the fact that with the stations now loaded up to their full capacity, as so many of them are, the heating of the iron wire in the boxes becomes perilous. Once the evil is known, it will, of course, be remedied, but it took this development and prosperity of the business, loading up the station to their fullest capacity, to expose the source of danger.

A very interesting Paper was read last week before the Boston Electric Club by Mr. G. W. Mansfield of the Thomson-Houston Electric Company, on the subject of elevated railroad systems, and their adaptability to electrical propulsion. In this country, as you are doubtless aware, there are a great many advocates of elevated railroads, of which those in New York may be taken as pre-eminent examples of success and ugliness. The great advantage of elevated roads is, that while they meet the conditions of rapid transit between all parts of the city, they leave the streets below free for ordinary traffic. One of the greatest objections to them is that the use of steam renders them noisy and oftentimes very offensive, and it is believed that a great improvement will be effected by the substitution of electricity for steam. These points were brought out by Mr. Mansfield, who also gave some very interesting details of the various types of elevated railroads, such as where the car could run on two rails on a single support, or straddle a single rail, or hang from a single rail; the last use being exemplified in some degree by the Enos road at South St. Paul, Minn., now being operated with success with Thomson-Houston motors. Mr. Mansfield mentioned that to operate the elevated roads of New York would require 12,000 horse-power of electrical motors, and allowing 50 per cent. loss between the engine and the cars, 24,000 horse-power would be required, which could be divided up along the line in a number of stations with 5,000 horse-power each.

In the June number of the *Street Railway Journal*, Mr. F. J. Sprague has a forcible letter in which he replies, on behalf of the parallel system for street railways, to certain statements which have been made by Mr. S. H. Short, in favour of the series system, in that journal. Mr. Sprague points out the great riskiness of operating the series system, due to the fact that there would be a variable pressure between

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different machines on a circuit, and from base to base through the earth of from to 100 to 6,000 volts. This, he says, it would be criminal for any public official to allow in use on a street railway, and worse than folly for any street railway man to depend on. As he points out, the case is different from that of the electric light wires, which presumably are well insulated, whereas those for street railway purposes would be perfectly bare, and with such high potentials would be liable to leakage and other trouble at any number of points. Mr. Short, in his article too, had figured out that 10 miles of track with 20 cars on the parallel system would require 2,450 horse-power, and that the daily running expenses would be nearly $250. Against this statement Mr. Sprague sets off the fact that his Richmond road, 12 miles long, with 20 cars each, doing 80 miles daily, requires only 200 horse-power in the station, and that the daily power expenses for operating are only $44.28, or only $1.48 per car. Mr. Short had also intimated that to operate 30 cars on the parallel system was practically impossible. Mr. Sprague replies that in the near future they will have 60 in operation at Richmond. The reply seems fairly conclusive. Mr. Sprague will probably go further, and give exhaustive data on this and on a variety of allied topics, when he reads his Paper before the American Institute of Electrical Engineers on the 19th inst.

The American Bell Telephone Company is now urging its suit against the American Cushman Telephone Company before the United States Court at Chicago for infringement. Cushman, it may be remembered, claims to have been engaged in 1851 in the construction of a Western railroad, and to have put in a little spare time in making a lightning arrester. He laid a telegraph wire from one point of the railroad to another, and enclosed the ends of the wire in plain pine boxes, one of which was put into the cellar of the telegraph station, and from which, much to Mr. Cushman's surprise, came noises like the piping of a bull-frog. He made an investigation, found that he could carry on a conversation over the line, and came to the conclusion that he had made a wonderful discovery. According to his story, he travelled through Ohio in 1867, exhibiting his invention, and he has produced twenty-one witnesses who remember this, and the earlier episode of 1851. The answer of the Bell Telephone Company is that Mr. Cushman had only invented an acoustic telephone, which was not in itself much of a success, and even granting Mr. Cushman all that he claims, his contrivance could not be held to be a prior invention to the Bell telephone and Blake transmitter. Another Western litigation which has just been settled is that of the Brush Company of Cleveland, at Indianapolis, against one of the Jenny companies, as to the infringement of arc lamp patents. The decision has been against the Brush Company, the judge dismissing the bills for want of equity; but it is said that the case will be carried on appeal to the Supreme Court.

NOTES FROM PARIS.

(FROM OUR OWN CORRESPONDENT.)

19*th June*, 1888.

I have no change in electrical matters to report since my last letter, and with all the difficulties which the local and Government authorities are placing in the way of those who wish to lay wires for public lighting, it does not seem at all probable that the situation will soon improve. The Minister des Finances, who is at the same time Chief of the Posts and Telegraphs, has obtained from the President of the Republic a new decree for the regulation of electrical installations. It would be too tiresome to give you the full text of this decree, which seems to have been drawn up entirely in the interests of the gas companies. The decree is accompanied by a report of the Minister, who, after having explained the favour which electrical lighting meets from the public, adds:—"However, we cannot refrain from saying that this new industry may give rise to serious accidents if well studied measures of precaution are not imposed upon contractors, in order to control and master, as far as possible, the powerful physical agent which is at work. Accidents, some of which were unhappily followed by loss of life, have already shown the dangers with which, in certain cases, the contact of the human body with conductors carrying powerful currents is accompanied; on the other side, experience proves that electric lighting, justly considered as likey to diminish the risks of fire, may, on the contrary, increase these risks if the fitting up of the wires has not been effected with all the care necessary. This situation, with due regard to the public security, could not be left by the Government," &c. After this preamble, you will have some idea of the nature of the rules which follow the report; they are simply an obstruction to any serious undertaking for the public supply of electricity.

This is for France in general; as regards the City of Paris, there is a new decision of the "Octroi" concerning the duty of coal at its entry in Paris, which if not cancelled, will cause great annoyance to those manufacturers who use the electric light in their works, and will probably stop it entirely. When, some years ago, several of the large manufacturers showed an intention to leave the city of Paris, and establish their works outside, on account of the increase of the Octroi duties, the Municipality, in order to retain them, consented to give them a special license, by which the duty on coal was reduced to about 7 francs per ton. The Administration now says that this reduction cannot be applied to the coal consumed for producing the current for lighting the works, and without taking into consideration the small quantity which is used for this special purpose, they have notified their intention to withdraw the license for the whole. The manufacturers are therefore called upon, either to pay full duty on all the coal they burn, or to stop electric lighting and return to gas in order to preserve their license. It would be difficult to conceive anything more arbitrary and unjust. The Cahier des Charges voted by the Conseil Municipal had already paralysed all serious prospects of the distribution of electricity from central stations for a long while to come, and this new decision of the Octroi will do the rest by preventing the introduction of electric lighting in the manufactories and works of Paris.

In spite of the animosity shown in words by the Conseil Municipal and the Administration against the Parisian Gas Company, it is believed that some important secret reasons exist which induce these bodies to lend their support to the great monopoly of this company.

The shareholders of the Compagnie Continentale Edison had their ordinary meeting on Tuesday last, when a dividend of 35fr. per share was declared. The shares are quoted at 560fr., with dull business. You have already reported the amalgamation of the owners of the Edison and Swan patents in France for incandescent lamps. The new company formed for this purpose takes the name of Compagnie Générale de Lamps à Incandescence, and the registered capital is two millions of francs.

A good deal has recently been said about a new dynamo without brushes, invented by M. Maiche, who up to the present time has chiefly occupied himself with telephony. It is said to give an efficiency of 300 incandescent candles per horse-power. I must, however, confess that in spite of all the efforts I have made I have as yet been unable to see a specimen. I hope soon to be more fortunate, and to be able to send you a description of it.

The Exhibition of 1889 has been, *pour ainsi dire*, inaugurated at the Champs de Mars, by the opening to the public of the Restauration de la Bastille et de la Rue St. Antoine, as they were in 1789. This Exhibition is opened every evening, and lighted electrically by lamps enclosed in lanterns of old style. The lighting of the shops and streets is effected with 900 lamps of 10 candle-power; the gardens are fitted up with 50 Thomson-Houston arc lamps. The plant has been erected by M. Georges Tournier, for the Compagnie Parisienne de l'Air Comprimé.

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CORRESPONDENCE.

PARAMAGNETISM AND DIAMAGNETISM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your review of Tyndall's "Researches on Dia-Magnetism" in *The Electrician* of June 8th, p. 146, you remark:—

"There is no doubt that the more recondite problems of magnetism cannot be properly handled without a fuller recognition than is usually made between the *inducing* and *induced* fields. Becquerel's theory ought, probably, to be restated in a form in which it would be shown that the induced field of a paramagnetic body is stronger (or contains more lines per unit area) than the inducing field; while in diamagnetics the induced field is relatively weaker. On this assumption we believe that Prof. Ewing has been able to explain the difference in the direction of rotation of the plane of polarisation without assuming an intrinsic difference in the sign of magnetisation."

There is some mistake here, in the personal reference. We must certainly recognise a distinction between what you term the inducing field ($\mathfrak{H}$) and the induced field ($\mathfrak{B}$), and I am accustomed to regard both of these as having a real existence at any point in a magnetised substance. But I have never suggested that this method of expressing magnetic quality will serve to explain the different rotations of polarised light by paramagnetic and diamagnetic media. And I have always accepted the conclusion which Maxwell has expressed thus: "that the difference between ferromagnetic and diamagnetic substances does not arise merely from the magnetic permeability being in the first case greater, and in the second case less, than that of air, but that the properties of the two classes of bodies are really opposite."—Yours, &c., J. A. EWING.

Dundee, June 11, 1888.

ELECTRICAL OSCILLATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Dr. Fleming's inquiry in your number of the 8th inst. for the remainder of the current curve up to steady current, I did not take it beyond the firm line in the diagram, because that and other curves indicated the arrival at steady current in about ·05sec., which is confirmed by the action of certain of our apparatus. The increase of current appears to become more uniform after the first perturbation is over.

The successive counter electromotive forces which are set up on the application of the battery appear to diminish in intensity as the electromotive force becomes equally distributed throughout the circuit.

The manner in which the current was measured was by employing an alternate-current commutator driven by an electromotor at uniform speed. One battery was used, a galvanometer being inserted in the circuit between the battery and the commutator, which showed perfectly steady deflections at all the speeds shown in my diagram.

These deflections were reproduced through neutral resistances, which were substituted for the electro-magnets by means of a switch.

The inductive retardation of the galvanometer was unimportant, as it contained only two convolutions of thick wire, and the current was in one direction.

It is well known that the counter electromotive force set up in an electro-magnetic inductive circuit of many turns may be felt as a violent shock, as, for instance, upon the application of a battery to the secondary terminals of an induction coil. The circulation of this discharge of higher potential than the battery and of successively diminishing discharges through the circuit provided by the battery itself may account for the oscillations.

In the case of the cessation of current in such a circuit the number of oscillations per minute may be approximately ascertained by bridging over the terminal wires of a powerful electro-magnet with a telephone; for this purpose it is necessary to short-circuit the electro-magnet just before removing the battery and immediately afterwards, to introduce the telephone without having interrupted the circulation of the induced discharge from the electro-magnet.

This discharge will continue for a length of time dependent on the mass of iron and copper and the degree of magnetisation, and will be heard in the telephone like gentle breathing.

With an electro-magnet like the field-magnets of a dynamo electric machine the discharge will circulate for several seconds.—Yours, &c., F. HIGGINS.

17, Cornhill, E.C., June 21st, 1888.

REPORT BY MESSRS. ALABASTER, GATEHOUSE AND CO., ON THE WEYMERSCH BATTERY.

We have been furnished with the following copy of a report made by Messrs. Alabaster, Gatehouse and Co., to Mr. R. McKenzie, on a new type of the Bunsen cell:—

22, Paternoster-row, E.C., June 15th, 1888.

DEAR SIR: In compliance with the request which you made to us towards the end of last month, that we should conduct a series of

REPORT ON THE WEYMERSCH BATTERY.

Date.	Time.	Duration (t)	Current (c) amperes.	E.M.F. volts.		Resistance per cell ohms.	C E t (external circuit). Watt hours.	Theoretical weight of zinc dissolved. Grammes per cell.	Actual weight of zinc dissolved. Grammes per cell.	Difference between theoretical and actual consumption. Per cent.
				Open.	Closed.					
June 7th.	11:0 a.m.	...	10·1	9·26	5 70	·070	...	...	.....	.....
	12:0 ,,	1	10 4	...	5·75	...	58 97	12·436	.....	.....
	1:0 p.m.	1	10·4	9·26	5·90	·065	60·58	12·618	.....	.....
	2:0 ,,	1	10 4	...	6·04	...	62·09	12·618	.....	.....
	3:0 ,,	1	10 5	9·26	6·04	·061	63·12	12·679	.....	.....
	4:0 ,,	1	10·5	...	6·08	...	63·63	12 740	.....	.....
	5:0 ,,	1	10·6	...	6 C8	...	64·14	12·800	.....	.....
	6.0 ,,	1	10·6	9·26	6·08	·060	64·45	12·861	.....	.....
	7:0 ,,	1	10·6	...	6 08	...	64·45	12·861	.....	.....
	7:30 ,,	½	10·6	9·08	6·08	·057	32·22	6 430	.....	.....
June 8th.	11:0 a.m.	15½	10·5	9·06	5·89	·060	978·70	198 400	.....	.....
	12:0 ,,	1	10·4	...	5·85	...	61·34	12·679	.....	.....
	1:0 p.m.	1	10·3	9·06	5·85	·062	60·55	12·558	.....	.....
	2:0 ,,	1	10·3	...	5·85	...	59·65	12·497	.....	.....
	3:0 ,,	1	10·2	8·95	5·75	·063	59·45	12·436	.....	.....
	4:0 ,,	1	10·2	...	5·70	...	58·40	12·376	.....	.....
	5:0 ,,	1	10·1	8 95	5·70	·064	57 86	12·315	.....	.....
	6:30 ,,	1½	10 0	8·95	5·65	·066	85·54	18 290	.....	.....
...	...	31½ hours	...	...	...	...	1955·14 per cell = 391	399 594	439·7	10·0

REMARKS.—From 7:30 p.m. on the 7th June to 11 a.m. on the 8th the battery was left to itself 15½ hours. Current density 0·12 ampere per square inch.

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tests with, and report upon, a new depolarising liquid discovered by M. Weymersch, and employed in batteries of the Bunsen type, we beg to submit to you the results of our investigations.

A preliminary trial was made with three square open jars, each having the following internal dimensions :—8¼in. by 8¼in. by 12in. deep.

The quantity of liquid sulphuric acid and water in the proportion of 1 to 20 in each jar was about 16 pints. Immersed in this solution were two 6⅝in. wide zinc plates to the depth of 6½in. Between the zinc plates, and placed in a porous pot 7¼in. by 1½in. by 12in. deep, containing nearly 3¾ pints of the depolarising fluid, was the carbon electrode, of the same linear dimensions as the zincs. These cells were connected in series to an ampere-meter, the current being adjusted by iron wire resistances to 10 amperes or thereabouts, and kept in circuit for 26 hours. The results obtained showed that the battery ran for 26 hours without the current ever falling below 10 amperes, or varying more than 5 per cent., and with a drop of less than 5 per cent. between the maximum and minimum free potential of the cells, whilst an actual rise in the working or available E.M.F. took place. The measured consumption of zinc in the battery, moreover, was only about 8 per cent. above that indicated by theory.

We then decided to employ another battery of 5 cells precisely similar in all respects to the above, and in the table page 220 all the necessary data is furnished.

After keeping the cells on closed circuit for 31½ hours we were compelled, owing to our desire not to leave the battery alone through another night, to put an end to the experiment, although we have not the least doubt that several hours' more work could readily have been obtained before the electrical constants were reduced to the extent of rendering it undesirable to continue the readings. During this lengthened run it will be seen that the free potential of the battery did not vary more than approximately 3 per cent., that the working electromotive force was practically the same at the end of the test as in the beginning, and that the current varied only between 10 and 10·6 amperes.

The actual and theoretical consumption of zinc differ by only 10 per cent., which agrees closely with the data obtained in the preliminary trial, the weighing of the electrodes in the last run having been carried to a greater degree of precision and exactitude, necessitating the employment of grams in balancing-plates of zinc, each weighing nearly 3lb.

The electrical measuring instruments, which had very kindly been loaned to us by Messrs. Sharp and Kent, were independently checked by Mr. H. R. Kempe and Mr. W. M. Mordey. The price per horse-power-hour agrees more closely with the theoretical cost of batteries in which zinc is consumed than that of any other with which we are acquainted, although, of course, the precise figure will largely depend upon the charge per gallon the inventor chooses to make for the depolariser, which we are informed can be manufactured at 6d. per gallon.

We have not hitherto had any battery submitted to us which has given results approaching those above tabulated, and we have no hesitation in expressing the opinion that M. Weymersch has effected a great advance in two-liquid primary batteries.

We may add that the liquids did not appear to rise in temperature during the whole period of the test, a fact which we imagine is unprecedented in batteries of the Bunsen type.

It has long been the aim of inventors to discover a primary battery which should give a high electromotive force, possess a low internal resistance, and give a large and constant current for a considerable period of time with the minimum amount of attention and at the lowest possible cost.

In our opinion M. Weymersch has distanced all competitors n the attempts hitherto made to fulfil the above conditions.—

Yours, &c. H. ALABASTER, GATEHOUSE AND Co.

R. McKenzie, Esq.

ILFRACOMBE LOCAL BOARD AND THE ELECTRIC LIGHT.

At a recent meeting of Ilfracombe Local Board the Surveyor reported that he had received a number of replies to his advertisement in connection with the lighting of the shelter by electricity. Most of the firms wrote to the effect that the affair was so small that, though they would willingly supply the plant, they could not undertake to light the building. The Gülcher Company wrote offering to light the promenade with twelve 300 candle-power incandescent lamps from sunset until 11 p.m., at £360 per year, for a period of not less than three years, after that at £335 per year for a further period of three years, the whole of the plant and work to be provided by the firm, and to be removed by them at the expiration of the term.

Another offer was made by Mr. Woodley, of London, who had that day waited upon the Chairman and surveyor. If the Board would take 200 lamps, and any other party in the town would take 200 additional lamps—each of 50 candle-power—Mr. Woodley would erect and keep them burning on an average for five hours a day. The cost to the town for the 200 lamps (which would be sufficient to light the whole of the town and the shelter) would be £1 a day—£365 a year.

Mr. BAKER : What is the present cost ?

Mr. DAY : Close on £400 a year.

The CLERK announced that the bill for the consumption of gas last year was £423. This was, of course, exclusive of the men's salaries and the cost of lamps.

Mr. GOULD said five hours had been mentioned as a fair average. Mr. Woodley was willing to erect and work the electric light with 200 lamps at the rate of ¼d. per lamp per hour. If they took six hours the cost for the 200 lamps would be 25s. per day.

Mr. RUSSELL said there was no doubt they would be justified in spending that amount.

The SURVEYOR, continuing, said Mr. Woodley's offer was for a year. At the end of the year the Board would have to replace the lamps, and they would cost 4s. per lamp per year.

Mr. DAY : That will be an additional cost of £40 a year after the first year.

It was ultimately agreed to postpone the further considera'ion of the matter for a special meeting.

PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

12,437A. R. E. B. CROMPTON and J. SWINBURNE. Chelmsford. Electrical measuring instruments. September 14, 1887. (Note.—This application having been originally included in No. 12,437, dated September 14, 1887, takes, under Patents Rule 23, that date.)

8,401. E. W. CLIFTON and V. ROBINSON. London. Improvements in electric batteries. June, 8, 1888.

8,457. L. MILLETT. London. Improvements in telephones. June 9, 1888.

8,496. J. LEA and H. R. HAMMOND. London. Improvements in electro-coating metals with zinc. June 9, 1888.

8,503. E. DUCRETET. London. Improvements in magneto-electric fuses or exploders. June 9, 1888.

8,525. F. L. RAWSON and P. JOLIN. London. Improvements in electric trembling bells. June 11, 1888.

8,596. J. Y. JOHNSON. London. Improvements in automatic telegraphy (E. J. Mallett, United States). June 12, 1888.

8,611. W. LAUGHTON. London. An improved form of galvanic belt for medical purposes. June 12, 1888.

8,637. A. L. PARCELLE. United States. Improvements in electric clocks. June 12, 1888.

8,657. H. BARCROFT. Belfast. Improvements in dynamo-electric machines. June 13, 1888.

8,700. L. M. J. C. C. RENARD. London. Improvements in and relating to electric batteries. June 13, 1888.

8,724. W. SNELGROVE. Birmingham. An improved appliance or switch for electrical machines or apparatus. June 14, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

June 16, 1888.

8,641. H. EDMUNDS. London. Improved system and means to be used in the supply or distribution and control of electricity for lighting or other purposes. June 15, 1887.

8,795. W. E. AYRTON and J. PERRY. London. Improvements in galvanometers with suspended coils. June 18, 1887.

10,233. M. MAITLAND, London. A novel combined electrical vapour bath. July 21, 1887.

11,004. M. H. SMITH, London. Improvements in apparatus for the electrical propulsion of tramcars and other vehicles. August 11, 1887.

16,473. S. S. BROMHEAD. London. An electrical signalling device for railway purposes (S. T. Street, United States). November 30, 1887.

1,932. F. H. ROYCE. Manchester. Improved forms of electrical contacts for switches and similar fittings. February 9, 1888.

4,673. P. M. JUSTICE. London. Improvements in dynamo-electric machines and in regulating and measuring apparatus for use with same (C. Heisler, United States). March 27, 1888.

4,964. A. J. BOULT. London. Improvements in apparatus for transferring electric currents (S. Doubrava, Austria). April 3, 1888.

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PATENTS SEALED.

June 15, 1888.

6,104. A. Le Neve Foster (London) and F. V. Anderson (Catford). Improvements in electrical measuring instruments. April 26, 1887.

6,219. J. Swinburne, Chelmsford. Improvements in or connected with induction apparatus and the use of it in studying dynamo-electric machines. April 28, 1887.

7,184. W. Mackie. London. Improvements in electric arc lamps. May 17, 1887.

7,950. D. J. Smith (Glasgow) and H. F. Jackson (London). Improvements in or connected with telephones for indicating and recording the number of times that a telephonic instrument is used for ascertaining payments due or for other purposes. June 1, 1887.

7,982. C. L. W. Fitzgerald. London. Improvements in or additions to telephonic instruments for enabling them to be used only on prepayment for such use. June 2, 1887.

8,159. W. Smith. London. Improvements in effecting electric telegraphic communication applicable especially for telegraphing to lighthouses (either floating or on rocks), at a distance from the shore, or for telegraphing to and from vessels. June 7, 1887.

2,179. M. Wheeler. Canada. Improvements in incandescent electric lamps. February 13, 1888.

2,246. H. H. Lake. London. Improvements relating to dynamo-electric machines (R. Eickemeyer, United States). February 14, 1888.

2,250. J. H. Linville. United States. Improvements in printing telegraphs. February 14, 1888.

2,308. C. Coerper. Germany. Improvements relating to dynamo-electric machines February 15, 1888.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

Amended Specifications.

4,362, 1882. Gaulard, L., and Gibbs, J. D. Distributing electricity. (Price, 8d.)

4,219, 1887. Desmazures, C. Accumulators of electricity, &c. (Price 8d.)

Specifications.

5,648, 1887. Holmes, J. H. Making and breaking electric circuits. (Price 8d.)

10,454, 1887. Gent, J. T., and Ellery, H. G. Electrical signalling apparatus. (Price 8d.)

1,851, 1888. Johnson, J. Y. (The Volta Graphophone Co.). Graphophone. (Price 1s. 3d.)

5,713, 1888. Hallock, J. K., and Blickensderfer, G. C. Electric elevators. (Price 8d.)

5,913, 1888. Heaviside, A. W. Electric insulators. (Price 6d.)

LEGAL INTELLIGENCE.

Gouraud v. The Edison Gower-Bell Telephone Company of Europe and the Consolidated Telephone Construction and Maintenance Company.

In the Chancery Division, on Tuesday last, Mr. Justice Chitty dismissed with costs an action by Colonel Gouraud, a shareholder in the Edison-Gower-Bell Telephone Company, for an injunction to restrain the two defendant companies from carrying out an arrangement between them with reference to certain patent rights.

Mr. Moulton, Q.C., Mr. Byrne, Q.C., and Mr. Farwell appeared for the plaintiff; Mr. Romer, Q.C., and Mr. Wace, and Mr. Maclean, Q.C., and Mr. Reginald Brown were for the defendants.

COMPANIES' MEETINGS.

LA COMPAGNIE FRANCAISE DU TÉLÉGRAPHE DE PARIS À NEW YORK.

The shareholders of this Company held their annual meeting recently in Paris, M. Brueyre-Dellorier in the chair.

After some remarks from the CHAIRMAN,

M. SORDIER complained of the outpayments which had to be made to foreign companies, which was not the case when there was an understanding with the English companies, and he urged the Company to come back to it. £40,000 was now taken out of their total earnings of £68 000. If the law suit should be lost they would have to pay some 7,000,000fr. or 8,000,000fr., and if they had to pay that and go on paying out £40,000 every year, what would be the end? In twelve years the cable would be worn out. The directors were only instruments of Mackay, and they were his victims. Mackay had made a large fortune, but he was now seeking to make something out of the French shareholders. The directors had been helped in all this by M. Granet.

The CHAIRMAN interposed. He could not allow M. Granet to be attacked. He had been a Minister, and was supported when the English agreement was broken off by M. Peytrail, who considered that what M. Granet had done was quite right.

M. SORDIER said M. Granet had ruined them. He would ask for an indemnity from the Government, who ought to repay the Company for their losses. He proposed to present a petition to the Deputies, which he hoped the other shareholders would sign; if not he would prepare it and send it himself to endeavour to get back their money. He had bought his shares at 150fr. Look at their price to-day!

The CHAIRMAN could not say what their position would be if they lost their lawsuit. They could not re-enter the common purse. It was difficult to suppose they could lose it. The action taken by two Ministers was in conformity with their Articles of Association, and it was difficult to see how the Conseil de Préfecture could upset what had been done. The war of rates had been the cause of all their trouble. He had himself been always against it. They were bound hand and foot, and could not do otherwise than they had done. If they lost their suit they had, perhaps, other means of getting advantages. They might join in the Antilles business, or with the General Telephone Company. When the Antilles scheme came forward some time ago their own shares rose some 50fr. or 60fr. He was asked whether they had power to deal with any of these companies. He could only say they could only do so if they were free from their law suit. Within two months they hoped to have the decision of the Conseil de Préfecture, and they were pushing matters on with all their might. They could do nothing with their legs tied; but as soon as they were free they would be able to swim. They had accomplished a *tour de force* in getting the last judgment; they hoped by another *tour de force* to get a final decision in their favour, and that within three months.

M. DESPECHER said he did not generally take part in these meetings; but he would like to hear some explanation as to what these outpayments were, and to whom they were made—that was, the £40,000 paid to foreign companies.

M. DE BELLEVILLE, in answering, said he must first do full justice to the English companies, who had done their best to facilitate the course of the law suit, and had put no obstacles in the way. The cause of the outpayments was the sums they had to pay to the land lines in America. When they received, say, 30 francs for a message, they had to pay out 45 francs for it, which was 15 francs loss. Again, one word was allowed for an address; but in America they insisted on three being paid for. They had to ask the Government to allow them to refuse messages for the Antilles and South America on account of the outpayments. Since the rupture of the agreement they had met with great hostility from the land lines of America.

M. DESPECHER said as 70 per cent. of the traffic was with New York it did not seem to account for the large total of outpayments. Was any portion of the sum paid to the Commercial Cable Company?

M. BELLEVILLE: Certainly not.

The report was put and adopted, after which the retiring Directors were re-elected and the proceedings closed.

Western Counties and South Wales Telephone Company (Limited).

The third annual meeting of this Company was held at the Royal Hotel, Bristol, on the 7th inst., Mr. Charles Nash presiding.

The MANAGER (Mr. H. F. Lewis) having read the notice convening the meeting,

The CHAIRMAN said that the proposal to increase the company's capital to £500,000, by the creation of new Preference shares, was adjourned for consideration until the 12th of July. He drew the attention of the shareholders to the increased business during the past year, and to the increase which had taken place in the revenue of the Company since 1886—the gross sum now being £23,597, against £15,406 in December, 1886, or an increase of 53 per cent. If they took the subscribers to the various exchanges in 1886, and compared them with the number now, the increase was very satisfactory, the total being 2,044, against 1,318, or at the rate of 54 per cent. The reason why the net result was so good was explained in the report, the wire extensions during the past year being an increase of 977 miles on that of 1886, or no less than 84 per cent. A proportion of that extension was in trunk lines, chiefly in South Wales, where they had a territory which it was desirable to occupy as soon as possible. The cost, however, of extending the trunk wires down to last December had been nearly £19,000, and, so far, the outlay had been unremunerative; but at the same time there had been a demand for the communication, and the Directors felt confident that the current year would bring in a substantial revenue from the trunk system. The total trunk calls now numbered nearly 10,000 a month, as against 5,000 in September, when the system was started, and, generally speaking, the messages had been satisfactorily heard. He had spoken of the importance of occupying the South Wales ground, this being shown by the rapid growth of business from that direction; but, as he had already said, the outlay had been very great. The accounts would have admitted of their paying a small dividend on the Ordinary shares, but the Directors did not think it wise, preferring to carry on the business of the ensuing year by raising the reserve fund to the sum of £1,000. Generally speaking, the business of the Company continued to increase satisfactorily, very few weeks passing without substantial additions being made to the list of subscribers. The report referred to a desire to connect London, Birmingham, and other large towns with their system, and while it was very desirable to do so, still it was a heavy undertaking, and could not be entertained without good promises of support. There was an indirect advantage, the Chairman added, in having trunk lines, for they had the effect of adding

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materially to the exchange subscribers in the various towns. They were making careful inquiries about connecting the Eddystone Lighthouse with Plymouth and the dockyard, and the Admiralty officials there supported the idea; the Mercantile Marine authorities also looked favourably upon the idea of connecting the lighthouse with the shore, as ships passing up and down Channel could be reported more easily. If the company could see their way to a fair remuneration for their outlay, they might deem it desirable to make the connection. He could not but think it would prove a great advantage to have their coastguard stations, lifeboat stations, and possibly some of their lighthouses connected with their system; and if it was thought desirable these stations should be put in communication with the shore, the telephone system would be by far the best, as it was more easily learnt than the telegraph. Another extension they were looking forward to was the connection of all police stations, and already in Glamorganshire they were making arrangements for connecting the various police stations in that county. There was still, however, room for the further growth of the Company. He moved the adoption of the report.

Mr. MARK WHITWILL seconded the motion. He said that a great deal had been done during the past year by way of preparing for the future. They had been breaking new ground and sowing the seed, and they expected to reap a rich harvest very speedily. People in England, and especially in the West, were only beginning to wake up to the importance of the telephone; but as it was more widely known, its use, he felt confident, would increase month by month. They had evidences of it in the number of fresh connections made during the year.

Mr. RICHARD CORY supported the motion. He said that the telephone was found of great use, and he believed they would in the future find the invention more extensively used than in the past. The Company had a valuable property, and he hoped they would do their best to get other people to adopt the telephone. It was a great convenience to be able to speak with one another in different towns by means of the telephone, and so far as South Wales was concerned their prospects were exceedingly good. Those who had adopted the system were well pleased with it, and they had many others desirous of taking advantage of the convenience offered.

The resolution was then adopted.

On the motion of the CHAIRMAN, a dividend of 6 per cent. to the Preference shareholders was declared.

Mr. J. MORGAN moved, and Mr. BATTEN seconded, the re-election of Messrs. Charles Nash and R. Cory as Directors.

The motion was unanimously carried.

On the motion of Mr. MORGAN, seconded by Mr. CORY, Messrs. Hudson Smith and Co. were appointed to act as auditors, a vote of thanks being accorded to Messrs. Tribe, Clarke and Co., the retiring auditors.

A resolution was adopted to increase the remuneration of the Directors from £300 to £400.

A vote of thanks to the Directors terminated the proceedings.

The Maxim-Weston Electric Company (Limited).

A meeting of shareholders in this Company was held on Friday, the 15th inst., at Cannon-street Hotel, for the purpose of submitting for signature a requisition to be sent to the office calling upon the secretary to summon an extraordinary general meeting for the election of Directors.

Mr. JOHN NEWTON: Gentlemen—This is an informal meeting of shareholders, and in our opinion if Mr. Hugh Watt had attended he would not be entitled to take the Chair. This meeting is entirely free to elect a chairman, and I have much pleasure in proposing that Mr. Greig, the chairman of the last committee, should take the chair.

The motion was seconded and carried unanimously.

The CHAIRMAN: Gentlemen—We have come here, I hope, to do a little practical business, at all events for ourselves—therefore I will not make a speech of any great length; but I wish to explain to you the reasons why we have taken upon ourselves—the five members appointed at the half-yearly meeting and the enlarged committee amongst the sixteen of the largest shareholders—to call you together. To put in print all we had to say is not advantageous for a trading company, therefore we thought it better to meet you face to face. The circumstances in which the Company finds itself are somewhat peculiar. At the general meeting of the shareholders—the annual meeting—we passed the report and the balance-sheet; the meeting then was adjourned. Part of the proceedings on that day ought to have been the re-election of two of the retiring Directors, Mr. Watt and Mr. Swaby. At the adjourned meeting a good deal of feeling was shown, and the two Directors were not re-elected; but, by the Articles of Association of the Company, if by any accident Directors are not re-elected at the annual meeting, they stand as members of the Board until the following year. Mr. Watt, therefore, by that Article of Association remains a Director, and Mr. Swaby also remains a Director, though it was his desire at that time to place his resignation in the hands of the shareholders. The result is that, legally, there are only two Directors, Mr. Watt and Mr. Swaby. Probably Mr. Watt found that out, but Mr. Swaby, up to the time he did find that out, had been warned off the premises. You will remember Mr. Swaby held about 2,000 shares in the company, on which he had not paid the 5s. call. Mr. Watt, just before the meeting was held, came forward and paid the unpaid amount, relieving Mr. Swaby of the liability. Please bear that in mind, because it is rather important. He told us himself that he had paid the money due on those 2,000 shares, and as we looked at the balance-sheet we found that all the shares were paid. Mr. Swaby still held 400 shares, which are sufficient for his qualification, and although I am not here to whitewash Mr. Swaby or anybody, I think it is only fair to that gentleman to say that he has given us a great deal of valuable co-operation. When the shares were issued at 5s. each—in order to place as many shares as he could with the public, not to make any profit himself—he subscribed for 4,000 shares; 2,000 he placed amongst the public. He was saddled with 2 000 shares, but as Mr. Watt relieved him voluntarily of that liability Mr. Swaby's liability to the Company ceased, but he still was a Director. When the unpleasantness arose he was ordered off the premises, but as his 400 shares were not cancelled he was still a Director, and Mr. Watt was rather at his wit's end to know how he was to prevent Mr. Swaby from coming. He arrived at the most extraordinary conclusion—that if he cancelled these 400 shares Mr. Swaby would no longer be a Director; therefore he wrote a letter saying that as there was 5s. a share owing on 2,000 shares, therefore the Company had forfeited the 400 shares, and would take them towards that debt, which was not due to the Company, because Mr. Watt had assumed it. It was one of the funniest things that ever came before me. Then Mr. Swaby was ordered off the premises. Then came our meeting, the committee presented their report, and we were told to consult sixteen of the largest shareholders. Then there was a very painful meeting, at which Mr. Watt thought it necessary to have a criminal lawyer on his right and a solicitor on his left, armed with an opinion of the legality of the meeting, and it was dissolved as an illegal meeting. Of course, Mr. Watt was in a difficulty then; there were only two Directors, himself and Mr. Swaby. Probably the solicitor pointed that out. Mr. Watt wrote to Mr. Swaby, saying on reconsideration he had cancelled the cancellation of the 400 shares and restored them to the register, and Mr. Swaby was a full-fledged Director. Mr. Swaby went on the Board again, and there Mr. Watt suggested to him that they had better strengthen the Board. Mr. Swaby said that the sixteen largest shareholders were to consult together, and until that was done they had better do nothing. Mr. Watt said, "As a compliment to you you can propose the first Director." "No," said Mr. Swaby, "I shall get myself into difficulties with the shareholders: I shall propose nobody." He left the Board meeting, and within a few hours afterwards received another letter from Mr. Watt saying he had again cancelled his 400 shares. It is one of the funniest things that has ever happened in the City of London. I may say that it is with a feeling of regret that I have to mention Mr. Watt's name so often; it is solely because Mr. Watt has made himself the Company. The 16 largest shareholders could get nothing from him; he would not recognise that they were appointed at a legitimate meeting. Mr. Swaby was warned off the premises, and his 400 shares are in the air. I had to mention his name to show the position we took up. We thought the proper thing was to ask you to choose five independent Directors. If Mr. Swaby is the bad man that Mr. Watt told us he is, the new Directors can take that into consideration; but he has treated us with such courtesy and kindness all through, besides giving us information which has been of the utmost value, that I do not think the five Directors will find him at all in the way. I would ask you to choose five independent Directors. If you think Mr. Watt a man of such excessive value to the Company that we cannot get on without him, well and good; we do not want to sway your opinion one way or the other. Mr. Goschen said that joint-stock companies did not succeed because shareholders do not take an intelligent interest in their own affairs; we have not till quite recently, and I think we have now seen enough to know that Mr. Watt is the autocrat not of the breakfast table but of the Board table. We should have gentlemen as Directors who are not interested in the Watt dynamo, but in the old Maxim-Weston, which I think shines as brightly as ever. I will not go into the question of office expenses, but you know the offices are rather expensive. I believe that if you have an independent Board this Company will have a good future.

Mr. JACKSON: Mr. Watt, the Chairman, is evidently disappointed and disgusted at the position he finds himself in, but I think we should know whether there is a possibility of his raising an issue which may upset a resolution of this meeting. I think the shareholders are much obliged to you, but they should feel assured that the course you recommend is a legal one, and can be acted upon, and, further than that, can be enforced.

The CHAIRMAN: I can answer that question very simply; it is in accordance with the Articles of Association. An extraordinary general meeting can carry anything. We must have signatures representing 62,400 shares calling on the Directors to summon an extraordinary general meeting. We are quite within our legal powers; the Directors must summon a meeting if we send in the requisition. Though we have no money at our disposal my back was put up a little, and I have taken counsel with my own solicitor all through as to the steps we were taking to satisfy myself.

Mr. JACKSON: Has the Company issued the notice calling this extraordinary meeting?

The CHAIRMAN: This is not an extraordinary meeting, it is a private meeting.

Mr. JACKSON: You will call upon the Chairman to call an extraordinary general meeting in accordance with the Articles of Association.

The CHAIRMAN: That is it.

Mr. NEWTON: I was the one to suggest this meeting, and therefore I may explain the object I had in view. We cannot get a requisition signed by the holders of 62,400 shares without very considerable expense, and we thought it would be much cheaper to engage this room so that those of you who are desirous of assisting the committee in getting signatures to enable us to have a legally constituted meeting can do so. At that meeting we can elect Directors. We cannot elect Directors in this Company unless the gentlemen who will consent to go on that Board have sent in a written statement to that effect to the Company seven days prior to the holding of that meeting. We, the committee of 5 or 21, whichever you choose to call us, could have selected the names of five gentlemen to go on the Board, but it would have looked like a hole and corner selection. I have no desire to go on that Board, and none of my colleagues have; but I have a great desire that there should be put upon that Board five gentle-

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men who have a knowledge of how to buy a patent and how to sell it, in case of need, and act in the interest of fair play and justice to both the buyer and the seller. We have no faith in Mr. Watt being in a position to buy for us something which he has to sell. It is utterly impossible for Mr. Watt to occupy that position, and yet we are inclined to think he is quite prepared to undertake it. I have lost all faith in any company and in any matter with which Mr. Watt may be connected. I will give you my reasons. At the last meeting Mr. Watt told us very straight from that chair—I am very sorry he is not here because I wanted to say this in his presence, but I say it deliberately in order that his secretary, who is taking notes, may report what I say to him—he told us he had had some sort of communication with Mr. Brown, a retiring Director, which empowered him in some sort of way to elect Mr. Howell in some sort of manner, and Mr. Howell was elected with the concurrence of Mr. Brown. I believed that statement because I believe a gentleman who speaks from the Chair. I believed it until I saw under the handwriting of Mr. Brown a letter to this effect which simply amazed me. I do not think it is a forgery. This is the letter:—

"May 4th, 1888.

"Dear Mr. Swaby: In reply to your letter, which I have just received, I write to inform you that since I retired from the Board of the Maxim-Weston Electric Company (Limited) I have held no communication with any of the officials or anyone connected with the Company respecting its proceedings. I have never been consulted on any matter connected with it. I have not held a share in the Company for the last two months, and have taken no interest in it of any kind. (Signed) JOHN BROWN."

That letter is diametrically opposed to the statement made by Mr. Watt. If Mr. Watt will make that statement to us shareholders, I cannot have faith in Mr. Watt to be in the position to purchase, on behalf of myself and you, a patent of which he is the proprietor. Therefore, it is necessary we should elect five gentlemen to the Board. We do not want to turn Mr. Watt out. (A Voice: "Yes.") I want to do the best for the shareholders. The resolutions will be—

"That, considering the peculiar position of the Board as at present constituted, it is desirable that at least five independent shareholders be elected as Directors."

That is one of the resolutions we propose to submit to a legally constituted meeting. The next will be

"That the following gentlemen" [and then there are five blank spaces] *be elected Directors of the Company."*

We have no object but that you at this meeting should nominate five gentlemen whom you think worthy of trust to negotiate the purchase of the Watt patent, supposing that after they have examined it as business men, and got the opinion of a capable and independent expert as to its merits, it is worth purchasing—

A SHAREHOLDER: Also that it has not been made by the Company's engineers. I dispute Mr. Watt's ownership.

Mr. NEWTON: We do claim that so much of that patent as belongs to Mr. Watt belongs to us, as he was our trustee. I do not want to take advantage of that; I am desirous we should deal fairly, and pay him something for it if he is entitled to it.

A SHAREHOLDLR: What provision is made under the Articles as to the number of Directors?

The CHAIRMAN: They provide for seven, with a remuneration of £500 a year amongst them, but Mr. Watt, as Chairman, is entitled to receive £1,200 a year.

A SHAREHOLDER: Is there any engagement?

The CHAIRMAN: Yes; subject to six months' notice.

After some further discussion, the following gentlemen were selected for the Directorship, namely, Messrs. J. M. Klenck, G. H. Hilyard, Marks, W. Harvest and Couchman.

The CHAIRMAN stated that Messrs. Hilyard and Couchman would retire in favour of two experts as soon as they could be found to take their places.

The shareholders then proceeded to sign the requisition, and the proceedings terminated in the usual manner.

PATENT

SILICIUM BRONZE AND SILICIUM COPPER WIRE.

The best for overhead Telephone and Telegraph Lines,

AND ALL ELECTRICAL PURPOSES.

Hard Drawn High Conductivity Copper Wire.

ROLLED AND DRAWN

PHOSPHOR BRONZE.

PHOSPHOR BRONZE

BEARINGS, BUSHES,

AND OTHER PARTS OF

ELECTRICAL MACHINERY.

SOLE PROPRIETORS of the British, Indian and Colonial Patents,

THE PHOSPHOR BRONZE COMPANY (Limited),

87, Sumner Street, Southwark, London, S.E.

WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Dr. GASSNER'S PATENT

BRY BATTERY

Dr. GASSNER'S PATENT

FOR

TELEGRAPHIC WORK, ELECTRIC BELLS, AND MEDICAL USE.

Possesses all the advantages of a Leclanché Cell, and none of its deficiencies.

Sole wholesale depot for England,

MAYFIELD, COBB & CO., LTD., 35a, QUEEN VICTORIA STREET, LONDON, E.C.

THE NEW BURGLAR ALARM CONTACT (Patent applied for); cannot get out of Order. Rubbing Contact, and Wetproof.

THE NEW INDICATOR MOVEMENT (Patent applied for). Simplicity and Efficiency.

Trade Terms and particulars on application to MAYFIELD, COBB & CO., Limited.

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NEW COMPANIES REGISTERED.

AUTOMATIC ELECTRICAL CORPORATION (LIMITED).—This company was registered on the 7th inst., with a capital of £75,000 in £20 shares, to act as undertakers for the supply of electricity for lighting and other purposes, within the United Kingdom and elsewhere. The subscribers are:—

	Shares.
E. J. Hermandez, 7, Liverpool-street	1
T. G. Kostzentein, 27, Phillimore-place, Kensington, secretary	1
T. G. Blanchard, 25, Huntley-street, Tottenham Court-road, accountant	1
D. Doherty, 6, Great Newport-street, W.C., printer	1
E. Guitton, C.E., 8, Canning-place, W.	1
R. G. Upton, Mitcham	1
W. Sherratt, 461, Oxford-street	1

The number of directors is not to be less than three, nor more than 10; qualification, £250 in shares; the company in general meeting will determine remuneration.

LUTHER HANSON AND COMPANY (LIMITED).—This company was registered on the 6th inst., with a capital of £7,500, in 900 Ordinary and 600 Deferred shares, of £5 each, to acquire patent rights in connection with improvements in electric arc lamps, field-magnets, and in dynamo electric machines and motors, now the property of Messrs. Luther Hanson and Charles, of North Bridge Electrical Works, New Bank, Halifax. The subscribers are:—

	Shares.
*Joseph Longbottom, Wood Bottom Dye Works, Luddenden Foot, dyer	20
*Louis Ingham, Salterhebble, dyeware grinder	20
*G. Charnock, Halifax, contractor	20
*Luther Hanson, Halifax, electrical engineer	100
C. Dobson, Halifax, clerk	3
J. R. Farrar, Halifax, solicitor	1
J. Duff, Halifax, chartered accountant	1

The number of directors is not to be less than 3, nor more than 7; the first are the subscribers denoted by an asterisk.

PETROLEUM ENGINE COMPANY OF AMERICA (LIMITED).—A notice of the prospectus of this company appeared in our last issue. The registration of the company was effected on the 6th inst., the nominal capital being £150,000 in £5 shares. It proposes to acquire and work United States patents for petroleum engines, and for such purpose to adopt an agreement between J. J. Revely Humes and Ernest Whitehead. The subscribers are:—

	Shares.
T. T. Curtis, 17, Triangle, Ruby-street, Old Kent-road, cashier	1
G. F. Adams, 152, Fanbridge-road, N., clerk	1
H. F. Adams, 126, Bayham-road, N.W., clerk	1
W. Micklethwait, 34, Millman-street, Bedford-row	1
C. Chilcott, 39, Frederick-street, Caledonian-road, schoolmaster	1
G. F. Tuker, 30, Kerrett-road, Brixton, stationer	1
E. Whitehead, 73A, Queen Victoria-street, clerk	1

The number of directors is not to be less than 3 nor more than 9; qualification, 40 shares; the first are the Duke of Manchester, Sir Hy. Cartwright, Major Alex. H. Ross, M.P.; Wm. Tipping, Esq.; Major-Gen. W. O. Swanston; Robt. O. Ritchie, Esq.; and Joshua Priestman, Esq.; remuneration, £200 per annum for each director, with an additional £100 for the chairman.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 15th, 1888, were £4,760.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The directors of this company have declared an interim dividend for the quarter ended March 31st last of 2s. 6d. per share, free of income-tax, payable on July 14th prox.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 15th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,923.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month to June 15th, 1888, are £2,931, as compared with £2,792 in corresponding period of 1887.

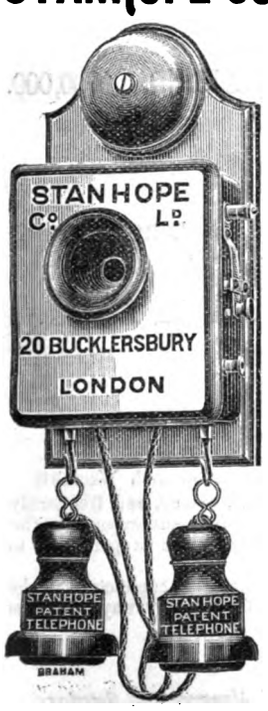
REMOVAL.—Messrs. Crossley Brothers (Limited) announce that on the 24th inst. their warehouse and office will be removed to their new premises at No. 10, St. Bride-street, Ludgate-circus. Their premises at 24, Poultry will be used as a show room only.

STANHOPE TELEPHONES.

NO CARBON OR OTHER MICROPHONE EMPLOYED.

ARTICULATION ALWAYS CLEAR AND DISTINCT. FULLY GUARANTEED. PRIVATE LINES FIXED AND MAINTAINED.
ASYLUMS, WORKHOUSES AND OTHER PUBLIC BUILDINGS FITTED.

STANHOPE COMPANY (LIMITED), (UNDER LICENSE FROM H.M. POSTMASTER GENERAL) **20, Bucklersbury, London.**



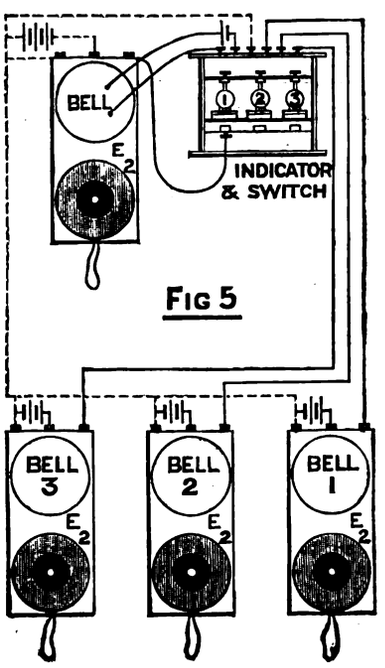
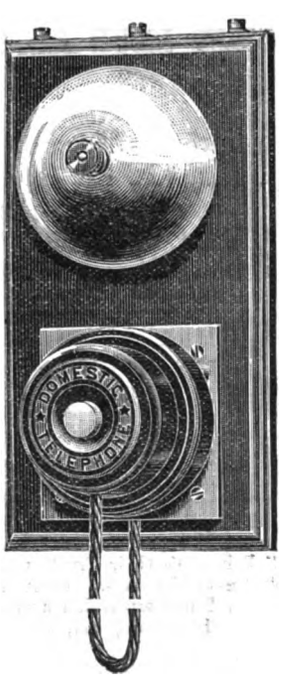


FIG 5



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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, June 20, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending June 20, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	35½ 36¼	3 16 4	Jan., Apr., July, Oct.	36¼	35½
2,614,320	Stock	10/0	Do. Preferred	59½ 60⅛	4 10 11	,, ,,	61	59⅝
2,614,320	Stock	nil.	Do. Deferred	11¼ 11⅝	...	February	11⅝	11
130,000	£10	3/0	Brazilian Submarine	12⅜ 12⅝	4 15 0	Mar., June, Oct., Dec.	12⅝	12½
16,000	10	8/0	Cuba Submarine	13 13½	5 18 9	February and August	...	...
6,000	10	10/0	Do. Preference	18½ 19½	5 2 6	,, ,,	...	..
12,931	5	4%'87	Direct Spanish (£4 paid)	3⅜ 4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference	8½ 9¼	5 5 3	April and October	...	...
60,710	20	2/0	Direct United States	8⅜ 8⅝	4 12 9	Jan., Apr., July, Oct.	...	...
380,000	10	2/6	Eastern	11⅜ 11⅞	4 12 7	,, ,,	11⅛	11⅛
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜ 15½	3 19 0	,, ,,	15⅜	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	110	...
250,000	10	5/6	Eastern Extension	12⅜ 12⅝	5 1 0	Jan., Apr., July, Oct.	13 1/16	12⅝
22,050	10	8/3	German Union Telegraph and Trust	9 9⅛	7 7 4	January and March	...	...
179,177	10	2/0	Globe Telegraph and Trust	5⅜ 5⅞	5 6 5	Jan., Apr., July, Oct.	5 13/16	5⅜
178,992	10	3/0	Do. 6 per Cent. Preference	13⅜ 13⅝	4 6 6	,, ,,	13⅞	13 1/16
150,000	10	7½% '87	Great Northern	14 14½	5 3 5	Jan., July, and April	14½	14 3/16
17,000	25	37/6	Indo-European	36 38	6 11 9	April and October	38	37½
38,348	10	3%	London Platino Brazilian	5⅞ 6¼	...	May and November	...	...
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	7½	...
338,225	Stock	15½%	Submarine	140 150	9 3 4	February & August	141	139
30,000	10	6/0	West Coast of America	6 6½	7 13 10	January and July	...	...
150,000	100	8%	Do. Debentures	112 117	6 16 9	June and December	...	...
88,321	10	nil.	West India and Panama	7/8 1⅛	...	...	...	...
34,563	10	*10/0	Do. 1st Preference	10⅜ 11	8 12 8	April and October	10⅞	...
45,181	15	9/0	Western Brazilian	9⅝ 10⅛	6 5 11	March & September	10⅜	9 1/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance ... xd	3/8 3/4	5 0 0	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	7/8 15/16	3 13 6	...	...	...
80,000	5	5/0	United	14½ 14⅝	4 8 2	June and December	14½	13¾
50,000	5	2/6	United River Plate	5 5⅛	...	April and October	5 1/16	...
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb.'86	Anglo-American Brush (£4 paid)	2⅛ 3	...	...	3	...
23,692	5	nil.	Do. (fully paid)	3⅛ 4	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅛ 2⅜	...	...	2 1/16	2 1/16
312,000	½	5% '86	Maxim-Weston	1/16 3/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39½ 40½	5 18 4	March and July	40½	...
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16⅞ 17⅛	5 14 8	February & August	17⅛	17

* On account of arrears of dividends.

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

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Offices—**WINCHESTER HOUSE, OLD BROAD STREET, LONDON, E.C.**

The principal objects of the Corporation are :—

1. Performing the duties of Trustee, Executor and Administrator.
2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the duties of the family solicitor.

The Corporation acts as Trustees for the Debenture Holders in Public Companies.

For terms, &c., application should be made to the General Manager at the Company's Office.

GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 528.—Vol. XXI. FRIDAY, JUNE 29, 1888. Price 4d.

NOTES.

In connection with the great exhibition to be held next year in Paris the Société Internationale des Electriciens has decided to take the initiative in convening an International Congress of Electricians "to continue the work of the Congress of Paris held in 1881." The proposal is one which will probably be received with some degree of favour, although we scarcely think it will evoke any marked enthusiasm. The Congress of 1881 had before it a definite programme of pressing importance in determining the nomenclature and definition of the practical electrical units. It is true that the definition of the unit of electrical resistance then arrived at was avowedly of a makeshift character, but even those who at the time were opposed to its adoption will not now seriously propose to upset the established usage. If ever the legal value of the ohm undergoes a final revision it must be at a time when the authorities are agreed not only upon the true theoretic value, but also upon some practical unit incontestably superior to the accepted mercury standard. As for minor questions of nomenclature, it is true that there are many terms in use, both in this country and abroad, which have never received authoritative sanction, but they are not of a character which need to be settled upon an international basis. It would also be a sad pity if the protracted and arduous labours of the Nomenclature Committee of the Council of the Society of Telegraph-Engineers and Electricians were to be over-ruled by an international congress, whose decisions would probably be arrived at after a few hours' hasty consideration. But although we fail to see exactly in what sense "the work of the Congress of 1881" can be "continued" in 1889, yet it is impossible to doubt that an international assembly of the representatives of electrical science could be held without producing a marked effect upon the progress of the age, both in science and in industry.

Our reference to the mercury standard leads us to mention that the *Comptes Rendus* of June 4th contains a paper by M. H. Wuilleumier, describing a redetermination of the ohm by a method due to M. Lippmann. We need not now go into details, as we hope shortly to find room for the text of the Paper, but meanwhile it may be stated that M. Wuilleumier arrives at the conclusion that the length of the column of mercury of 1 square millimetre section, whose resistance represents the ohm, is 106·27 centimetres. This gives for the value of the legal ohm, 0·9979 *true* ohm, instead of the usually accepted ratio of 0·998, a difference which is substantially a verification of the previous estimates.

Returning for a moment to the prosposal of the Société Internationale des Electriciens, an additional reason may perhaps be found for wishing success to the project in the fact that the Society has hitherto scarcely fulfilled the expectations of the founders, and indeed has done nothing to justify its lofty style and title. So far as its actual proceedings are concerned, it has long since degenerated into a purely local society; and although it is difficult to see how this could well have been different, yet it might at least have been expected that as the only purely electrical society in all France it would have maintained a leading position in its own department. This, however, is not the case, and the most brilliant and interesting contributions of the French *savants* to electrical science still find their way into the *Comptes Rendus* of the Academie des Sciences, or into the *Bulletin* of the Société de Physique. We venture to think that if there be no prospect of the further development of the Society in justification of its title, the "International" status should be abandoned as misleading.

The number of the *Transactions* of the American Institute of Electrical Engineers which is now to hand contains the report of the discussion on the important Paper by Mr. J. W. Howell on the "Maximum Efficiency of Incandescent Lamps" (see *The Electrician*, Vol. XX., p. 754). The discussion does not add very much to the facts already in our possession, except perhaps in one particular—namely, that the lamps were run direct off the dynamo machine, and not from secondary batteries. We have nothing to say against this procedure, which, indeed, is likely to give results more in accord with average practice, at any rate in America; but the reasons which induced Mr. Howell to discard the more convenient battery will be read with some surprise. He says: "I have had a good deal of experience with lamps on storage batteries, and I am perfectly willing to be criticised when I make the statement that the pressure on the storage battery, as ordinarily installed, varies, I think, five times as much as it does on the average dynamo plant; and that the life of lamps on a storage battery plant, as ordinarily installed and handled, is very much lower than it is on the average dynamo plant, due to nothing else than the simple impossibility of keeping their pressure anywhere." The sentences which follow leave us doubtful whether or not Mr. Howell does not intend to confine

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his statement to the case where the lamps are being run while the battery is being charged. In any case we find it difficult to reconcile these views either with practice or theory as understood in this country.

THE forthcoming trials of electric motor traction by the Metropolitan Railway Company will be watched with the greatest possible interest both by engineers and electricians and by the public at large. It is hoped that a beginning will be made in October or November next, but considering the supreme importance of the case and the necessity that nothing shall be be left undone to ensure success, we shall not be surprised if a little further delay arise. At the same time we understand that the Railway Company are anxious to have the system in full operation by the time their extension to Pinner, Rickmansworth and Chesham is in operation, since it is their intention to employ the discarded engines upon this service. If the new line be further extended to Aylesbury and Birmingham—as is already proposed—the whole of the engines at present in their possession would find full employment thereon, and the underground lines could be worked—so far as the Metropolitan Company is concerned—entirely by electric traction. It will therefore be seen that the question has been taken up at a favourable juncture, seeing that new engines of one or other type would in any case have to be ordered shortly. The engines at present in use are of 450 horse-power, but it is proposed that the electric engines shall be capable of developing not less than 600 horse-power each. It is also proposed that the storage capacity shall be sufficient to take the train twice round the inner circle—which is equivalent to about 1½ hour actual running. What this means in regard to dead weight we do not care at this moment to specify, but that it will be something considerable is very obvious. It is this question of dead-weight (amongst several others) which in the case under consideration has already led us to express a decided preference for the system of working direct from the dynamo, and in our issue of April 27 (p. 705) we proposed a method of experimentally introducing either a conduit or an overhead conductor system, which involves no interference whatever with the ordinary traffic of the line. However, we do not pretend to have had the subject so fully under consideration as the engineers who are responsible for the present scheme, and we must believe that they are justified in preferring the use of secondary batteries, at least for the experimental trials. The final decision as to the methods best adapted to the special circumstances may well be postponed until the railway company has had time to familiarise itself with the working of the new locomotives, and if desirable or necessary the conversion of the system could then be effected without serious additional cost.

WITH regard to the economical side of the question, it is interesting to know that the railway company will be able to save the wages of one man on every train. The starting, brake, and resistance levers or switches can, of course, be managed with the greatest ease by one man; but as it is scarcely safe to have less than two persons on the engine, it is proposed to let the front guard ride with the driver. The wages of the stoker will thus be saved.

IN connection with electric traction, one of the most vital considerations is the choice of suitable gearing. For some time past a tendency has been shown to adopt steel chain gear with sprocket wheels. Very excellent chains are now to be obtained for this purpose, and the arrangement has an advantage over the various forms of toothed gearing in taking jolting strains off the motor. At the same time, for the heavier class of work it has long been recognised that some form of gearing in which the ratio of armature speed to speed of driving wheels is variable is a great desideratum. Various forms of frictional clutch-gearing have been designed for this purpose, but—with one remarkable exception—they have in all cases involved loss of power, with accompanying wear and tear, and the possibility of increasing the useful effort by diminishing the speed has not been attained. The exception we refer to is that of the extremely ingenious "epicycloidal gear," designed by Mr. WORBY BEAUMONT, and described by him in a Paper read before the British Association in 1886. For some reason or other—chiefly, perhaps, owing to the modesty of the inventor—this device has not met with the attention it deserves. In another column of the present issue will be found a detailed description of the arrangement, which we commend to the careful attention of all engineers who are interested in electric traction.

IT is to be hoped that Lord CARNARVON'S warning with regard to the free use of our fortified ports by foreign war-ships may be applied also to our submarine telegraph cables and military land lines. The imprudence which Lord CARNARVON so much deprecates has, indeed, only one excuse, namely, that it arises from a generous characteristic of the English race, and from their ineradicable disbelief in the possibility of war until hostilities have actually commenced. It is just possible, however, that in the present temper of the public a word of caution may not be thrown away; and we venture to point out that the routes of our submarine cables, their landing places abroad as well as at home, and the track of our land lines, subterranean or overhead, are all perfectly well known to every war office in Europe. This is not a satisfactory state of things; and we call attention to it because it is capable to some extent of being remedied, if the British Government has a mind to.

A LIEUTENANT-GENERAL of the Royal Artillery has complained in the *St. James's Gazette* of the inefficiency of the flag-signalling by Morse code which prevails in the British army, and which he alleges cannot be learnt except with great difficulty, or remembered except with constant practice. He suggests as a substitute a divided alphabet, with so many "wags" to the right for the first half, and so many to the left for the other half. We should not have noticed this very crude proposal—which would in practice be much slower and not so simple as the author imagines—only for its coming from a military man of high rank, although now retired, and the influence it may possibly have in military circles. Speaking with knowledge, we deny every one of the General's allegations, except, perhaps, that the Morse code is not so well known in the army as it ought to be. Praiseworthy efforts are now being made to extend and perfect this knowledge, not only in the army but

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in the navy, and we should be sorry to see these good intentions discouraged. As a matter of fact, the Morse code can be learned in half an hour. To use it requires practice, for which the army has plenty of leisure; and when once thoroughly mastered, the code cannot easily be forgotten, especially when supplemented, as flag-signalling ought to be, by electric signalling with the Morse key. Telegraphists make the best flag-signallers, the Post Office Volunteers supplying a contingent who can beat the regulars in this particular off their own ground. The moral of this is that army flag-signallers should all be made to learn to work the telegraph. A secret code is as applicable to the Morse system as to any other.

THE extraordinary general meeting of the shareholders of the Pilsen-Joel Company gave rise to some very lively proceedings, but not at all livelier than was fully anticipated. Our issue of April 20th last may be consulted by anyone desiring further information as to the recent history of this company. We have every reason to believe that under proper management the Central Stations owned by this company might become prosperous and paying concerns, and it is a thousand pities that the policy of the directors should have been directed to any other purpose than that of the straightforward development of their business. On the whole, we think that the shareholders may be congratulated on the fact that the efforts of the directors to effect a sale have not yet proved successful. The Board has now been strengthened by the appointment of a committee (containing some practical men) in conjunction with whom the future policy of the company will be thoroughly considered.

WE furnish, in another column, a report of the POSTMASTER-GENERAL'S reply last week to the deputation which waited on him in reference to the now abandoned Bill of the United Telephone Company. This report will be found to differ materially from that which has appeared in the daily papers. In several journals the POSTMASTER-GENERAL was made to refer explicitly to the position which the proposed County Councils would occupy in regard to the question of overhead wires. We have reason to believe that he made no such reference.

Lighting Tender.—It has been decided to call for tenders, in Sydney and Melbourne, for lighting the town of Young with electricity.

Selby.—The Local Board of Health at Selby are advertising for tenders for lighting the streets of that town by electricity. Particulars will be found in our advertisement columns.

City and Guilds Technical Institute Old Students' Association.—On Wednesday evening last this association gave a highly successful smoking concert at Anderton's Hotel, Fleet-street.

Sale by Auction of Post Office Telegraph Apparatus.—We would call the attention of our readers to a sale of Government telegraph apparatus, the announcement of which will be found in our advertisement columns.

The Claude Telegraph.—The Paris-Lyons and Mediterranean Railway Company have decided to try the Claude system of telegraphy, which has given such good results on the Government lines.

Telephone Exchange Burned Out.—The *Electrical World* states that the Telephone Exchange at Thirty-ninth-street and Sixth Avenue, New York, was burned out on the 23rd of May, through a cross between the telephone and electric light wires.

The Sawyer-Man Lamp.—We learn that Mr. Henry C. Davis, the president of the Sawyer-Man Electric Company of New York, is now in London, and has made proposals to several firms to supply incandescent lamps to the extent of half a million a year.

"The Electric Transmission of Energy."—We are pleased to see that the admirable work by Mr. Gisbert Kapp on "The Electric Transmission of Energy" has been translated into French by M. E. Boistel, and is published by the Bibliothèque Internationale de l'Electricité.

The Lighting of the Leeds Fine Art Gallery.—The Electric Lighting Committee of the Leeds Corporation recently visited the establishment of Messrs. Greenwood and Batley, in Armley-road, Leeds, in connection with the illumination by electricity of the Fine Arts Gallery which the Corporation is building.

Toynbee Hall.—The school and guild of handicraft, in connection with Toynbee Hall, Whitechapel, was formerly opened last Saturday afternoon by Sir W. Hart-Dyke, M.P., vice-president of the Council of Education. Some seventy pupils can already be accommodated, and the applications for admission far exceed this number.

Halifax and Bermuda.—In the House of Commons on Tuesday Mr. Raikes, in answer to Sir E. Watkin, said he had invited and received tenders for the laying of a cable between Halifax and Bermuda, and that they were now under the consideration of the Government. The work would be pushed forward as soon as the Government had come to a decision on the subject.

R.M.S. "Tartar."—This fine ship, of 4,339 tons burden, is lit throughout by electricity, an installation of 290 lights having been recently put in by Messrs. Siemens Brothers. There are duplicate sets of engines and dynamos, each capable of supplying 200 lights of 16 candle-power. The ss. "Tartar" is one of the Union Steamship Company's vessels which run between Southampton and the Cape.

Shackle Oil Insulators.—In the description of the oil shackle insulator of Mr. Higgins in our last issue, by an error due to the engraver the block was inserted upside down. The mistake was probably sufficiently apparent to mislead no one. We have since learnt that oil insulators of the shackle form have already been made by Messrs. Johnson and Phillips, to whom the introduction of this type of insulator is originally due.

Tory Island Lighthouses.—In the House of Commons on Tuesday, Sir M. H. Beach, replying to Sir E. Watkin, said he had reason to believe that Lloyd's were now in communication with the Postmaster-General on the question of taking further measures for the protection of life and property by connecting the improved lighthouses on Tory Island by electric cable with the mainland, and that there was a Bill on the subject now before Parliament.

South London Polytechnic Institutes.—A public appeal, signed by the Archbishop of Canterbury, Lord Ripon, Lord Rosebery, Lord Brassey, Dr. Lyon Playfair, Sir W. Hart-Dyke, and other influential persons, on behalf of the funds required to meet the liberal offer of the Charity Commissioners for the creation of technical institutes in South London. Donations may be paid to the chairman of the Executive Committee, E. Spicer, Esq., 50, Upper Thames-street, E.C., through the Bank of England.

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Thunderstorms.—During the whole of the last fortnight scarcely a day has elapsed without the occurrence of thunderstorms of greater or less intensity in some parts of Great Britain, and in several cases loss of life and serious damage to property have been recorded. On Hampstead Heath two men who had taken shelter under a tree were struck by lightning, and one of them had his clothes partially torn off; both were severely injured. Storms of the same character are reported from many parts of Europe.

Transformer Litigation.—It is expected that the petition entered by Mr. Ferranti for the revocation of one of the Gaulard-Gibbs patents for secondary generators will come before the Courts to-day (Friday). In the original action, brought by Messrs. Gaulard and Gibbs against Sir Coutts Lindsay and Co. and Mr. Ferranti for infringement, the plaintiffs, having found it necessary to amend their pleadings, have decided in preference to abandon the action. We understand, however, that instructions have already been given to commence a new action against the same parties.

Edison's "Perfected" Phonograph.—*The Times* of Wednesday last contained an interesting letter from Colonel Gouraud, who has just received the first Edison phonograph of the new design which has reached this country. The instrument was accompanied by a set of phonograms giving a description of the invention in Edison's own voice, also an interesting selection of musical performances, &c. Although the phonograph is not an electrical instrument, it is yet so nearly related to the telephone that we feel sure that all our readers will watch its development with the greatest interest.

Alexandria.—Some further particulars have come to hand with regard to the scheme of M. Menasce for lighting Alexandria, Ramleh, and Helouan by electricity. In addition to the *concessionnaire* becoming responsible for all damage done to drains, gas pipes, and water pipes, which may be caused by running the leads underground, and having also to guarantee the Government against any legal proceedings which may be taken, the investigation committee advise that M. Menasce should deposit £10,000 as security. The concession is to be strictly personal, and is to confer no special privilege or monopoly. It is to last fifteen years, and lapses if the works are not begun by the 1st January, 1890. Finally, the *concessionnaire* is to pay the authorities an annual rental, based on the length of the mains. He may, however, if he chooses, in lieu of this tax, charge the authorities 50 per cent. less than the current price for all lights supplied to them.

The Chandler High-Speed Engine.—When the Chandler "Silent" high-speed engines were first introduced to notice by Mr. Bumsted, of Hednesford, some doubts were not unnaturally expressed as to the durability of single-acting, high-speed engines. The experience which has since been gained in ship lighting, particularly on board the British India Company's vessels, has, however, sufficiently demonstrated the perfectly reliable character of this type of engine. This satisfactory result is, no doubt, largely due to high-class workmanship, but it is also a consequence of the very perfect method of lubrication adopted. In addition to the greater simplicity of the single-acting engine, this type possesses also the advantage of running in almost absolute silence. We may add that the ss. "Taroba," the latest addition to the fleet of the British India Company, has been fitted with electric lighting plant by Messrs. W. Harrie and Co., of Glasgow, the dynamos being driven direct by a Chandler "silent" of 30 brake horse-power, running at the moderate speed of 400 revolutions per minute.

The Cost of Electrical Traction on Tramways.—The Fourth Avenue Street Car Company, which is one of the largest tramway companies in New York, has recently decided to adopt electric traction. This decision was only arrived at after an elaborate calculation as to the relative cost of traction by electricity, by horses, and by cable. The following table shows the results arrived at:—

	Electric.	Horse.	Cable.
Cost of cars	1	0·54	0·81
Motive power	1	1·45	1·06
Construction of roadway	1	0·53	2·09
Depreciation and repairs	1	1·47	2·04
Operating expenses (including wages)	1	3·38	1·71
Totals	5	7·37	7·74
Average	1	1·47	1·55

There are now at least sixty electric street tramways in the United States. The question is no longer concerning the success of the electric motor, but what kind of motor should be used—whether it shall be by continuous current or the storage batteries. The Fourth Avenue Company have selected the storage batteries and separate motors. A depot will be erected midway on the line of railway, where the batteries can be recharged when necessary. It is expected that one set of batteries will run for two consecutive trips.

The Barcelona Exhibition.—The *Diario de Barcelona* of 19th June, 1888, contains the following:—"The magic fountain, which attracts great attention in the Universal Exhibition, was seen for the first time in the Health Exhibition, South Kensington, London, in 1884. In the Inventions Exhibition in 1885, and in the Colonial of 1886, it appeared in much greater perfection than before, and was reproduced in Liverpool and at Staten Island, New York, in 1886, as also at the Glasgow Exhibition of the present year. The fountain of this city, however, considerably excels all the others. The motive power which is employed when all the jets of water and projectors of the electric light are at work is not under 300 horse-power. The constructors of the fountain are the Anglo-American Brush Electric Light Corporation, represented in Barcelona by Don José S. Noble, and the work has been under the management of Mr. William Bates, acting on behalf of the above-named firm. We must mention that the fountain was completed in a very short space of time, considering the great difficulties which had to be encountered in the course of erection. Mr. Raworth, the chief engineer of this English firm, has come out expressly to Barcelona for the official opening ceremony."

Summer Course of Lectures and Laboratory Instruction at the City and Guilds of London Institute.—We have pleasure in calling attention to the fact that a course of experimental lectures and special laboratory work on "The Construction, Testing and Use of Electrical Measuring Instruments" will be given in July next at the Central Institution, Exhibition-road, by Prof. W. E Ayrton, F.R.S. The lectures will comprise the principles and practice of the construction, calibration, and testing for faults of ammeters, voltmeters, ohmmeters, wattmeters, coulombmeters and ergmeters as used for direct and alternating current systems. The students' practical work will be conducted in a laboratory specially fitted with accumulators, standard instruments, &c., for electrical instrument testing, and they will have the opportunity of examining and practically trying all the more important electrical meters at present in ordinary use. The course will extend over two weeks, and will consist of six lectures, from 8 to 9 p.m., on Mondays, Wednesdays and Fridays in the fortnight com-

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mencing on Monday, July 16th; and also of practical work in the physical laboratories, daily, Saturdays excepted, from 2 to 5 p.m., commencing on Tuesday, July 17th. The fee for the course, including laboratory instruction, is £2, and for the lectures only, 7s. 6d. Applications for admission should be received at the Central Institution, Exhibition-road, S.W., not later than July 6th.

Pierce v. the Liverpool Electric Supply Company (Limited). This was an action brought before the Chancery Court of the County Palatine of Lancaster, on June 14th and 19th, by Mr. Pierce, an emigration agent and hotel proprietor, against the Liverpool Electric Supply Company, of which Mr. Arthur Bromley-Holmes is managing-director, to restrain the company from working their engines at their central station in Tithebarne-street in such a manner as to annoy the plaintiff. It was contended on behalf of the plaintiff that the vibration caused by the machinery injured his business and the health of both his wife, sister, and himself. The company contended that for their own sake they ran the engines as far as possible without vibration, and stated that if the relative positions of the boilers and engines were so altered as to bring the former next the plaintiff's premises it would involve the stoppage of the light and an outlay of £900. The Vice-Chancellor, Sir H. F. Bristowe, when the evidence on both sides had been concluded, paid a personal visit to the premises of the plaintiff and of the company. Upon his return to the court his Honour said he thought it was rather a case for damages than for an injunction. The counsel on either side having agreed to this, his Honour assessed the damages to be paid to the plaintiff at £100, with costs. At the same time he stated that he had never seen better working machinery than that of the company.

Analogies of Heat and Electric Conductivity.—The analogies of heat and electric conductivity induced M. Bellati and S. Lussana to study the influence of light on the heat conductivity of selenium, the electric resistance of which, as is well known, is diminished on exposure. The plan of experiment consisted in sprinkling the double iodide of copper and mercury on the disc of selenium, on which a circular figure had been blackened with Indian ink. The selenium was heated by the passage of an electric current, which produced at first a dark spot, owing to the change in colour of the double iodide. This subsequently extended into a fairly regular circular figure, the measurement of the diameter of which afforded a means of determining the heat conductivity of the selenium. This method was found to be more practicable than the usual method of melting wax. In all cases, the diameter of the circle was greater when the selenium was exposed to reflected sunlight from which the greater part of the heat rays had been removed by passage through solutions of alum and of ammoniacal copper sulphate. The relation of heat conductivity without and with exposure to light was found to be in the ratio of 1:1·1 as the result of several concordant experiments. The same ratio was observed between the electric conductivities without and with exposure to light under conditions similar to those described above. The authors, however, would not insist on this concordance of results in the two phenomena.

Messrs. Lancaster and Tonge's Catalogue of Steam Traps, Pistons, &c.—Many of our readers will be already acquainted with the specialities manufactured by the firm of Lancaster and Tonge, engineers, of Pendleton, near Manchester, but if not, an examination of this catalogue will prove of considerable interest. The experience of over seven years has abundantly proved the value of the "Lancaster" steam trap, which consists of a loose disc valve at the orifice of the discharge pipe, in connection with a quick thread screw motion worked by the float. The special advantages of this form are found in its prompt action and entire freedom from sticking. The working parts are very simple, and are easily examined, and, in addition, no adjustment is required for varying pressures of steam. Another speciality of the same firm is the "Lancaster Serpent Coil Piston," in which the piston springs are made of tempered steel of circular cross-section, which renders it practically impossible for the piston to bind in the cylinder, and at the same time causes a revolving tendency in the packing rings. We select these two appliances as specially worthy of mention, because electrical engineers can afford to neglect nothing which promises to contribute to smoothness and certainty of action, and freedom from risk of breakdown in their steam plants. The catalogue describes various other appliances of interest, including vibration lubricators, adjustable pedestals, American unions, boiler fittings, high-speed governors, &c. The firm also manufacture engines of vertical, horizontal and diagonal types. At the Glasgow Exhibition their stand is No. 474, in the department of machinery in motion.

Royal Meteorological Society: Photographs of Lightning. The following circular has been issued by the Roya Meteorological Society:—"Sir: The Council of the Roya Meteorological Society are desirous of obtaining photographs of flashes of lightning, as they believe that a great deal of research on this subject can only be pursued by means of the camera. The council would esteem it a great favour if you, or the institution which you represent, could give them any assistance in this matter, either—1. By sending them copies of any photographs of flashes of lightning that may have already been taken. 2. By endeavouring to procure them yourself, or to interest others in so doing. It may perhaps be well to mention that the photography of lightning does not present any particular difficulties. If a rapid plate, and an ordinary rapid lens, with full aperture, be left uncovered for a short time at night during a thunderstorm, flashes of lightning will after development be found in some cases to have impressed themselves upon the plate. The only difficulty is the uncertainty whether any particular flash will happen to have been in the field of view. A rapid single lens is much more suitable than a rapid doublet, and it is believed that films on paper would effectually prevent reflection from the back. The focus should be that for a distant object, and, if possible, some point of landscape should be included to give the position of the horizon. If the latter is impossible, then the top of the picture should be distinctly marked. Any additional information as to the time, direction in which the camera was pointed, and the state of the weather, would be very desirable. The council hope, now that the thunderstorm season is approaching, many photographers, both amateurs and professionals, may be found willing to take up this interesting branch of their art. Last year a similar circular was issued by the society, and about 60 photographs of lightning flashes were received from various parts of Europe and America. These photographs have brought out several facts about lightning which had hitherto been entirely unsuspected. The committee of the society who are now investigating the subject feel that the amount of material at their disposal does not justify them in making any generalisations at present. They therefore earnestly appeal to you and others for further photographic evidence of the true nature of lightning flashes.—Yours, &c., WM. MARRIOTT, Assistant Secretary, 30, Great George-street, Westminster." [Some of the photographs alluded to above were reproduced in *The Electrician* of April 13th, 1888.]

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UNIPOLAR INDUCTION.—IV.

BY G. W. DE TUNZELMANN, B.SC.

(Continued from page 204.)

In the last article, in referring to the experiments with the apparatus of Fig. 1, it should have been stated that the explanation that the lines of force are cut continuously by the disc applies only to the case in which the disc is made to revolve while the magnet remains fixed. When the magnet and disc revolve together, the fixed portion of the circuit is cut continuously by the lines of force, always in the same direction, and no lines of force cut the circuit in the opposite direction. The central portion of the magnet in Figs. 2 to 8 takes the place of the disc when the latter is rigidly connected to the magnet. This experiment is of considerable importance, owing to its having led Faraday to the conclusion that when a magnet rotates upon its axis the lines of force do not rotate with it.

As an E.M.F. was found to exist in the disc from the centre to the periphery, both when it revolved with the magnet, and when it revolved, while the magnet remained at rest, Faraday assumed that in each case the E.M.F. was due to the intersection of the lines of force of the magnet by the disc. On this assumption the experiment would show that the lines of force remained at rest, and Faraday's further conclusions from the whole series of experiments, that a magnet could receive opposite statical charges at its equatorial and polar portions respectively by rotation amongst its own lines of force would be justified. Having once taken up this point of view, Faraday would naturally suppose it to be confirmed by the result that no effect was produced when the magnet was made to rotate while the disc remained fixed. We have seen, however, that the results may also be explained on the assumption that the lines of force revolve with the magnet, only in this case the E.M.F. will not be due to an intersection of the lines of force by the disc when both magnet and disc revolve, but to the intersection of the fixed portion of the circuit by the revolving lines of force. These experiments, therefore, do not decide the question either way. Mr. S. Iolver Preston, in a Paper in the *Philosophical Magazine* of March, 1885, calls atention to this oversight on the part of Faraday of the possible explanation of the results by the intersection of the fixed circuit by the revolving lines of force.

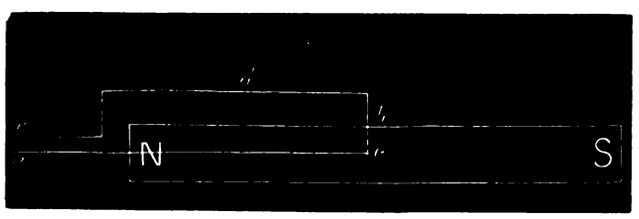

FIG. 13.

N S, magnet; *a e b d e*, loop of wire partly consisting of portion *a c* of axis of magnet.

One objection to Faraday's theory lies in its involving very complicated explanations of some of the experimental results obtained. Consider, for example, the experiment described in the first article with the apparatus shown in Fig. 8, according to which no current was obtained when the strip and the compound magnet rotated together. The arrangement is shown diagrammatically in Fig. 13. See Faraday's "Experimental Researches," No. 3,091.

N S is the magnet, *a*, *c*, *b*, *d*, *e* a loop, the portion *a c* of which consists of the axis of the magnet as far as its equatorial part *c*. The end *e* of the loop and the axis at *a* are connected with the terminals of the galvanometer. Faraday's explanation of the experimental result, that no current was obtained when the whole arrangement rotated about the axis of the magnet, was that the E.M.F. produced by the portion of the loop *b*, *d*, *e* intersecting the external lines of force, supposed to remain stationary, exactly balanced the E.M.F. produced by the portion *a c b* intersecting the lines of force in the interior of the magnet, and he considered ("Experimental Researches," No. 3,117) that this experiment proved that the lines of force are closed curves, so that there are the same number inside the magnet as outside. On the supposition which we have made, that the lines of force revolve with the magnet, the result follows at once as a result of there being no relative motion of the magnet and the circuit, and therefore no intersection of the lines of force by the circuit.

Plücker, in a Paper published in *Poggendorff's Annalen*, Vol. LXXXVII., 1852, described a number of experiments of the same general character as those made by Faraday, and he came to the same conclusion as Faraday, making the same oversight with regard to the effect which the revolving lines of force would have on the fixed portion of the circuit. He, too, was obliged to give very complicated explanations of many of the phenomena observed. For example, in one of his experiments he used six magnets fixed in a disc like the two magnets in the apparatus shown in Fig. 8 of the first article, the magnets being equidistant from each other and from the centre of the disc, and he accounted for the E.M.F. acting along the radius of the disc, which was produced by rotating the disc and magnets about the axis of the former, by supposing the field of force of each magnet to undergo a rotary displacement, without rotation, their motion being like that of a weight suspended by a ring from a peg which projects horizontally from the edge of a fly-wheel revolving in a vertical plane. He then supposed that currents were set up in the disc by the lines of force being made to intersect it in this manner.

A more fundamental objection to the view adopted by Faraday and Plücker consists in the fact that it involves an essential difference in the behaviour of the field of force of a magnet when the magnet undergoes a motion of translation and one of rotation respectively, as in the former case the magnetic field must necessarily move with the magnet. Faraday himself saw the difficulty, but believing that his

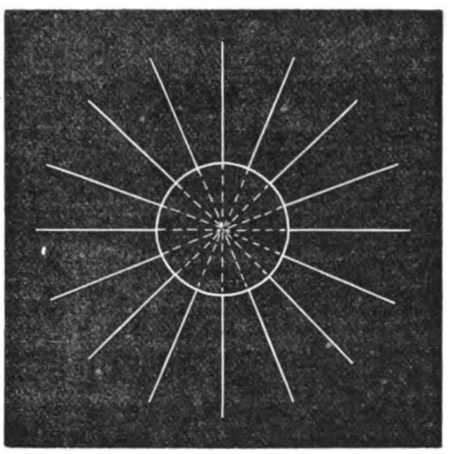

FIG. 14.

Section perpendicular to the axis of an infinite homogeneous circular cylinder, showing lines of force for gravitational attraction.

experimental results proved the field to be stationary when the motion of the magnet was one simply of rotation about its axis, he merely points out that the conclusion is singular. The inadmissiblity of making this distinction between the effect on the field, of motion of translation, and of rotation respectively, may, I think, be most easily seen by considering the simpler case of gravitation potential, where a line of force is the direction in which a small particle of matter tends to move in obedience to gravitational attraction.

Consider an infinite circular cylinder of homogeneous material, then the lines of force are straight lines, perpendicular to the surface, as shown in Fig. 14, which is a section perpendicular to the axis of the cylinder and its system of lines of force. The field of force will be exactly similar if the cylinder is a hollow one bounded by two concentric circular tubes. The field of force in either of these cases, like that of a cylindrical magnet, is not altered by rotation; the direction of the force at a given point in space will be the same whether we suppose the field to rotate with the cylinder or to remain stationary.

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But consider now a thin, hollow cylinder formed by two tubes, every section perpendicular to the axis consisting of two concentric, similar and similarly situated ellipses. The equipotential surfaces will then consist of a series of elliptic cylinders, confocal with the outer surface of the hollow cylinder, so that the section perpendicular to the axis will give us the equipotential curves, a series of ellipses confocal with the outer section of the cylinder, and the lines of force, which must cut the equipotential curves at right angles, and will therefore consist of a series of hyperbolas confocal with the ellipses, as shown in Fig. 15. If the cylinder is now made to rotate about its axis, it is perfectly clear that the lines of force must

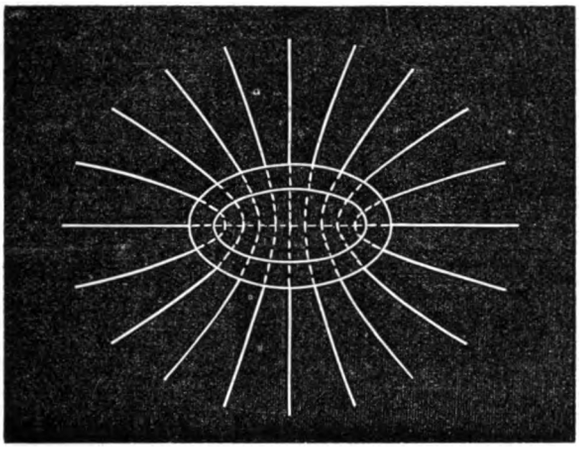

FIG. 15.

Section perpendicular to the axis of a homogeneous, thin, hollow cylinder, bounded by concentric, similar and similarly situated elliptic tubes, showing the hyperbolic lines of force for gravitational attraction confocal with the outer bounding ellipse of the section of the cylinder.

rotate with it. If the ellipses be made to approach a circular form the foci will approach the centre, and the system of hyperbolæ will approach more and more nearly to a set of straight lines passing through the centre, until in the limit, when the ellipses become circles, the field of force will be as shown

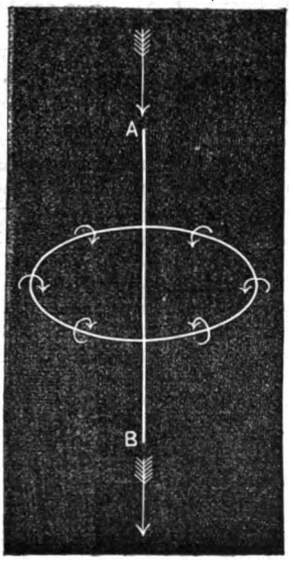

FIG. 16.

Straight current A B, showing one of its circular lines of force surrounded by electric whirls.

in Fig. 14. Now, however little the ellipses differ from circles, the field of force must be admitted to rotate with the cylinder when the latter turns about its axis, and it would be absurd to suppose a sudden change to take place in the limiting case when the field becomes symmetrical with regard to the axis. Similar considerations will evidently apply to magnetic lines of force, and we may therefore, I think, consider it proved that when a magnet rotates upon its axis, its lines of force rotate with it.

We now have to consider the physical meaning of this rotation of magnetic lines of force, and to do this we must try to form some conception of the nature of the action which goes on in a medium traversed by the lines. Ampère, as everyone knows, explained the actions of magnets on the assumption that every molecule of a magnet had an electric current circulating in it, which we may call an electric whirl. Sir William Thomson (*Proc.* Royal Society, June, 1856) expressed the opinion that the fact that the rate at which circularly polarised light is transmitted through magnetised glass, parallel to the lines of magnetic force, depends on whether the direction of transmission is the same or opposed to the positive direction of the lines of force, could only be explained by the existence of some kind of rotation in the medium. He therefore considered that Faraday's discovery of the magnetic rotation of the plane of polarisation of plane polarised light gave a confirmation amounting to demonstration of Ampère's explanation of the ultimate nature of magnetism. Two years later Helmholtz, in his famous memoir on vortex motion (*Crelle, Journal für Reine und Angewandte Mathematik*, Vol. LV., which was translated in the *Philosophical Magazine*, Vol. XXXIII, 4th Series, 1867), pointed out the analogy existing between an electro-magnetic field and a mass of fluid in which there is vortex motion. In 1861 and 1862 Clerk Maxwell published a series of papers in the *Philosophical Magazine*, in which he developed a theory of molecular vortices according to which lines of magnetic force were to be considered as forming the axis of electric whirls or vortices, as in Fig. 16, which shows a portion of a straight current, A B, with one of

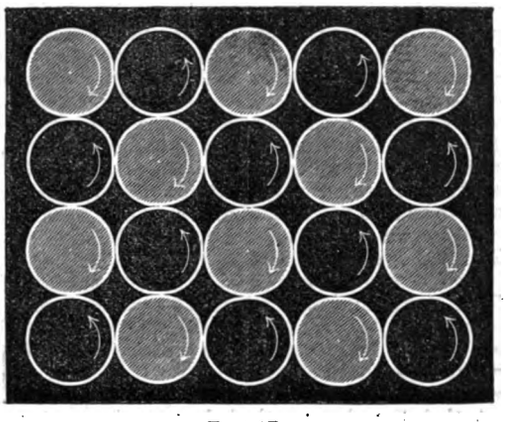

FIG. 17.

Maxwell's representation of a magnetic field.

its circular lines of force with the electric whirls round it. As two neighbouring whirls would be moving in opposite directions, he assumed that between every two of them was a particle turning in an opposite direction to the whirls and forming a connecting mechanism. Fig. 17 shows a magnetic field on this theory, the plain circles representing the electric whirls and the shaded circles representing the connecting particles. The directions of rotation are shown by the arrows. From this theory Maxwell deduced the following conclusions:—

(1) Magnetic force is the effect of the centrifugal force of the vortices.

(2) Electro-magnetic induction of currents is the effect of the forces called into play when the velocity of the vortices is changing.

(3) Electromotive force arises from the stress on the connecting mechanism.

(4) Electric displacement arises from the elastic yielding of the connecting mechanism.

On this hypothesis an electric current would be produced when a continuous slipping took place in the connecting mechanism, and we should have therefore to suppose that in a conductor continuous slip could take place, while in a dielectric there was no slip, but only an elastic yielding of the connecting mechanism.

This has been very well worked out, with some modifications, by Prof. Lodge in an admirable series of articles on

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"Modern Views of Electricity," which have recently appeared in *Nature*. These papers are entirely non-mathematical, and are well worthy the attention of practical electricians.

Mr. R. T. Glazebrook, in a very interesting paper on the "Molecular Vortex Theory of Electromagnetic Action" (*Phil. Mag.*, 5th Series, Vol. XI., 1881), shows that if the moving medium be supposed to have the properties of a viscous fluid in conductors, and of an elastic solid in dielectrics, the additional particles, or idle whirls, become unnecessary, except as explaining how the vortices may be conceived to rotate.

If we adopt Maxwell's original theory or any of its modified forms, we have at once a physical explanation of the rotation of a magnet's lines of force, which will consist in the actual motion of the vortices through the medium surrounding the magnet. The electric currents which arise in a conductor traversed by the lines of force will therefore, on this theory, consist of motions of the medium within the conductor, due to the forces called into play as it is traversed by the series of vortices or vortex-filaments surrounding each line of force.

(To be continued.)

PROTECTION OF BUILDINGS FROM LIGHTNING.*

BY PROF. OLIVER LODGE, D.SC., F.R.S.

I made several assertions last week which it is my business now to justify by actual experiment.

The word "inertia" one uses as conveying a correct general notion of the behaviour of an electric circuit to sudden electromotive forces; a behaviour which is caused by the influence of induction which every portion of a circuit exerts on every other portion. Consider a conducting rod as analysed into a bundle of parallel wires or filaments, and let a current be suddenly started in all. The rising current in any one filament exerts an opposing force on all the others; and this self-generated opposition E.M.F., due to induction between the different filaments of the conductor, exactly imitates the effects of ordinary inertia as observed in massive bodies submitted to sudden mechanical forces. (For some illustrations of these well-known effects see a letter by Mr. Maclean, in *Nature*, Vol. XXXVII., p. 612.)

The term commonly employed to denote the electrical inertia-like effect is "self-induction," which is becoming gradually shortened to "inductance;" its original form when first dealt with by Sir Wm. Thomson was the "electromagnetic capacity" of the circuit.

Now since electrical inertia is due to a mutual action between the filaments into which a conductor may be supposed divided, it is manifest that the closer packed they are the greater their inertia will be; and that to diminish inertia it is only necessary to separate the filaments and spread them out.

The main count of the indictment against ordinary procedure is that too much attention has been hitherto paid to conducting power, and too little to inertia. In fact, it is not too much to say that practically nothing but conductivity has been attended to, or thought of, in the erection of lightning conductors.

I want to show that conductivity is, from many points of view, of hardly any moment, and that the circumstances of a discharge are regulated far more by inertia than by conductivity. I can even show that, under certain circumstances, high conductivity appears to be an actual objection, and that a stout rod of good conducting copper carries off a flash less well and quietly than a thin wire of badly-conducting iron.

Let us proceed to verify this paradoxical statement at once.

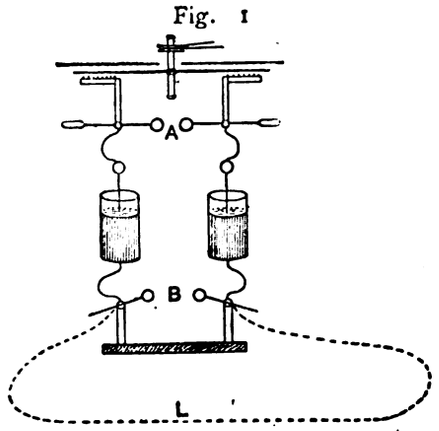
Experiment of the Alternative Path.

The first form of experiment I have to describe is a very simple one. I call it the experiment of the alternative path. It consists in giving a Leyden jar discharge the choice between a certain conductor and a certain length of air, and in adjusting the length of air until it had as lief take one path as the other.

I am not aware that the particular mode of carrying out this simple experiment has any special significance, but to be definite, I depict, in Fig. 1, the symmetrical arrangement I have most frequently, though not exclusively, adopted.

The knobs marked A are the ordinary terminals of a Voss machine. The jars stand on an ordinary wood table, and their outer coats are led to the discharger B, the distance of whose air-space can be varied. The alternative path L is shown by a dotted line. The discharge has to choose between B and L. Sometimes L is absent, and in that case the charging of the jars is quite well effected through the wood of the table; this is the advantage of having the jars imperfectly insulated. At the same time the conducting power of the wood is too low to enable the jars to discharge themselves at all satisfactorily, unless the knobs B are within striking distance, or unless some path, L, is provided. The only discharge obtained at A when both paths, B and L, are absent, is a feeble spitting or intermittent and frequent sparking, very different from the loud report heard as soon as the knobs B are brought within striking distance. But it is not to be supposed that the B knobs must be as close together as the A knobs in order to permit complete discharge; on the contrary, the B knobs may be almost twice as far apart as the A knobs, and yet the discharge shall be complete and noisy.

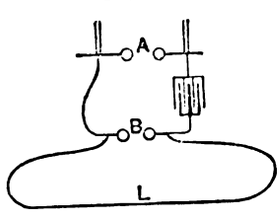
Fig. 1



It will be understood that the two sparks occur together; a spark at A precipitates, and is the cause of, the spark at B. Not *vice versâ*, for until the A spark occurs there is not the slightest tendency for a spark at B. The two B knobs are at the same zero potential, and may be touched with impunity except at the instant when the flash occurs at A. Remember that the jars are standing on a common table all the time.

Lest it be thought that there is anything occult in this mode of obtaining the spark at B, let us subjoin as Fig. 2 another arrangement of connection, which does just as well, and, in fact, represents the first experiment I tried. The condenser is a very large one of tinfoil and glass plates, with carefully insulated terminals. My object in making it was to obtain a sudden rush of a considerable quantity of electricity (like lightning), and then study its behaviour under various circumstances. I found afterwards that for most experiments an ordinary gallon or even pint Leyden jar served just as well, was much quicker in use, and less dangerous. Moreover, the use of insulated terminals necessitates the continued presence of some alternative path (L) or other, else of course the condenser declines to charge.

Fig. 2.



It may be noted at once that with either arrangement the spark A was very loud whenever the spark was allowed to occur at B as well; but so soon as the discharge was compelled to traverse the alternative conductor L, by putting the B knobs too far apart, then the noise of the discharge was much diminished, not merely because there is now only one spark instead of two, but plainly because, for some reason or other, the discharge meets with considerable obstruction in the wire, whereby its duration is lengthened, and its noise therefore very greatly lessened.

The numbers given below are extracted from a page of the laboratory note-book, and refer to an experiment with two Leyden jars, of a size which I sufficiently specify by calling them "gallon" jars, arranged as in Fig. 1. The length of the A spark was maintained at one inch throughout the experiment; or as it happened to be accidentally convenient to measure lengths in tenths of an inch, I will call the A length 10. The B length is variable, being altered until a B spark sometimes passes and sometimes misses.

* Lecture II. of the Dr. Mann lectures, delivered before the Society of Arts, March 17th, 1888.

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The first alternative path I show is a length of about 40ft. of stout No. 1. (B.W.G.) copper wire or rod, suspended round the room by silk ribbon. Its resistance to ordinary currents is very small, being ·025 ohm. Nevertheless, we shall find that the discharge refuses to take this apparently easy path, and persists in jumping the air gap B instead, until the B knobs are separated 14·3 tenths of an inch. This is the critical distance. If they are further apart than this the discharge chooses the thick copper wire by preference, and its noise or suddenness is then much less.

As a contrast with this, I next try a similar length of fine iron wire (No. 27, B.W.G.), whose resistance to ordinary currents is 33·3 ohms, or 1,300 times as great as the other. We find that the discharge very distinctly prefers this wire to the other. For if the B knobs remain at the distance 14·3 we never now get a B spark, nor do we get one until they have been brought distinctly nearer. The critical spark length is now 10·3. I confess I was surprised at this result.

Let us next try an enormous resistance—a capillary tube of liquid (very dilute acid), giving to ordinary measurements some 300,000 ohms. The critical spark length at B is, indeed, a little increased by this great resistance, but not much above that found for the stout copper wire. I have not an exact measure of it, but 16 or 17 will not be far out. The spark at A now becomes very quiet indeed, pointing to the fact that what we were observing all along was, in some sense or other, the effect of true resistance; for the undeniable resistance in the capillary tube gives just the same kind of effects as does the copper or iron wire, only a little more pronounced.

I have suspended three other conductors of about the same length, which it is easy to try in the same way, keeping the A spark-length 10 all the time. The results are here summarised :—

Alternative Path.		Critical B spark-length.
Stout copper wire, No. 1	R= ·025 ohm	14·3
Ordinary copper wire, No. 19	R= 2·72 ,, ...	13·4
Stout iron wire, No. 1	R= ·086 ,, ...	10·8
Ordinary iron wire, No. 18	R= 3·55 ,, ...	10·8
Thinnest iron wire, No. 27	R=33·3 ,, ...	10·3

The copper wires seem to obstruct almost equally, and the iron wires also obstruct equally among themselves, notwithstanding their very different diameters; but the coppers obstruct more than the irons.

There is nothing absolute about these numbers; they are the record of a definite experiment, but their precise value depends on the circumstances of the experiment. It is easy to arrange it so that the iron is less effective than the copper—so that, in fact, ordinary resistance seems to become of consequence again. This is done by putting a long lead into the A circuit of the jars. But whenever the flash is made as sudden as possible—and there seems little doubt but that a lightning flash is very sudden—then the order of the numbers is something like the figures quoted.

Reason of the Enormous Obstruction Offered by a Good Conductor.

Now, what is the cause of all this astonishing obstruction offered by good conductors to the sudden rush of electricity? One may express it in a popular way, thus :—It is due to electrical inertia, or what is also called "self-induction." A current cannot start in an inductor instantaneously any more than water in a pipe can start moving at full speed in an instant. Give the water a violent blow to make it move, and it resists like a solid. The blow, if very quick and violent, may burst the pipe, but it will not appreciably propel the water. So, in a manner, is it with electricity. The flash occurs, and the conductor must either carry it off at once or not at all. There is no time to think about it, and the E.M.F. needed to overcome this inertia-like obstruction is so great that a considerable thickness of air may be burst by it, and the discharge may flash off sideways to anything handy.

Another way of putting the matter is this :—A lightning discharge is essentially a varying current; it manifestly rises from zero to a maximum, and then dies away again, all in some extremely small fraction of a second, say 100,000th, or thereabouts. But that is not all; there is a certain amount of energy to be got rid of, to be dissipated, and it may easily be that a single rush of electricity in one direction does not suffice to dissipate all the stored-up energy of the charged cloud. If the conductor is highly resisting, a single rush is sufficient, but if it be well-conducting it is quite insufficient. What happens then? The same as would happen with compressed air or other fluid rushing out of an orifice. If it is a narrow jet there is a one-directioned blast, but if a wide, free mouth be suddenly opened the escaping air overshoots itself by reason of inertia, and springs back again, oscillating to and fro till the stored-up energy is dissipated. Just so is it with an electric discharge through good conductors; it is not a mere one-directioned rush, it is an oscillation, a surging of electricity to and fro, until all the energy is turned into heat.

This fact is often forgotten by lightning-rod men; they speak as if there were a certain quantity of electricity to be conveyed to earth and there was an end of it, but they forget the energy of the electric charge, which must be got rid of somehow. If a great weight or a large reservoir of water were propped up above one's house, one would not say that, the safe thing being to get it down as quickly as possible, it was advisable to knock the props away or to blow the bottom out of the reservoir; no, one would prefer to let it slide slowly and gradually down a well-resisting channel, so as to disperse the energy gradually.

We will remember, then, that a Leyden jar discharge through good conductors is oscillatory, and that the oscillation continues until all the stored energy is rubbed away. The oscillations have an enormous frequency; they may be millions a second, for the whole lot of them have to cease during the excessively minute duration of the visible flash. It is well known that a flash is of far less real duration than the persistence of optical impression on the retina would lead one to believe; as is easily illustrated by illuminating a spinning wheel by an electric spark. However fast (ordinarily speaking) the wheel is spinning it appears to be stationary, and the spokes are seen singly and clearly by the light of each spark.

It is for this reason that, although the illuminating power of a powerful flash need not be greater than weak moonlight, its actual intensity while it lasts may exceed strong sunlight, and hence may exert a damaging effect on the retina, and cause blindness.

There is another fact which it behoves us to be aware of. It is one to the importance of which the attention of scientific men has but recently been called. Experimentally it has been discovered by Prof. Hughes, theoretically by Mr. Oliver Heaviside, Lord Rayleigh, and Prof. Poynting; for though the necessary theory is really contained in Clerk Maxwell, it required digging out and displaying. This has now been abundantly done, but the knowledge has scarcely yet penetrated to practical men; indeed, it has not yet been thoroughly assimilated by most physicists. The fact is this. When a current starts in a conductor, it does not start equally all through its section, it begins on the outside, and then gradually, though rapidly, penetrates to the interior. A steady current flows uniformly through the whole section of a conductor, a variable current does not. It is started first at the surface, and it is stopped first at the surface.

Remembering the rapidly oscillating character of an electric discharge, remembering also the fact that a rising current begins on the outside surface of a conductor, we perceive that, with a certain rate of alternation, no current will be able to penetrate below the most superficial layer or outer skin of the conductor at all. In the outer skin, of microscopic thickness, electricity will be oscillating to and fro, but the interior of the conductor will remain stolidly inert and take no part in the action.

Thus we arrive at a curious kind of resistance, caused by inertia in a roundabout fashion, and yet a real resistance, a reduction in the conducting substance of a rod, so that no portion except that close to the surface can take any part in the conduction of these rapidly alternating currents or discharges. It must naturally be better, therefore, not to make a lightning conductor of solid rod, but to flatten it out into a thin sheet, or cut it into detached wires; any plan for increasing surface, and spreading it out laterally will be an improvement.

Perhaps it may be as well to guard against one favourite misconception. It has long been known that static charges exist only on the surface of conductors; it has also long been known that ordinary currents flow through the whole section and substance of their conductors. It is now beginning to be known that alternating currents may be sufficiently rapid to traverse only the outer layers of conductors, and this last piece of knowledge is felt to be rather disturbing by those who have been accustomed to dwell upon the behaviour of steady currents, and seems like a return to electrostatic notions, and an attempt to lord it over currents by their help. But the first and third facts mentioned above—the behaviour of static charges, and the behaviour of alternating currents—are two distinct facts, independent of each other; not rigorously independent perhaps, but best considered so for ordinary purposes of explanation.

We have thus mentioned two causes of obstruction met with by rapidly oscillating currents trying to traverse a metal rod. First there is the direct inertia-like effect of self-induction to be added to the resistance proper; the resulting quantity being called by Mr. Heaviside "impedance," to distinguish it from resistance proper. For there is a very clear distinction between them; resistance proper dissipates the energy of a current into heat, according to Joule's law; impedance obstructs the current, but does not dissipate energy. Impedance causes tendency to side flash, resistance causes a conductor to heat and perhaps to melt. The greater the resistance of a conductor, the more quickly will the energy of a discharge be dissipated, its oscillations being rapidly damped; the greater the impedance of a conductor, the less able is it to carry off a flash, and neighbouring semi-conductors are accordingly exposed to the more

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danger. Resistance is analogous to friction in machinery; impedance is analogous to freely suspended massive obstruction, in addition to whatever friction there may be. To slowly changing forces friction is practically the sole obstruction; to rapidly alternating forces inertia may constitute by far the greater part of the total obstruction; so much the greater part that friction need hardly matter.

This is a fairly accurate popular statement of the direct way in which self-induction aids the resistance proper in obstructing an alternating current. But, in addition to these considerations, there is that other indirect way which we have also mentioned, viz., the fact that conduction of alternating current may be confined to the surface of a rod or wire if the alternations are rapid enough. This cause must plainly increase total impedance; for the total channel open to such a current is virtually throttled, as a water pipe would be throttled by a central solid core.

But which part of the total impedance does it affect? Does it increase the resistance part or the inertia part? In other words, does this throttling of a conductor act by dissipation of energy or by mere massive sluggishness? Plainly, it must act like any other reduction of section, it must increase the resistance, the dissipating power of a conductor, the heating power of a current. Hence the resistance of which we have spoken as entering into the total impedance has by no means the same value as it has for steady currents, and as measured by a Wheatstone bridge. It is a quantity greater—possibly much greater—than this; and in order to calculate its value, we must know not only the sectional area and specific conductivity of the conductor, but also the shape of its section, and the rate of alternation of the current to be conveyed.

Tape *v.* Rod.

We may here note a vigorous controversy, or difference of opinion, between Faraday on the one hand, and Sir W. Snow Harris on the other. Faraday was often consulted about lightning conductors for lighthouses, and consistently maintained that sectional area was the one thing necessary, weight per linear foot, and the shape was wholly indifferent. Harris, on the contrary, maintained that tube conductors were just as good as solid rods, and that flattened ribbon was better still. Each is reported to have said that the other know nothing at all about the matter. Of course we know that Faraday was thinking of nothing but conduction, and conduction for steady currents. Harris had probably no theoretical reason to give, but was guided by either instinct or by the result of experience. I think we shall have to admit that, in this particular, Faraday was wrong and Harris was right. The following experiment may serve to illustrate the point further:—

I take two copper conductors of the same length and approximately of the same weight, but one of them in the form of wire, the other in the form of ribbon, and I use them successively as an alternative path. The knobs at A being fixed at two centimetres apart, the B knobs were adjusted until the spark sometimes chose the air gap, and sometimes the alternative conductor. (*See* Fig. 1 or 2.) The critical B spark length was then:—

	Millimetres.
With the wire as alternative path.....	8·36
With the ribbon ,, ,, ...	6·26
,, wire ,, ,, ...	8·45
,, ribbon ,, ,, ...	6·05
,, wire ,, ,, ...	8 21
,, ribbon ,, ,, ...	6·06

Very distinctly showing the advantage of a flattened form of conductor over a mere round section.

The dimensions of the two conductors here compared are as follows:—Wire: No. 12 B.W.G., 218 centimetres long, weight 91·6 grammes. Ribbon: 218 centimetres long and 6·4 centimetres broad, weight 88·7 grammes.

But, it may be said, have not experiments often been made as to the advantage of tape over rod forms of lightning conductor, with negative results? Yes, but the point usually attended to is the deflagration of the conductor. Mr. Preece, for instance, with Dr. De la Rue's battery, found ribbon and wire equally easy to deflagrate by the discharge. But we are not examining which form of conductor is least liable to be destroyed by a flash—probably there is not much to choose between one form of section and another, for there is no time for surface cooling—we are examining which form will carry off a charge most easily, and with least liability to side-flash; and here thin ribbon shows distinct advantage over round rod.

Iron *v.* Copper.

You remember we have found that a rod of iron carries off a discharge more satisfactorily than a rod of copper. It would seem as if the poorer conducting qualities of iron enabled the discharge to penetrate deeper, and so to make use of a greater thickness of skin.

But everyone will say—and I should have said before trying—surely iron has far more self-induction than copper. A current going through iron has to magnetise it in concentric cylinders, and this takes time. But experiment declares against this view for the case of Leyden jar discharges. Iron is experimentally better than copper. It would seem, then, that the flash is too quick to magnetise the iron; or else the current confines itself so entirely to the outer skin that there is nothing to magnetise. A tubular current would magnetise nothing inside it. Somehow or other the peculiar properties of iron, due to its great magnetic permeability, disappear.

I do not believe anyone could have expected this result. Possibly Lord Rayleigh might have predicted it, and perhaps Mr. Oliver Heaviside. It would scarcely become me to express admiration for the work of so great a master of science as Lord Rayleigh (though, parenthetically, I may mention that I feel such admiration in the highest degree), but I must take the opportunity to remark what a singular insight into the intricacies of the subject, and what a masterly grasp of a most difficult theory, are to be found among the eccentric, and in some respects repellant, writings of Mr. Oliver Heaviside. I cannot pretend to have done more than skim these writings, however, for I find Lord Rayleigh's papers, in so far as they cover the same ground, so much pleasanter and easier to read; though, indeed, they are none of the easiest.

Can this suggestion with regard to iron be examined and verified or disproved in some other more direct way?

It is easy to try another experiment. I have here two conductors made of tinfoil; each is made of a long slip of tinfoil, about three inches broad and 21ft. long. One is zigzagged backwards and forwards, with the interposition of three thicknesses of paraffin paper between each zigzag to secure insulation, so as to abolish self-induction as far as possible. This I call the tinfoil zigzag. The other is coiled spirally on a glass tube—again with the interposition of paraffin paper—so as to give as much self-induction as possible. This I call the tinfoil spiral. A bundle of fine iron wires—the core of an induction coil, in fact—can be introduced into this glass tube, or withdrawn, at pleasure. The resistances of these conductors, measured in the ordinary way, are:—·614 ohm for the spiral and ·708 ohm for the zigzag. They were intended to be alike.

The connections being made as in Fig. 1, one or other of these tinfoil conductors is used as the alternative path L, with this result:—

The length of the A spark being 7·3, the critical spark length at B, when sparks sometimes passed and sometimes failed, was 11·1 when no alternative path was provided. When the tinfoil zigzag connected the outsides of the jars instead of the wire L it was not possible to get a B spark till the distance was shortened to 0·6; when this was replaced by the tinfoil spiral, the critical B spark length rose to 6·4. The iron bundle was now inserted in the spiral, and the experiment tried again. The B spark length remained 6·4. The iron made no perceptible difference whatever.

Here is a magnetic time-lag raised to an extreme. Prof. Ayrton tells me they have noticed the permeability of iron begin to diminish with very quick alternations. Here it is becoming virtually no bigger than that of air. It may be said that the iron fails to get magnetised because of the opposing action of the inverse "Foucault" currents induced in it, just half a period behind the inducing currents. I thought this would be so, of course, with thick rods of iron, but with a bundle of thin wires I felt doubtful. Lord Rayleigh, however, thinks these induced peripheral currents competent to explain magnetic time-lag in every case; and I can have no doubt that he is right. Whatever the explanation, the fact of time-lag in iron is patent. Yet there is something strange about it, for that a steel knitting needle can be magnetised by discharging a Leyden jar round it is mentioned in every text-book, and (what does not necessarily follow) it is certainly true. There are points here requiring further examination.

However, if it turns out to be true that an iron rod does not get magnetised by the passage of a rapidly alternating current, it may be held a natural consequence of the fact that such currents flow mainly in its outer surface, and that such tubular currents have no magnetising power on anything inside them.

The magnetisability of iron is no objection to its employment in lightning conductors. Its inferior conductivity is an advantage in rendering the flash slower, and therefore less explosive. Its high melting point and cheapness are obvious advantages. It is almost as permanent as copper, at least when galvanised, and it is not likely to be stolen. I regard the use of copper for lightning conductors as doomed.

(To be continued.)

The Telephone in Hungary.—A Bill has just been laid before the Hungarian Chamber relating to telephone lines. Concessions lasting fifty years are to be granted, and the Bill contains elaborate instructions on various points connected with the general uses of electricity.

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ALTERNATE-CURRENT ELECTROLYSIS.*

When the current from an alternate-current dynamo is passed through an ordinary voltameter containing platinum electrodes and acidulated water, no evolution of gas is, as a general rule, observed. There seems, in fact, to be no decomposition of the dilute sulphuric acid, although the circuit is closed. For instance, with currents of 4 to 5 amperes and an E.M.F. of from 250 to 300 volts, no trace of gas is found at the electrodes, provided that the platinum rods exceed ·1 centimetre in diameter and 4 to 5 centimetres in length. Hence arises the common notion that alternate currents are as incapable of splitting up the liquid in a voltameter as they are of deflecting the needle of a galvanometer. This idea is erroneous. It is only an apparent inability to electrolyse, since, if we substitute fine wires for the larger electrodes in the very same voltameter, the same alternate-currents will immediately liberate gas freely.

The experimental study† of this phenomenon has led us to form the following conclusions :—1. For every current there is a platinum electrode whose surface is such that gas is not evolved, and electrolysis actually is, or seems to be, completely checked. If now we gradually reduce the surface of the electrode, gas is liberated more and more as the area of the electrodes is diminished. 2. Conversely for every platinum electrode of a certain size there is a current below which there is no evolution of gas. On the other hand, more and more gas is evolved as the current strength is increased. 3. In every case chemical analysis has shown that the gases at either electrode have the same composition. They are, in fact, the gases of water, forming an explosive mixture, but in which oxygen forms less than a third of the total volume. Moreover, the volume of gas liberated per ampere-minute is always more or less under the theoretical quantity of 10 4cc., which would under similar conditions be evolved by a continuous current.

One of the most interesting phenomena of this electrolysis is the fact that we have ozone liberated at each electrode, notwithstanding the presence of hydrogen. If the gases are allowed to evolve freely in the open ozone is soon detected by its strong smell and even by the characteristic white fumes. We were easily able to measure it, and found that its proportions, at the same temperature, depend chiefly upon the current density and the nature of the electrodes and electrolyte. At present, however, we will speak only of the fact of its production, which plays an important part in the correct interpretation of these phenomena.

It seems natural to us that, given a simultaneous evolution of highly ozonised oxygen, and of nascent hydrogen upon the same electrode, the slightest external action should be quite sufficient to cause the re-formation of water and the consequent disappearance of the gases. Now, in the case of platinum electrodes an external cause is present in the property of occlusion possessed by this metal, which is proportional to the metallic surface in contact with the gases. We have here, therefore, a plausible explanation of the phenomena. This view is confirmed by several of our experiments, of which we will only now cite two.

1. Copper electrodes do not decompose acidulated water under the same conditions of current density as do platinum electrodes. Nevertheless, they become coated with a film of reduced red copper. If finer wires are used there is an abundant liberation of gas, which, however, does not last long, as the electrodes soon dissolve, so to speak, in the liquid in streaks of powdery reduced red copper. The copper is thus first oxydised by ozonised oxygen, then it is reduced by the hydrogen with recomposition of water. It is easy to see that if the surface is only large enough, not a single bubble of gas can be evolved. We have here, therefore, re-absorption of the gases caused by a double chemical reaction.

2. With large mercury electrodes a slight quantity of gas is liberated, and from time to time a cloud of white matter is produced, which slowly spreads over the whole voltameter. This gas is formed almost entirely of hydrogen. The solid is a sulphate of mercury (a salt which is hardly soluble). It is known that a continuous current would only produce sulphate-protoxide. Here again, therefore, we have re-composition of water at the expense of the gases which might otherwise have been liberated. The cause must be sought for both in the absorptive properties of mercury and in the double reaction which the metal and sulphate-protoxide undergo.

These secondary reactions explain also the difference between the volume of the gases liberated for a given strength of alternate-current and the theoretical volume deduced from Faraday's law. Nevertheless, we shall show in a later communication that by a proper choice of electrolyte and electrodes results may be directly or indirectly obtained which will be strictly proportional to the total quantity of electricity traversing the electrolyte. We shall then have an electrolytic means of measuring alternate-currents. These two experiments prove, moreover, how very much the primary and secondary reactions of alternate-current electrolysis differ from the ordinary electrolytic reactions caused by continuous currents. We have noticed several other instances of this. We think it our duty to add that the evolution of this explosive mixture renders these investigations rather delicate, not to say dangerous. There is always a chance of a spontaneous explosion, unless certain precautions, which we will mention in our next Paper, are taken.

* Translation of a Paper by MM. Maneuvrier and J. Chappuis, read before the Académie des Sciences, by M. Lippmann (*Comptes Rendus*, Vol. CVI, No. 25).

† These investigations were carried out at the Sorbonne Laboratory of Physical Research.

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"*Transactions* of the Royal Society of Edinburgh." "Botany of Socotra." By Prof. Bayley Balfour. Vol. XXXI. (Edinburgh : Robert Grant and Son.)

MEETINGS OF SCIENTIFIC SOCIETIES.

MONDAY, July 2nd.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

*** Particulars of meetings to be held or papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

The Cascade Tunnel.—The tunnel of the Northern Pacific Railroad through the Cascade range, in Washington Territory, which was completed recently, is to be lighted by electricity, the power being obtained from a large waterfall near the east portal, which will be used to run the dynamos.

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The Electrician.

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SPECIAL NOTICE.

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ANSWER TO CORRESPONDENT.

PERCY W. LONG.—(1) *In the company you name promotion is slow, but the rate of payment depends in part on the skill attained. Cannot say what the salaries are.* (2) *The profession is undoubtedly overcrowded at the present time, but really clever men have still a chance of coming to the front.*

TELEPHONIC COMMUNICATION.

No one can be surprised that the United Telephone Company have decided to drop for the present Session their Bill seeking further powers in respect to the erection of overhead wires and other matters affecting the future development of telephonic business in the metropolitan area. It seems to have been generally admitted that the company were asking for more than they were at all likely to get, and if any doubt on this point remained in the minds of the promoters it was speedily disposed of by the action of the metropolitan parliamentary representatives, who let it be known that they intended to offer the Bill a somewhat uncompromising opposition. Added to this there were the several recent utterances of the POSTMASTER-GENERAL, indicating with more and more distinctness every time he referred to the subject that he was not disposed to concede to the telephone companies greater powers of extension than they already possessed. The Bill promoted by the parent company closely concerned all the subsidiary companies as well, for it would have been impossible to refuse to the provinces any privileges which the metropolis had obtained for itself; and thus there was a widespread desire to know precisely what Mr. RAIKES intended to do when the United Company's Bill came on for discussion, as it was expected to do in the present week. The deputation which waited on him last week was therefore a representative one; and the practical suggestion it had to offer in face of a formidable opposition in Parliament was that the Bill should be referred to a Select Committee. This the POSTMASTER-GENERAL flatly declined to countenance, and the upshot was that the deputation came to the unanimous conclusion that it would be better not to press the Bill any further.

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Besides the reasons above mentioned for taking this sensible course, there was no doubt another and perhaps even more cogent one. The published accounts of the interview are very meagre indeed; but it seems pretty clear that Mr. RAIKES repeated the declaration which created such a sensation a few weeks ago with reference to the moribund condition of the telephonic patents. To tell the public that the patents have only a few years to run, and that he will then see what can be done, was a piece of candour as uncalled for as it was unprecedented; but to say the same thing to the patentees themselves, as some accounts say he did last Friday, was frankness which may fairly be called brutal. No wonder the deputation retired disconcerted; and no wonder that the organs which profess to safeguard the interests of telephonic shareholders are furious with the present POSTMASTER-GENERAL for taking what they consider an unfair advantage of the company's position. We cannot pretend to sympathise with the financial organs in this particular, for they have done their very utmost to discredit the United Telephone Company by constant attacks upon its management and personal reflections upon its managers. The *Financial News*, at all events, has no need to be astonished that the Post Office does not adopt a superfinely magnanimous view of its duty towards the principal telephone company. If half of what has been said in that journal hostile to the company were true, Mr. RAIKES would be more than justified in taking sides against it on behalf of what he conceives to be the public welfare. But we do not share the opinions of these financial critics; and on the whole we think the telephone companies have been hardly treated in not having been apprised earlier of the policy the Post Office intended to pursue in regard to them.

In the first place the original agreements entered into with Mr. FAWCETT were for such a long period of years as to exclude the supposition that the strict legal rights of the Government would be enforced at a much earlier date when the patents expired. Secondly, the action of the Post Office ever since those agreements were signed has pointed rather to a gradual abandonment of its pretensions. Telephonic exchanges which the Post Office had then opened, or subsequently organised, have not been pushed forward; in many cases they have been allowed to languish, and in others have been abandoned altogether. We are unable to detect any sinister design in this apparently deliberate course of inaction; and it has certainly been interpreted as meaning that the private telephone companies were being left in undisturbed possession of the field not merely for a few years but for all time. The supposition was perhaps unreasonable; but we are speaking of facts, and one fact comes out conspicuously in the present discussion, namely, that the companies and their organs in the press have utterly forgotten that the agreements with the Post Office were terminable, and rested mainly on its grace and good pleasure at the end of a short term of years.

There is one passage, however, in Mr. RAIKES' speech which, if he is correctly reported, may be taken as a crumb of comfort to every one of the telephone companies, provincial and metropolitan alike. Next year this vexed question of telephonic extension by means of overhead wires may, to some extent, be relegated to the County Councils created under the Local Government Bill, if it passes this Session. With these County Councils the respective companies would then have to deal, and it will be their own fault if they do not succeed in obtaining any concessions they can reasonably demand. Meanwhile they should take care not to handicap themselves with a heavy weight of popular prejudice, as the metropolitan company has unfortunately done. On the part of the companies it may be fairly urged that the telephone cannot dispense with overhead wires, whether worked by private enterprise or by the Government. Although the Post Office in London has placed nearly the whole of its vast network of wires underground, its officials gave evidence before the Select Committee last year to the effect that overhead wires were not only perfectly safe but absolutely necessary. The question is partly one of expediency, partly of ultimate economy; there is at present very little danger of its becoming one of necessity. Nobody proposes to compel the removal of all house-top and over-street wires; and we do not suppose that the local councils will adopt any such policy. Some fresh powers, however, are needed by the companies, if only to prevent the very dangers and offences which they are sometimes charged with gratuitously occasioning. It is not to be expected that the Post Office will be content that private companies should obtain powers which the State Telegraphs do not possess; but, on the other hand, it may be hoped that any powers with which the telephone companies can be safely entrusted will not be withheld by local bodies, or vetoed by the POSTMASTER-GENERAL. According to our information, he expressed no intention of handing this matter over to the County Councils. Be that as it may, the POSTMASTER-GENERAL will have to be reckoned with in any case; and the way he has frustrated the United Telephone Company in London ought to be a lesson to its subsidiary companies in the provinces. The reflection may not be pleasant, but it is needed all the same.

GLASGOW INTERNATIONAL EXHIBITION.

The Glasgow International Exhibition of Industry, Science and Art was opened on the 8th of May by the Prince of Wales, and up to the present has been very successful in attracting a large attendance of visitors, over one million having passed the turnstiles during the first five weeks.

The electrical exhibits at this Exhibition are neither so numerous nor so important as might have been expected. Few of the leading firms of electrical engineers appear at all in the list of exhibitors, and those that do are nearly all in some way or other connected with the lighting of the buildings and grounds. Taken as a whole, the exhibits do not show the advance on those of previous Exhibitions that the progress made during the last year or two might have led us to expect. There is no installation on the transformer system shown, and no plant of any magnitude illustrating this very important factor in modern electric lighting practice. One or two specimens of alternate-current transformers are exhibited by Kennedy, of the Woodside Electric Works, Glasgow, and a transformer is being used in connection with an exhibit of electric welding shown by the Thomson-Houston Company. There are a few good exhibits of combined engines and dynamos suitable for ship and other lighting, and of electrical instruments and other appliances, among which may be mentioned those of Anderson and Munro, Glasgow; the Anglo-American Brush Corporation, London; Clark, Muirhead and Co., Westminster; The Edison-Bell Telephone Company, Glasgow; Greenwood and Batley, Leeds; Harvie and Co., Glasgow; The India Rubber and Telegraph Company, Silvertown; Rankin Kennedy, Glasgow; King, Brown and Co., Edinburgh; Millar and Co., Glasgow; Richard Miller, Glasgow; F. J. Rowan, Glasgow; and a few others. We hope to refer more particularly to some of these in future articles.

As was to be expected, electricity plays an important part in the lighting of the buildings and the grounds of the Exhibition. The interior of the main building is, with the exception of a small section of the machinery court, entirely lighted by arc and incandescent lamps. In the part of the machinery court which forms the exception just referred to, there is an excellent display of regenerative gas lamps. These lamps are of three types, namely, the Wenham, the Bower, and the Siemens flat flame lamps. The Wenham exhibit consists of

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sixteen lamps, the Bower of nineteen, and the Siemens of thirty lamps. These exhibits form excellent examples of what can be done by gas, and are good illustrations of the impetus which the electric light has given to that industry. There are several other examples of gas lighting, and also of one of the most modern systems of oil lighting, to be seen in buildings situated in the grounds. For example, there are thirty-nine Wenham lamps in use in the Royal Bungalow dining rooms, twenty Thomas lamps in the Bachelors' Café, while in two kiosks, one occupied as chocolate rooms and the other as smoking rooms, there are good exhibits of the Welsbach system of incandescent gas lighting. Defries' safety oil lamps are used in a large *café* occupied by Messrs. Lyons and Co., and in several tea rooms and lavatories. It will thus be seen that although the largest share of the lighting has been given to electricity, yet it has by no means got a monopoly, but is placed side by side with some of its most important rivals.

The arc lighting contracts have been secured by the Anglo-American Brush Company, and by Mr. Richard Miller, agent for the Thomson-Houston Company. The Brush installation includes the lighting of the whole of the grounds and all the electric lighting inside the main building, except the first-class refreshment rooms and the fine art galleries. The installation, which is one of the largest, if not the largest, that has been carried out by this company, comprises 519 arc lamps of their usual 2,000 nominal candle-power pattern. These lamps are arranged on twenty separate circuits, each supplied by a separate dynamo, of which there are eight capable of lighting thirty-five lamps each, six suitable for twenty-five lights, and six suitable for fifteen lights. The outside circuits include seventy lamps, of which forty-five are mounted in groups of three, on wrought-iron tubular masts, sixty-five feet high, fitted with raising and lowering gear inside the mast. The general effect of this arrangement is good, but the grounds are too extensive to be satisfactorily lighted by the number of lamps employed. The remaining lamps of the Brush installation are placed inside the main building, and are arranged in rows, running along the middle lines of the various avenues. Each row of lamps is supplied from two separate circuits, alternate lamps being taken from each circuit. In this way a failure of one dynamo, or of one circuit, still leaves half the lamps lighted, and there is little chance of any part being left in total darkness. In order to prevent a lengthened stoppage of any circuit due to the failure of a dynamo, three spare dynamos are provided, and are kept running, so that the faulty dynamo can be taken off the circuit and another substituted in a few seconds. The dynamos are connected to the various circuits through pairs of flexible leads to facilitate such a change. The dynamos and lamps are of the ordinary Brush type, and are too well known to require any special description in these columns. The actual aggregate lighting power of the lamps is such as to give about one candle-power per square foot of floor space.

The Fine Art Galleries are lighted by the Thomson-Houston arc lamps, the contractor being Mr. Richard Miller, of Glasgow, who acts as agent for that company. The installation consists of two circuits of twenty lamps each, and both circuits pass completely round the galleries, alternate lamps being taken from different circuits, so as to avoid as much as possible the risk of any part being thrown into darkness by an accident to either of the circuits or dynamos. These two circuits are supplied with current from two of the Thomson-Houston spherical armature dynamos, fitted with constant-current regulators, already frequently referred to in these pages. A third dynamo is kept in readiness for an emergency, and is so arranged that it can be instantly thrown on to either of the two circuits.

The first-class refreshment rooms are lighted by Edison-Swan 16 candle-power incandescent lamps, the contract for the supply of which has been secured by King, Brown and Co., Rosebank Electric Works, Edinburgh. The installation consists of 750 lamps, which are for the most part suspended in arched rows from the cross-beams of the roof, and fitted with tulip-shaped reflectors of amber and ruby coloured glass. These lamps are lighted by current from three dynamos, each capable of supplying 250 lamps. Fifteen circuits are used for conveying the current from the switch-board through the different rooms and back, and a circuit from each dynamo passes through each room. In this way only one-third of the lamps in any room is supplied from each dynamo or by one circuit, and hence it is unlikely that by any ordinary accident more than one-third of the lamps will be extinguished at any time. The circuits are arranged so that each lamp has the same electrode or leading wire resistance, which, with properly selected lamps, insures equality of brightness all through the rooms and avoids the bad effect of having under or over incandesced lamps in close proximity to those of normal brightness. In this case, as in the others, a spare dynamo is kept running, and can be made to take the place of either of the others almost instantly. A very convenient and effective switch-board is used in this installation, the arrangement of which is shown diagrammatically in Fig. 1. Referring to the diagram, D_1, D_2, D_3, D_4 represent the leads coming from the four dynamos; these are respectively connected to one set of terminals of four switches, A_1, A_2, A_3, A_4, the other terminals of which are connected to the

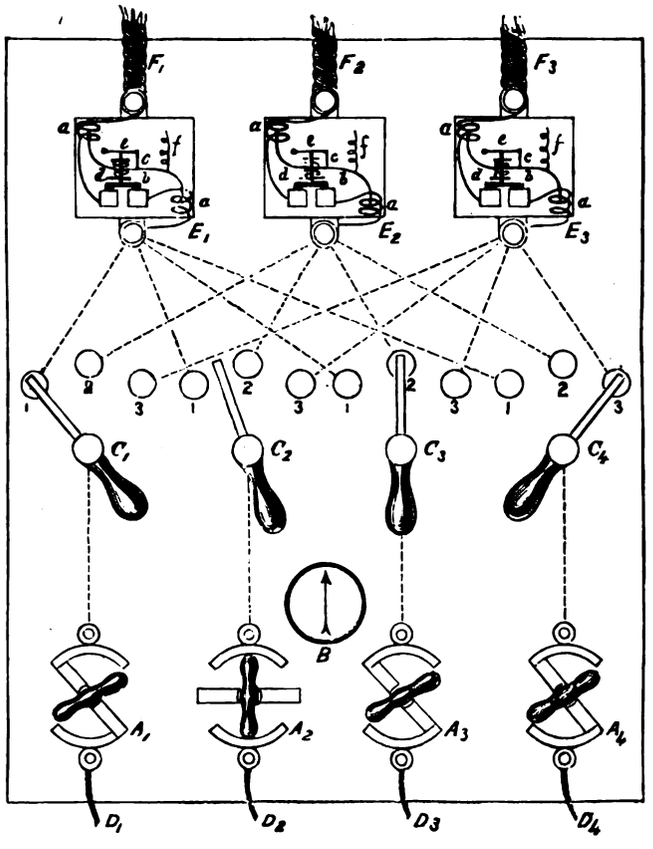

FIG. 1.

central studs of four lever switches, C_1, C_2, C_3, C_4. Each of the last-mentioned switches is provided with three contact plates, which are connected to one set of terminals of three electro-magnetic cut-outs, E_1, E_2, E_3, in the manner shown by the dotted lines in the diagram. To the other terminals of the cut-outs the groups of leads to the circuits supplied by each of the three dynamos that are supposed to be in action are connected. From the diagram it will be seen that should any dynamo fail, all that has to be done is to turn the spare dynamo (supposed to be D_2) on in its place by turning C_2 into contact with the proper contact plate, and closing the switch A_2. An ampere meter, B, is fixed on the switch-board, and fitted with flexible electrodes, so that it can be used to measure the total current flowing through the circuit of any one of the dynamos by putting the electrodes to the terminals of the proper switch, A_1 A_2, &c., and breaking the ordinary cross-connection of that switch. The general plan of the electro-magnetic cut-outs is indicated at E_2, where *b* represents a bent bar of soft iron surrounded at its end by two or three turns, *a a*, of the leading wire. The soft iron bar is held in position by an adjustable

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spring represented by *f*, and carries a catch, *c*, which, by means of a lever, *e*, holds a bridge, *d*, into two cups of mercury, thus closing the circuit. When the current reaches a certain strength the bar *b* is deflected, the lever *e* is relieved, and the bridge *d* is then shot up out of the mercury cups by a spring on the vertical spindle.

The motive power for the electric lighting is obtained from twelve steam engines of various sizes supplied by Robey and Co., Lincoln; A. and W. Smith and Co., Glasgow; Greenwood and Batley, Leeds; Adamson and Co., Dukinfield; and Alley and M'Lellan, Glasgow. The Brush Company's dynamos are for the most part driven through four sets of countershafting by means of four powerful engines. The Thomson-Houston dynamos are separately driven by belting direct from high-speed engines of about twenty-five horse-power each, supplied by Robey and Co. The King-Brown dynamos are driven by two Westinghouse engines of 75 and 63 horse-power respectively, each driving two dynamos directly by belts.

ELECTRICAL POWER APPLIED TO RAILWAYS.—THE BEAUMONT GEAR.

In our impression of the 1st inst. we published an article on this subject by Mr. Coerper, of Cologne, in which he described an arrangement of motor for tramcars, designed to permit the rotation of the armature when the car axle to which it is attached is either standing still or being brought to rest, or is being gradually put in motion from a state of rest. In another part of the same impression we commented upon the arrangement described as appearing to be in effect a form of friction clutch. Since then our attention has been further directed to this subject, and to a form of gearing devised to meet the necessities of tramcar requirements, and illustrated in *The Electrician* of the 10th September, 1886. This is the epicyconoidal gear designed by Mr. W. Worby Beaumont, and is sufficiently illustrated by the accompanying woodcuts, which we reproduce for the convenience of our readers. For propelling tramcars it is very desirable to be able to vary the relative velocities of the motor spindle and car axle without loss of power or without doing lost work. To this end it must be possible to employ the full power of the motor at normal speed, whilst the car is moving much below normal speed, as when climbing a hill or in starting; or, to employ a common form of expression, it is necessary to be able to reduce speed to gain power. If any form of friction clutch or brake is used to permit the change of relative velocities, the extra power that is sought with the reduction of speed of the driven part is not obtained, but is absorbed by the friction attending the lost motion. The power of changing the relative velocities is secured and the shock to the motor and gear is reduced, but the main object, namely, variability of the propelling power, is not attained. If this had not always been the accompaniment of variable velocity gear, in which change is effected by varying the rate of relative velocities between frictional surfaces, any of several forms of frictional gear well known to mechanicians could have been brought into use long ago. In Mr. Coerper's gear the whole of the frictional work done by or upon the brake on the armature shaft is lost work. In the gear we illustrate this loss is prevented. Our engravings show one form of the complete gear as designed for tramcar use, and are sufficient for the present purpose. Fig. 1 is a plan of the gear, Fig. 2 an elevation, and Fig. 3 an end view. For the full engravings we must refer readers to the impression already mentioned. In the above illustration the primary shaft is seen at S. Upon this are mounted a cone, K, capable of longitudinal movement on the shaft, and carried by means of a spherical joint, the externally geared wheel B, the excentric C (Fig. 2), the pinion D, and the internally geared wheel A, the last being also provided with teeth at J for conveying motion at the varied velocities by means of a pitch chain. The wheels A and B are both loose upon the shaft S, which may be a continuation of the motor spindle or driven therefrom. They are also both provided with internal teeth, B having, say, three less teeth than A. As D (Fig. 2) rolls round in gear with the teeth of both wheels, one being held fast, motion is communicated to the other. This, if B is held fast, A will revolve at the maximum speed due to relations between the numbers of teeth, &c. But if B is allowed to rotate at a greater or less speed, so much speed will be taken from A. Gearing with the external teeth of the wheel B is the pinion E, which is fixed upon the spindle H of the wheel F, which runs in frictional contact with the cone K. Running upon the excentric C (Fig. 2) is a pinion, D, which gears with the internal teeth of the wheel A and with those of the wheel B. The wheel F is held by a brake, X (Fig. 1), which is put into or out of gear by the movement of a handle, R, which changes the position of the cone by means of rod R′, which moves the carriage M and fork Q. As shown in the engraving (Fig. 2), the wheel F is not touching the cone. It is fixed when the cone is in the position shown, and therefore the wheel B is held stationary by the pinion E, which is on the same spindle. The cone in this case is inoperative, and the maximum velocity is imparted to A. Now, if the brake X which fixes F be withdrawn and the cone be brought into contact with the peri-

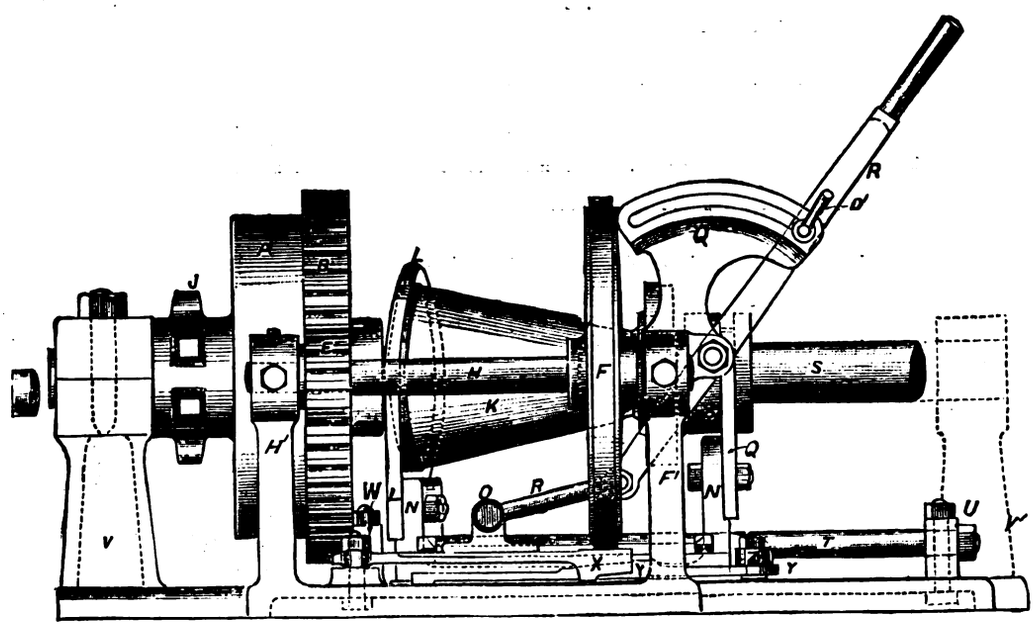

FIG. 1.

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phery of F, the wheel B will be permitted to rotate at a velocity depending upon the ratio of the diameters of the cone and wheel F, and of the pinion E and wheel B. When the wheel B rotates, the velocity of its rotation is taken from that of A, and the velocity of A will therefore vary in proportion to the larger and smaller diameters of the cone.

Inasmuch as the work done on E by the permissive rotation of the wheel B is given up to the cone K by the wheel F there is no loss of work, as there would be if B were permissively rotative by allowing it to slip in a brake.

It may perhaps be necessary to mention that the cone K is hollow, and is, in the form shown, carried in the boss P by means of a spherical joint. It thus, in rotating with the spindle S, always maintains the position shown, except that it is movable along the spindle, so as to rotate the wheel F at a higher or lower velocity.

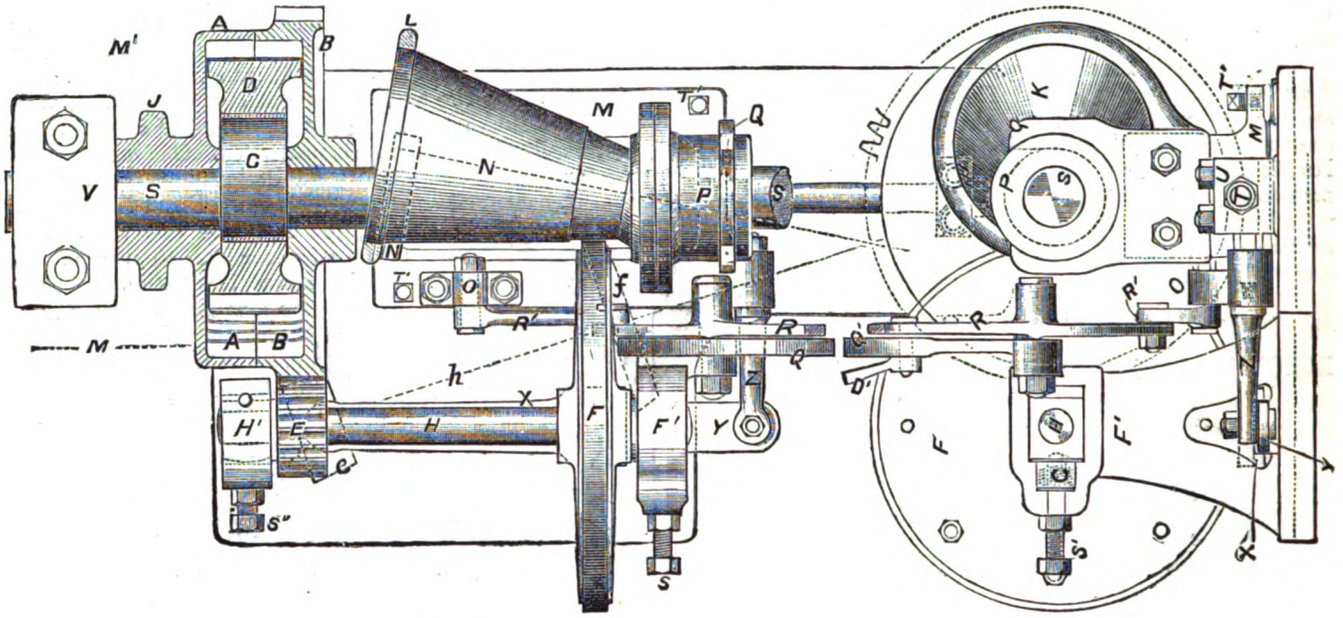

FIG. 2.

FIG. 3.

DELANY'S IMPROVEMENTS IN SUBMARINE CABLE TELEGRAPHY.

A system of submarine cable working which would permit the employment of ordinary Morse signalling has long been sought for. If a submarine cable of any length could be worked at the maximum rate of hand-signalling with the Morse key, this would be more than equivalent to doubling the rate of transmission attainable with the Thomson mirror or recorder. The nature of the difficulties which have to be encountered in expediting the rate of signalling upon submarine cables is too well understood to need any recapitulation here. It will be sufficient to remark that if it were possible to transmit Morse signals by means of a succession of very brief currents of alternate polarity, *and all of equal duration*, the rate of working would be materially increased.

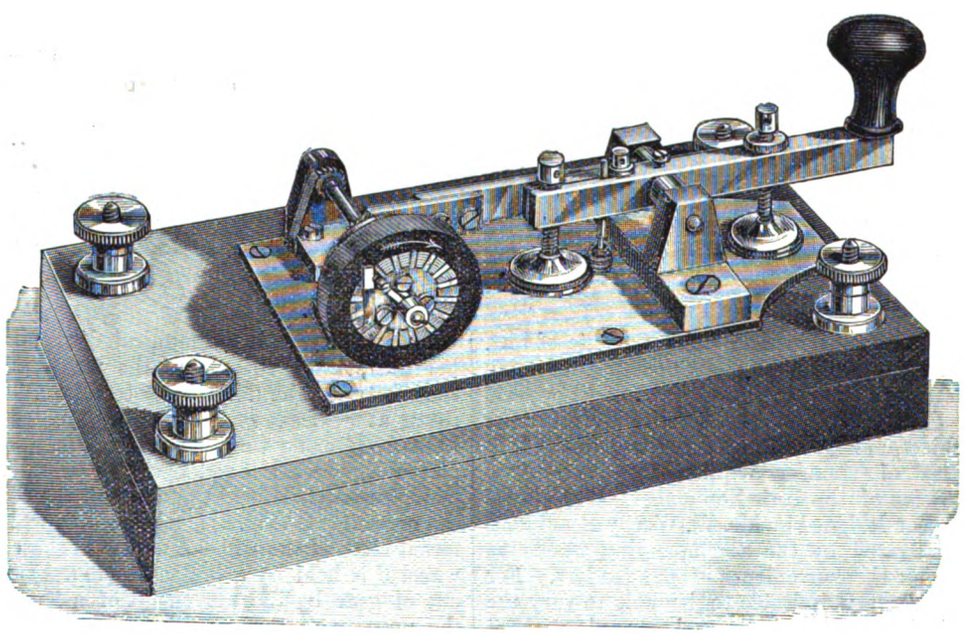

FIG. 1.

It is from this point of view that the problem has been attacked by Mr. Patrick Delany. The special features of his system are confined to the transmitting key, which we shall

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presently describe. But we ought first to say that in the autumn of last year Mr. Delany was permitted to make some preliminary trials of his system over an underground cable belonging to the Postal Telegraph Department in this country, and it was at once evident that a step had been made in the right direction. The transmitting key used in these experiments remains in the possession of Mr. Preece, through whose courtesy we are enabled to produce the engraving (Fig. 1) in which it is illustrated.

It will be seen that the instrument consists of an ordinary Morse key which, by means of a pawl and radial wheel, causes the step-by-step rotation of a trailing contact arm. The arm consists of a slit steel spring, and it makes contact upon a steel disc built up of segments. The central boss of this disc is star-shaped, and the space between each radial arm is filled by an insulated segment which is about twice the width of the arm itself. The central boss with its radial arms is connected through a condenser to earth. The insulated segments are connected alternately to the positive and negative terminals of the battery respectively (the middle cell of the battery being to earth), and the trailer is connected to the line. When the key is at rest and making contact *either with the front or with the back stop*, the trailer is in contact with one of the narrow radial arms of the disc, and

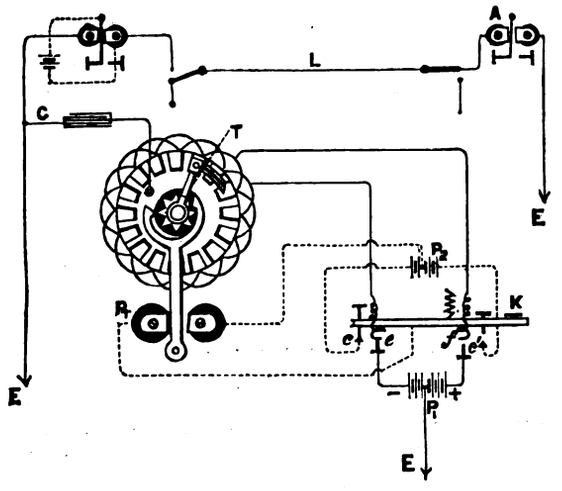

FIG. 2.

is therefore in a position to permit a condenser discharge to line. When the key is depressed the trailer moves across the intermediate battery segment to the next condenser segment. But the ratchet wheel is so connected that the trailer transfers the line from one battery segment to the other *in advance* of the movement of the key. In passing from a battery segment to the condenser segment the trailer connects the two together for an instant, thereby charging the condenser with the same polarity of current sent to the line. While the trailer is passing over the condenser segment *alone*, the condenser discharges into the line its induced current of opposite polarity, which meets and neutralises the static discharge coming out of the line or cable, and thereby leaves the cable perfectly clear for the next signal impulse. It will therefore be seen that there are no dashes sent into the line, that all currents are of equal duration and alternating in polarity. The capacity of the condenser is readily adjustable to the discharge from the cable. The duration of contact between the battery and line may be regulated by adjusting the key.

If the system should come to be employed by the English cable companies it is probable that the method of working direct from the key, as already described, would be preferred. In America, however, the use of a polarised relay as a repeater at the transmitting station is much in vogue. Mr. Delany has therefore adapted his device to this method of working, and in Fig. 2 we have a diagram of the circuit connections thus arranged. The following description of this diagram is taken from a recent article in the *Electrical World* of New York, and will probably assist in making clear anything not already fully explained:—

"It will be seen that the line L is connected to the trailing finger T, which moves from one segment to another at each reversal of the local current which controls the escape armature of the polar transmitter P T, all being under control of the single Morse key K. There are three groups or sets of segments in the circle, the battery-connected segments being joined to opposite poles of the main battery P_1. The intervening segments are all projections from a single plate which is connected through a condenser C d to earth. In the position shown the key is up or "open," the armature of the polar relay shown as a receiver at A is on the open side, and the trailing finger rests on a segment, which, if the key be pressed down, is put in connection with the positive pole of the main battery. As the key is open there is no current going to line. Now if the key be pressed down the connection to the positive pole of the main battery is first made at the spring contact f^1, but only for a moment, however; for, as soon as the key lever reaches its limiting stop c^1 the local battery P_2, through the polar transmitter P T, is reversed and the trailing finger

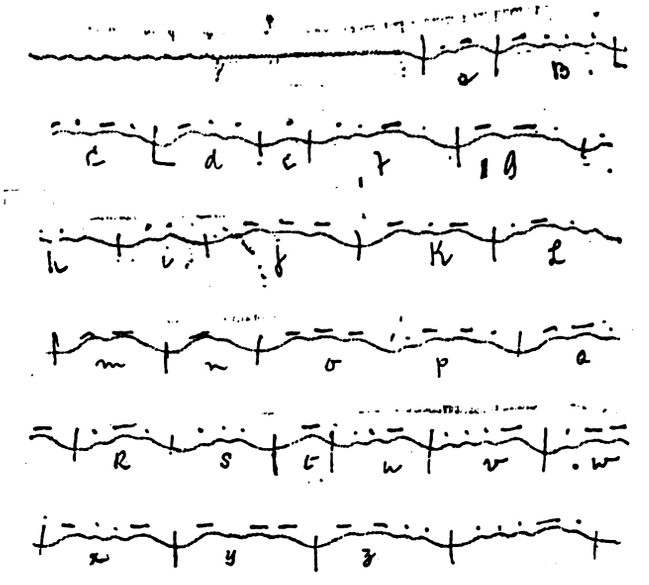

FIG. 3.

(line) is moved to the next battery segment, which finds its battery connection through spring contact e^1 at the back end of the key. So long as the key is held down this negative battery cannot go to line; therefore if the key be held down for the time represented by a dash the armature of the polarised relay at the receiving station, which went to its right hand or "marking" limit when the key was *first* pressed down, will remain there and keep the sounder circuit closed; and thus there is a continuous dash, although the line was disconnected from the battery as soon as the key was pressed down to its limit. Or, differently stated, when the key is pressed down a current of one polarity is sent. If it is immediately lifted up a current of opposite polarity is sent, lasting for the short time between the downward and upward movement, forming a dot. If the key be held down a dash is formed, not by the passage of a long impulse, but because the opposite polarity which terminates each signal is deferred until the key is lifted up. One current is the beginning of all signals, the other is the ending; the time between the beginning and the end determines whether the signal is a dot or a dash."

Fig. 3 is a facsimile reproduction of the Morse alphabet as transmitted by this system over an American cable 1,000 miles in length. The copper resistance of this cable is about 13,000 ohms, and capacity 900 microfarads. Fifteen Fuller cells were used for the experiment, although the cable is usually worked with twice that number of cells. The zigzag line at the beginning shows dots, and their perfect uniformity and clearness may certainly be taken to justify the expectation that the rate of signalling on long cables may be decidedly improved by the application of a system of regular reversals.

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CENTRAL STATION LIGHTING—CURVES OF OUTPUT AND COST.

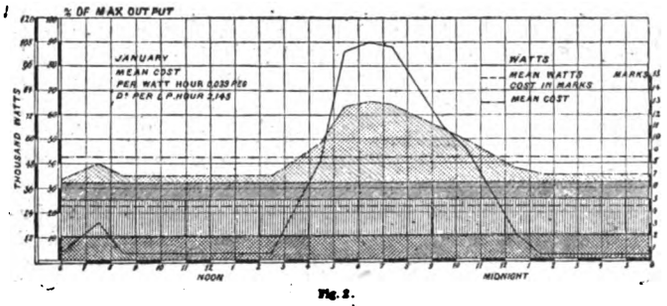

Fig. 2.

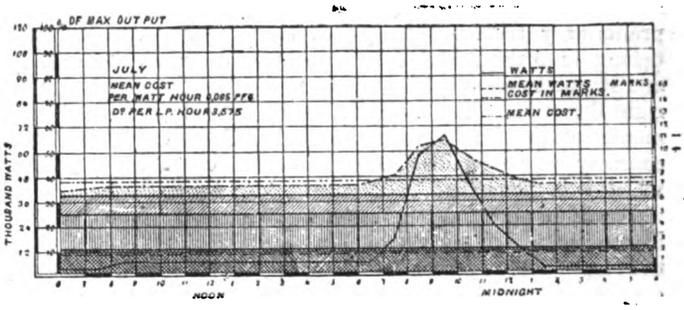

Fig. 8.

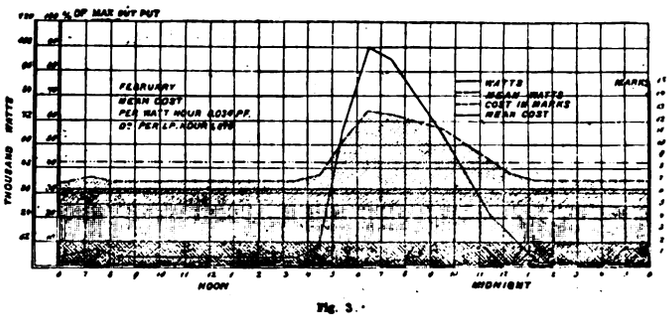

Fig. 3.

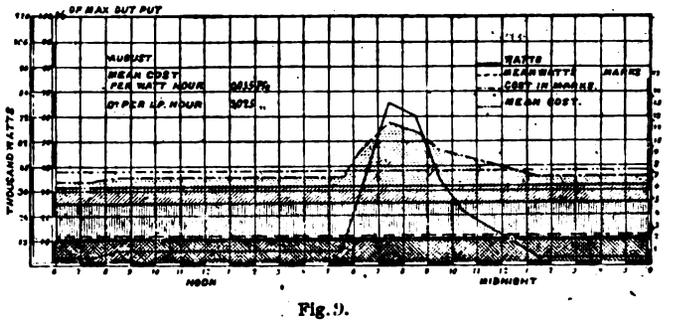

Fig. 9.

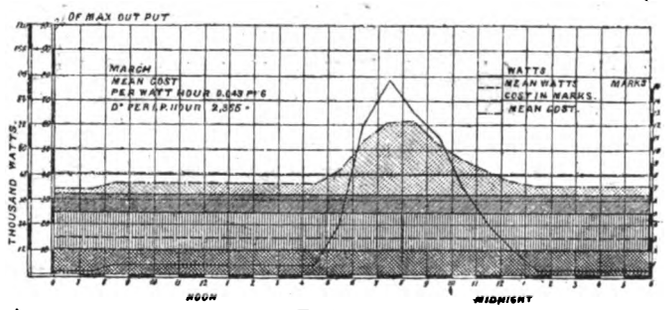

Fig 4.

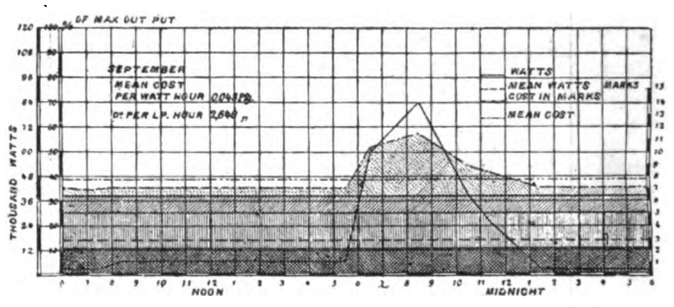

Fig. 10.

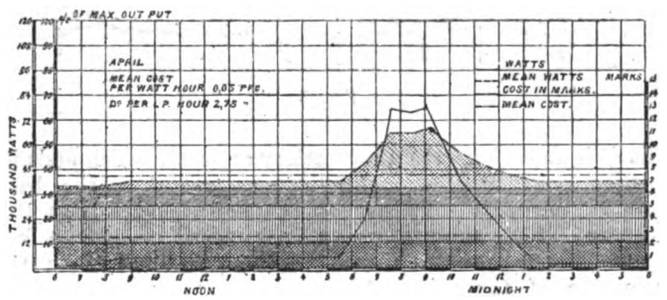

Fig. 5.

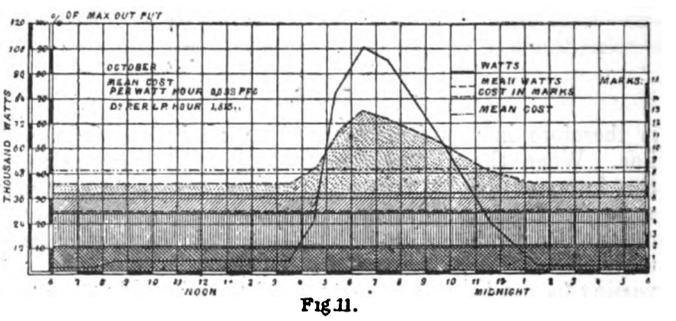

Fig 11.

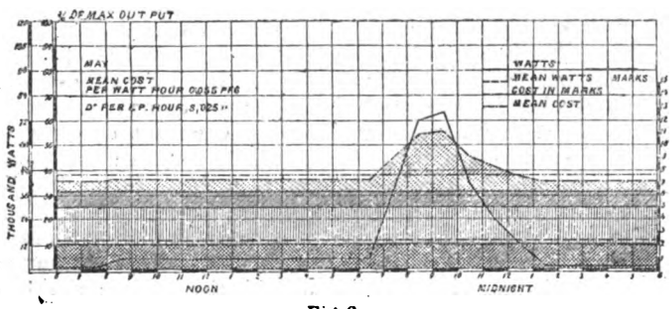

Fig. 6.

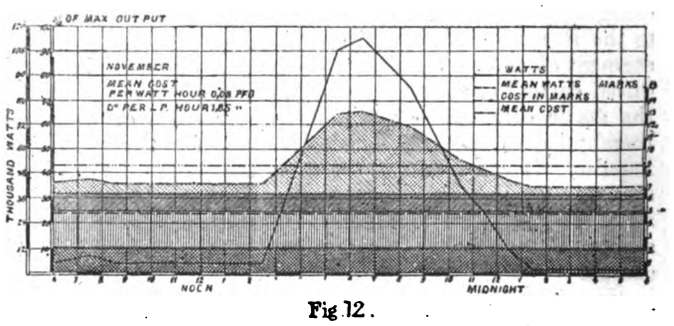

Fig 12.

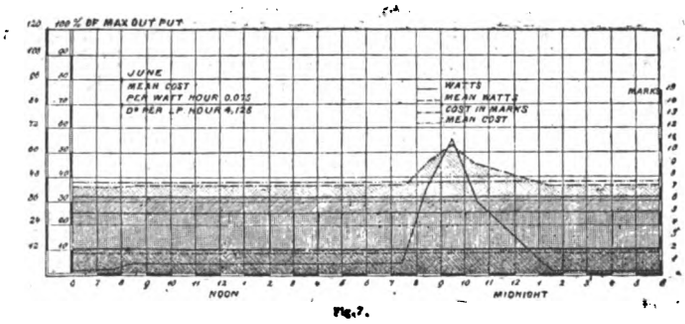

Fig. 7.

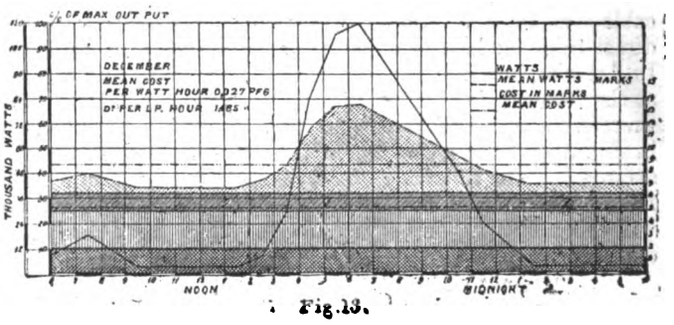

Fig. 13.

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The curves given on the preceding page are taken from an interesting Paper in the current number of the *Centralblatt für Elektrotechnik*, by Herr W. Fritsche, of Fritsche and Pischon, Berlin. Curve I. shows the actual total cost of an installation for outputs varying from *nil* to the maximum. The fixed charges are of course the same for all outputs, the principal variation being for fuel. Figs. 2—11 show the hourly variation from month to month throughout the year both with regard to output and cost, and hardly require any explanation. The

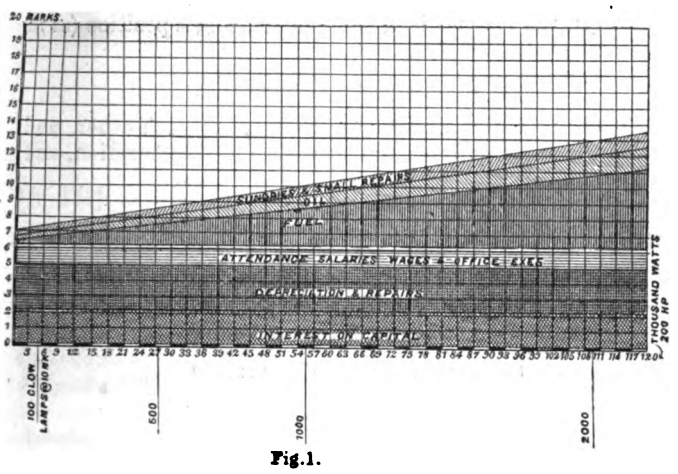

Fig. 1.

data appear to be taken from a central station now running at Berlin. Interest on capital is taken at 4 per cent on £23,500.

MAXIMUM OUTPUT=120,000 WATTS.

Month.	Percentage of Maximum.	Mean Output.	Mean total cost per hour.	Mean cost per watt-hour.	Mean cost per lamp-hour.
January.....	23	27600	8·5	0·03	1·65
February ..	20	24000	8·3	0·034	1·870
March	15 5	18600	8·0	0·043	2·365
April	12·8	15360	7·8	0·05	2·75
May	11·5	13800	7·6	0·055	2·025
June	8·2	9840	7·4	0·075	4·125
July	9·5	11400	7·5	0·065	3·575
August	11·5	13800	7·6	0·055	3 025
September ..	13·5	16200	7 9	0·048	2·640
October.....	20·5	24600	8·3	0·033	1 815
November...	24	28800	8·6	0·03	1·65
December ...	26·5	31800	8·65	0·027	1·485
Mean	16·375	19650	8·12	0·0461	2·54

GASSNER'S DRY BATTERY.

Various attempts have been made from time to time to do away with the necessity for the presence of a liquid electrolyte in the voltaic cell, but hitherto very little success has been attained. The use of sand or sawdust, or similar substances, to absorb the liquid has not been attended with satisfactory results; it adds considerably to the internal resistance, it necessitates more frequent attention to the cell, and renders that operation, if anything, more messy and troublesome than before. Moreover, it increases the tendency to polarise, and does nothing to prevent the creeping of the salts held in solution and consequent corrosion of the terminals.

In a cell of this type which has been devised by M. Gassner, it is, however, claimed that all these difficulties have been overcome, and judging from the reports of the tests made by Prof. Gerrard at the University of Liége, and from the success which the battery has already attained in practical use, we are inclined to believe that an improvement of considerable value has been attained. The cell is made up in a very compact form, and the outer case being of zinc (forming the positive plate), the danger of breakage is entirely done away with. Compared with the Leclanché cell, the current is much more constant, and weight for weight the battery has a much larger output. The cells can also be placed in any position, and being well varnished on the outside may even be packed one on top of the other; so that the combination is of a very portable character.

The exact method in which the electrolyte is made up is kept secret; but we understand that gypsum, or sulphate of lime, is employed as the medium of suspension, and that protoxide of zinc forms one of the chief ingredients. The electrolyte forms a dry and compact mass, which is yet sufficiently porous to allow the evolved gases to escape with freedom. The E.M.F. on open circuit is 1·5 volt.

The most remarkable peculiarity of the cell has yet to be mentioned. After having been run down to 0·1 volt, by passing a current through it in the reverse direction, it can be recharged just like a secondary cell. This operation can be repeated several times, the possible number of repetitions depending chiefly, we presume, upon the dimensions of the positive element. The cell tested by Prof. Gerrard was of circular pattern, 7in. in height and 3in. in diameter; the following is an extract from his report:—

"Tests of the Gassner dry cell by Prof. Gerrard. Electromotive force at starting, 1·508 volt. Internal resistance, 0·21 ohm. The element was put on short circuit:—

Time.	E.M.F. (Daniell's.)	Time.	E.M.F. (Daniell's.)
0	1·508	5 minutes	0·632
5 seconds	1·36	7 ,, ...	0·567
1 minute	0·935	10 ,, ...	0·525
2 minutes	0·800	15 ,, ...	0·433
3 ,, ...	0·682		

"It was then put on open circuit, and recovered itself as follows:—

Time.	E.M.F. (Daniell's.)	Time.	E.M.F. (Daniell's.)
1 minute	0·641	4½ minutes	0·832
2 minutes	0·750	5 ,, ...	0·850
3 ,, ...	0·791	3 hours 30 minutes	1·265
4 ,, ...	0·800		

"The element was again put on short circuit for 18 hours; the E.M.F. fell to 0·1015 volt. After this test, during which it had furnished work equal to 3·376 kilogrammeters, or 45 electric horse-power [·0125 horse-power-hours], it was left to rest, and recovered itself as before, showing that it was not exhausted.

Time of Rest.	E.M.F.	Time of Rest.	E.M.F.
10 minutes	0·172	45 minutes	0·289
20 ,, ...	0·234	19 hours	0·312
30 ,, ...	0·242	24 ,, ...	0·625

"After this, the regeneration of the element by charging in the same manner as an accumulator cell was attempted, with the following results:—

Time of Charging.	Current.	E.M.F.
1 minute	5 amp.	1·13 volts.
3 minutes	,, ...	1·20 ,,
5 ,, ...	,, ...	1·29 ,,
7 ,, ...	,, ...	1·305 ,,
10 ,, ...	,, ...	1·330 ,,
20 ,, ...	,, ...	1·425 ,,
30 ,, ...	,, ...	1·680 ,,
45 ,, ...	1 amp.	1·71 ,,
65 ,, ...	,, ...	1·92 ,,
75 ,, ...	0·8 amp.	1·89 ,,
4 hours 20 minutes	0·75 ,, ...	2·00 ,,

"Having thus raised the E.M.F. very considerably, starting from 0·1 volt, and running up to 2 volts, the element was next put on short circuit again, three minutes after removal from the charging cells, the E.M.F. then varied as follows:—

Time of closed circuit.	E.M.F.	Time of closed circuit.	E.M.F.
0	1·87 volts.	5 minutes	1·092 volts.
5 seconds	1·745 ,,	6 ,, ...	1·005 ,,
1 minute	1·54 ,,	7 ,, ...	0·940 ,,
2 minutes	1·338 ,,	8 ,, ...	0·886 ,,
3 ,, ...	1·285 ,,	15 ,, ...	0·770 ,,
4 ,, ...	1·100 ,,	18 hours 15 minutes..	0·100 ,,

"The efficiency of the element is calculated at 92 per cent., it having given back that amount of the current put into it during the regeneration. Two regenerations followed by successive discharges were tried; in each case the E.M.F. was

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brought higher, and the polarisation less than that of a new element. The pasty mass between the carbon and zinc is not liquefied during the regeneration. After the last regeneration, followed by the putting on short circuit, the E.M.F. was let down to 0·107 volt; after resting for 25 hours it rose again to 0·64 volt.

"These tests show that a regenerated element is much better even than a newly-formed one by the ordinary process."

We have only to add that the battery is being introduced by Messrs. J. T. Mayfield and Co., of 41, Queen Victoria-street, E.C.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER IX.—*Magnetic Fields.*

(Continued from page 211.)

116. "*Moment*" *of a* "*Couple.*"—When there are two equal parallel and opposite forces acting on a lever, each force tending to turn the lever in the same direction, we have what is termed in mechanics a "*couple*," and by what has been said above it will be understood that the "*moment*" *of a* "*couple*" *is equal to one of the forces multiplied by the perpendicular distance between them.*

The "moment" of the "couple" in Fig. 75 is

$$F \times \text{the perpendicular } DD' = F \times L \sin a,$$

as given above.

The "moment" of the "couple" in Fig. 76 is F L. The unit

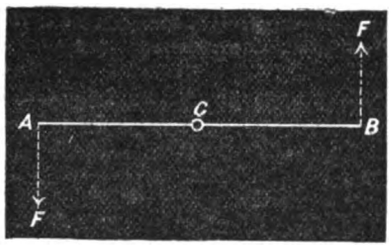

FIG. 76.

"moment" in the C.-G.-S. system is the dyne-centimetre—that is the moment of a force of one dyne acting at a perpendicular distance of one centimetre from the turning centre of a lever would be of unit value. Similarly, half a dyne acting at two centimetres distance, or ten dynes acting at one-tenth of a centimetre distance, would be of unit moment.

117. *The* "*Couple*" *due to the Earth's Field.*—Returning now to the magnetic needle (of strength of pole = m) capable of turning about its centre in the uniform magnetic field H, we know that the mechanical force acting at each end of the magnet is equal to H m dynes. These two forces then constitute a "couple," and we can now determine the moment of the couple exerted upon the magnet in any position in which it may be placed in the field. For example, when the magnet is in the meridian (Fig. 72) there is no moment at all, although the forces are acting at each end of the magnet. There is no perpendicular distance between their directions, since they are acting in the same straight line, like the opposite sides in a "tug of war." Now, when the magnet is at right angles to the lines of force of the field (Fig. 73) the moment of the couple is a maximum, and is equal to H $m l$ dyne-centimetres, where l is the length of the magnet expressed in centimetres. If, however, the magnet is in some intermediate position (as in Fig. 77) the moment of the couple is

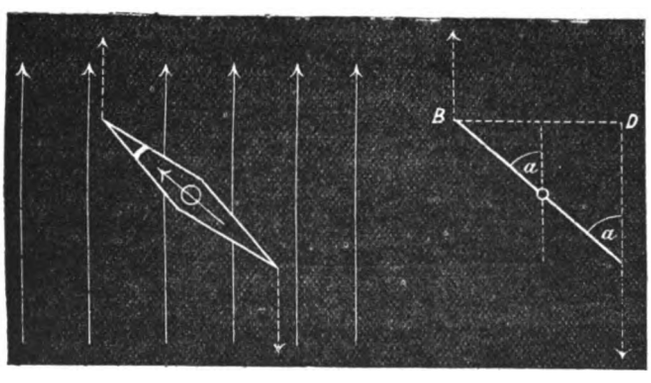

FIG. 77,

$$\text{H } m \times \text{the perpendicular B D.}$$

Now, the two angles marked a are equal to each other, and indicate the angle between the needle and the meridian, and we have the relation

$$B D = l \sin a;$$

hence

$$\text{moment of couple} = H\, m\, l \sin a.$$

Again, if the needle is displaced from the meridian more than a right angle (as in Fig. 78), and we still call a the angle between the needle and meridian, we have

$$\text{moment of couple} = H\, m \times B D = H\, m\, l \sin a.$$

Hence in whatever position the magnetic needle is placed, if we call a the angle by which it is displaced from the meridian, we have the moment of the couple tending to restore it to the meridian equal to

$$H\, m\, l \sin a.$$

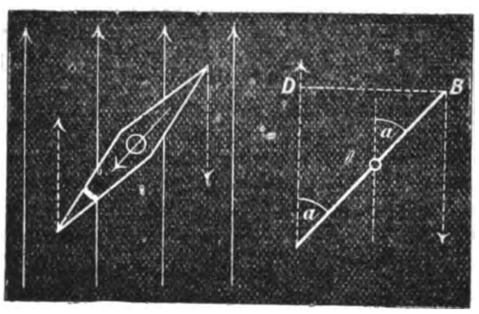

FIG. 78.

Example.—A magnetic needle whose strength of pole is 20 C.-G.-S. units and length 6 centimetres is moved 60 degrees away from the meridian; what is the moment of the couple tending to restore it to the meridian (H = ·18 C.-G.-S. units)?

$$\text{Moment of couple} = \cdot 18 \times 20 \times 6 \times \frac{\sqrt{3}}{2}.$$

$$= 18{\cdot}66 \text{ dyne-centimetres.}$$

What is the moment of the couple when the needle is 90 degrees from the meridian?

Ans. ·18 × 20 × 6 = 21·6 dyne-centimetres.

What mechanical force must be applied at right angles to this needle and *at one end* of it to keep it in equilibrium at 60 degrees?

Here the moment of the force F applied at one end is $F \frac{l}{2}$, and this must equal the moment of the couple due to the earth.

Hence

$$F \times \frac{6}{2} = 18{\cdot}66,$$

and

$$F = 6{\cdot}22 \text{ dynes.}$$

If this force was applied by attaching a thread to one end of the needle, passing it over a small frictionless vertical

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pulley, and hanging a weight on the end of the thread, what weight would this have to be?

$$\text{Weight in dynes} = \text{mass} \times \text{acceleration of gravity} = \text{mass in grammes} \times 981$$

and this must equal the force of 6·22 dynes.

Therefore

$$\text{mass required} = \frac{6{\cdot}22}{981} = {\cdot}00634 \text{ gramme.}$$

Now the gramme mass is equal in weight to 15·43 English grains. Hence

$$\text{weight required} = {\cdot}00634 \times 15{\cdot}43 = \frac{1}{10} \text{ grain nearly.}$$

(To be continued.)

ON THE CHANGE OF POTENTIAL OF A VOLTAIC COUPLE BY VARIATION OF STRENGTH OF ITS LIQUID.*

BY DR. G. GORE, F.R.S.

This paper contains a series of tables of measurements of the electromotive forces of a voltaic couple composed of unamalgamated zinc and platinum in distilled water, and in aqueous solutions of different strengths of the following substances:—Potassic chlorate, potassic chloride, hydrochloric acid, and bromine. The measurements were made by balancing the potential of the couple by that of a suitable thermoelectric pile† (*Proc.* Birm. Phil. Soc., Vol. IV., p. 130; *The Electrician*, Vol. XII., p. 414) through an ordinary astatic galvanometer of about 100 ohms resistance.

The following are the minimum proportions of those substances required to change the potential of the couple in water:—Potassic chlorate, between 1 in 221 and 258 parts of water; potassic chloride, between 1 in 695,067 and 1,390,134; hydrochloric acid, between 1 in 9,300,000 and 9,388,185; and of bromine, between 1 in 77,500,000, and 84,545,000 parts.

With each of these substances, a gradual and uniform increase of strength of the solution, from the weakest up to a saturated one, was attended by a more or less irregular change of electromotive force.

By plotting the quantities of dissolved substance as ordinates to the electromotive forces as abscissæ, each substance yielded a different curve of variation of electromotive force by uniformly increasing the strength of its solution, and the curve was characteristic of the substance. As the least addition of a foreign soluble substance greatly changed the "mininum point" and altered the curve of variation of potential, both the curve and the minimum proportion of a substance required to upset the balance of the couple in water may probably be used as tests of the chemical composition of the substance, and as means of examining its state of combination when dissolved. By varying the strength of the solution at each of the metals separately, a curve of change of potential was obtained for each positive metal, but not for every negative one.

* Paper read before the Royal Society, June 14, 1888. Abstract.

† This instrument is manufactured by Messrs. Nalder Brothers, Horseferry-road, Westminster.

THE UNITED TELEPHONE COMPANY BILL.

DEPUTATION TO THE POSTMASTER-GENERAL.

An influential deputation waited last week upon Mr. Raikes, the Postmaster-General, to ask him to support the reference of the United Telephone Bill to a Select Committee. The object of the Bill is to afford additional telephonic communication throughout the kingdom. The deputation was introduced by Sir John Lubbock, M.P., and included the following members of Parliament:—Messrs. Quilter, Robertson, Jacob Bright, T. A. Dickson, Murphy, Whitley, Bonsor, Colonel Anstruther, R. Heath, and Richardson; the Chairman of the Telephone Company (Mr. James Brand), the Deputy-Chairman (Mr. J. S. Forbes), and the General Manager (Mr. J. Morgan).

Mr. FORBES stated the case for the Company, and dwelt upon the facilities which had been given to the Hydraulic Power Company, the gas and water companies, and other semi-public institutions, compared with the restraints and hindrance which had been put in the way of the telephone companies, who were often subjected to very great and unreasonable complaints on the part of the public for imperfect communication when, in reality, it was chiefly owing to the want of proper facilities.

Mr. DICKSON, as a member of the committee of 1887, spoke of the strong feeling which had found expression in the report of the committee, and an industry of this kind should be fostered and encouraged, instead of being hindered by the Post Office, who, by some accident, had acquired a legal right to control the telegraphs.

Sir W. H. HOULDSWORTH, M.P., spoke of the great importance of the development of this system to Lancashire.

Mr. JACOB BRIGHT asked for some distinct statement as to what the Government were prepared to do in the question.

The POSTMASTER-GENERAL, in reply, said that he had consulted with some of his colleagues on the question of allowing the Bill of the United Telephone Company to proceed to the second reading. After this consultation he found himself compelled to state that the Government must oppose the second reading. The report of the committee, of which Mr. Dickson was a member, proposed a general Bill, and that whatever powers were granted to companies should also be given to the Postmaster-General. As a matter of fact, the present Bill related to a single company, which worked within a radius of 12 miles of the General Post Office, and it proposed to give this company considerably greater powers in the matter of overhead wires, &c., than the Postmaster-General himself possessed over the same area. He thought, therefore, that in any case, if any step was taken at a future period to confer all these facilities, it must be by a public and not by a private Bill. It was suggested that the present Bill might be extended in committee so as to effect this; but he thought that it would be much more satisfactory to deal with the matter at one time by means of a public Bill. At the present time, moreover, there were many questions before Parliament, especially the matter of the local government. As soon as that was disposed of he would take an early opportunity of laying the whole question before Mr. Ritchie, the President of the Local Board, with a view to the introduction of a public Bill. The matter should not be lost sight of.

According to the reports which appeared in *The Times* and other papers on the following day, Mr. Raikes added that the telephonic patents would expire shortly, and then the Government might be able to deal with the development of the telephonic system.

Afterwards a consultation was held, and the deputation decided to drop the Bill for this Session.

"INFLUENCE MACHINES, FROM 1788 TO 1888."

BY PROF. S. P. THOMPSON.

(Concluded from page 215.)

DISCUSSION.

Prof. AYRTON said he had listened with the greatest interest to the charming historical account that had been given them of the Darwinian development of a Darwinian idea. He did not think there was any one—certainly no other Englishman—who could have given them so complete an historical record of the development of the influence machine as Prof. Thompson (loud applause). The address was certainly on a par with the Paper which Prof. Thompson gave, some short time ago, to the Society of Arts, showing in the same complete way the development of another piece of apparatus of great value to electrical engineers, namely, the vacuum pump. There was one peculiarity in the history which he did not think that Prof. Thompson had sufficiently laid weight on. He (the speaker) had called it a Darwinian development, and as the author had described it, he thought one might fairly apply that term. It seemed to him that the peculiarity of this history was that, instead of the one machine developing out of the other—which was, of course, the Darwinian idea of progress—the subject had been re-invented over and over again, entirely *de novo*, without any knowledge apparently existing in the inventors' minds that anything of the same kind had been done before their time. He had occasion at the last meeting to speak of the marvellous inventive genius of the author of that Paper, Sir William Thomson. He did not think that, perhaps, the visitors would quite have grasped that evening that the same genius was really employed by Sir William Thomson in devising a machine which apparently is exactly the same as Belli's machine [see *Electrician*, June 8th, p. 152, Fig 6]. Belli's machine had every feature possessed by the ordinary Thomson replenisher, and it would not be very clear, therefore, to understand what great merit was due to Thomson for having, in 1867, made an instrument which had already been made in 1831, or about that time. But he himself happened to be with Sir William Thomson in 1867, and he knew the history of the development of the Thomson replenisher in the Glasgow laboratory. It was in no sense a development of any known electrical machine at that day. He did not know why, but nobody then seemed to know anything about what had been done before. Sir William

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Thomson most certainly was not aware that any influence machine existed in 1867. He wanted to devise a machine which had been of great practical use up to the present date. Sir William Thomson wanted to make recording instruments practicable for submarine cables; he wanted to electrify the ink. As he said at the time. "I cannot bear the idea of employing coolies to grind frictional machines all day and all night long for the purpose of electrifying the ink"; therefore it became necessary to invent or devise some sort of apparatus which should produce the amount of electric energy in a far more economical way—which should have, in fact, a far higher efficiency, which should convert a given amount of mechanical energy into a far greater amount of electric energy. He started apparently without any knowledge of anything that had been done on the subject. After various trials he developed his well-known "replenisher," which appeared to be almost exactly like the Belli machine of 1831. Seeing what enormous value the machine might have for commercial purposes, Sir William proposed to patent it, and he asked the speaker and Mr. Bottomley to go and consult the Patent Office to see if by any remote chance anybody had ever done anything of the kind before. It was very curious, although Mr. Varley was not only a great friend of Sir William Thomson's, but he was practically a partner of Sir William's, yet so little importance had been attached to Varley's patent of 1860, and to any machines that Varley had made, that Sir William was not aware apparently that Varley had done anything in the matter, and to the astonishment of himself and Mr. Bottomley they came across Varley's patent—the patent of seven years before, and Sir William Thomson then saw that he had merely re-invented a machine which had been very completely described by Varley at that date. There was one thing he wished to ask Prof. Thompson or Mr. Wimshurst. It had been stated that if brushes were used for exciters and combs for the parts which he would call inductors, the machine did not reverse. His own experience was that it did, and he would like to know why it reversed so extremely easily. He did not think that the combs got over that difficulty. That was the great difficulty that Thomson had originally with his form of machine in 1868. He remembered a suggestion sent by Sir William to his instrument maker, Mr. White, of an arrangement for disconnecting certain contacts so as to prevent the possibility of reversing. The Wimshurst machine of the present day, without the Leyden jars, seemed certainly to reverse not unfrequently. Was it easy to avoid that in any simple way without the use of Leyden jars? He would also like to ask why machines made by instrument makers were very often so extremely inferior to those made by Mr. Wimshurst himself (laughter)? He had bought a machine some time ago of a certain maker who had advertised, and still advertised very freely, but it would not work at all; then Mr. Wimshurst supplied them with two plates that he had made himself, and it worked at times extremely well. Prof. Thompson spoke of experiments that had been made as to the efficiency of the various machines. It was most interesting to consider what these experiments have done. In 1857 he made some experiments in Sir William Thomson's laboratory on the relative efficiencies of a *plate glass frictional machine* which had an efficiency of point—he forgot how many noughts—and a Thomson's replenisher. Without going into figures, the enormous efficiency of the Wimshurst machine, as compared with the plate glass machines, was quite clear. Long after Mr. Wimshurst had ceased turning the machine exhibited that night the machine had kept on turning and the lightning had continued to pass between the knobs.

Mr. MORDEY said that in the very interesting diagram Prof. Thompson had shown them (Fig. 19) they saw on either side of the machine three pairs of plates that were apparently in the same state all through that part of the rotation. Would Prof. Thompson or Mr Wimshurst explain why that was so, and whether it would not be possible either to reduce the number of plates, or in some way to increase the effect produced by the machine by using the space so obtained.

Prof. HUGHES said that in the list of inventors given by Prof. Thompson the name of Mr. Bertsch, who in 1853 brought out at the Academy a very interesting influence machine, had been omitted.

Mr. C. E. GROVE, with reference to Prof. Thompson's statement that the Voss machine hardly ever reversed, said as a matter of fact the Voss machine was one of the worst machines for reversing. It did not depend, apparently, upon the mere relative position of the brushes and combs, but it also depended upon the position of the diagonal conductor, of which nothing had been said that evening. The liability to reverse could be increased or diminished by the position in which the diagonal conductor was placed.

Mr. A. J. WALTER: There is one question I should like to ask Prof. Thompson. Why on the diagram indicating the distribution of electricity upon the surfaces of the plates of the Wimshurst machine, no charge is depicted either on the inner surfaces of the plates opposite the points of the prime conductors, or upon the outer surfaces of the plates at the top and bottom of the diagram? Is it that on those portions of the plates there is no electrical charge, or is it that there is no free charge which can be collected at those points?

Prof. SILVANUS THOMPSON, in reply to Mr. Walter, said that his diagram was drawn to represent what one found at the different parts of the machine. At the top and bottom of the machine they found that the charges were of opposite sign, and therefore attracted one another toward the glass, and there was next to no free charge on the outside, whereas right and left on the one side positive, on the other side negative, they had both plates with charges of the same sign—he did not say absolutely equal in amount. The result was that instead of attracting each other towards the glass they repelled each other away from the glass, and they had all the charge virtually free. Perhaps when his paper was read in detail that explanation would be a little more clear. In reply to the question about the Voss machine, he certainly did not intend to indicate that the Voss machine never could reverse itself. All the Voss machines that he had seen had brushes where there ought to have been combs only. They had combs with a brush or two interpolated among them in the discharging apparatus, and that of itself was quite enough to make the machine unreliable from that point of view. Also he did not like in the Voss machine the arrangements of tinfoil all along underneath those paper plates; that seemed to him to be rather a mistaken construction. The Voss machine was simply a sort of intermediate form which would sooner or later die out, and it had made its way simply because the instrument maker had seen that a handy machine of that kind was wanted and made one up at a fairly reasonable price. But he did not by any means regard the Voss machine as the final outcome of all influence machines. Certainly he had found Mr. Wimshurst's machines much less liable to reverse. He had a Wimshurst machine once, which had both brushes and combs on the discharging part, which was always reversing. He had removed the brushes and left the combs only on the discharging part, and he did not know that he ever had it reversed; in fact, with his eight-plate machine the difficulty was to get it to reverse, he could not do it. If they took a big discharge out on each side it did not reverse. If they turned it first backwards and then forwards it did not reverse as a Holtz would do. Mr. Wimshurst had told him how it could be done, but he would not have found that out for himself. It was very simple. Simply take a bottle-full with a Leyden jar from one side; then discharge the machine by putting the knobs together while turning the machine the other way; then turn the machine the right way, open the discharging knobs, and empty the charge of the Leyden jar into the other side from that which it was originally taken.

Prof. AYRTON said it had just occurred to him that this was a question of capacity, and that the large machines might not reverse, but he had been speaking of small machines, and the small machine Mr. Wimshurst lent him constantly reversed. It was a two-plate machine. It excited itself quite easily, worked extremely well, but reversed occasionally.

Prof. THOMPSON said, with respect to the position of the diagonal conductor, the liability to reverse in a Voss machine was certainly greater when the diagonal conductor was more nearly horizontal. When the diagonal conductor was in its proper place it greatly concentrated the stationary charge of the field-plates upon their extreme ends. When, however, the diagonal conductor was not opposite the end of the field-plate, then they did not have that concentration of field at either end, they had it further back; and the carrier, after having passed the most concentrated part, was still passing the field-plate with the same electrical sign upon it. The consequence of that was that they would have a greater tendency to instability if any instability were set up by a sudden discharge of one side. It was not, however, in his own mind very clear altogether what that instability depended upon. Prof. Hughes had asked why Bertsch was not in the list of names that he had given, but he had a much longer list than he had thought it necessary to put upon the board, and that of Bertsch was amongst them.

Mr. WIMSHURST said he thought there were only two points that he had to answer—the first was, why makers of instruments failed in certain points. That certainly was too indefinite for him to answer. He really could not say unless he saw the machines and examined them, and found the precise faults. He was astonished at the reversal of the current in the machine to which Prof. Ayrton had alluded. Throughout his experience, running over several years, he had never found one such case. There was no difference in the action between a large machine and a small one, and the large machine which had been experimented upon that evening was freely the property of any person who could make it reverse if they chose to practise it the whole evening—in fact, it was impossible to make it reverse. The small machine, which he lent to Prof. Ayrton some short time since, had 6in. glasses, and it had never reversed whilst in his own possession; there must, therefore, be some slight disarrangement.

Prof. THOMPSON said that he had omitted to answer Mr. Mordey's question. He had asked why at the top and bottom of the machine the sectors remained in the same state of charge. He believed it was because in between the two ends of that range nothing was done to them; they simply passed one another in precisely similar conditions, and it was no gain to shift the two sets of neutralising brushes either way. What they wanted in a machine of that sort was the most complete insulation between the parts of opposite sign. It would be no advantage whatever to shift those neutralising brushes towards one another unless one could in some way lengthen the distance between the charges of opposite sign on the same face. The length of spark they could get out of a machine of this sort was practically limited by the distance across the plate in the interspaces between carrier and carrier. He could not conclude his reply without saying that although it had been a great pleasure to him to bring these instruments before the Society, it was much more to Mr. Wimshurst than to himself that this exhibition of apparatus was due. He had relied upon Mr. Wimshurst's kind offices from beginning to end to be able to show the Society the latest and best influence machines.

The PRESIDENT: Gentlemen, I am sure you will all agree with me that the very lucid and interesting discourse to which we have listened affords a striking proof of careful, exhaustive research on the part of its deliverer, forming a worthy tribute to the memory of the discoverers of electrical influence and deserving a most hearty vote of thanks; and I beg, therefore, to move that the cordial acknowledgements of the Society be presented to Prof. Thompson for the discourse he has been kind enough to give us, coupling with that the name of Mr. Wimshurst, who has furnished the remarkable apparatus of his own devising.

The vote of thanks was then passed, amid loud applause.

Prof. Thompson and Mr. Wimshurst then proceeded to further experiment with the machine with Leyden jars.

The proceedings then terminated, and the Society adjourned until November 8th.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June 16th*, 1888.

The city of St. Louis has been recently the scene of a very lively controversy between the Telephone Company and the Local Government. Some few months ago the Corporation took upon itself to pass an ordinance making it a misdemeanour for any telephone company to charge more than $50 a year for the use of a telephone. The local company, which has given excellent law service under Mr. Durant, who is known to many of your readers, has been charging $100 a year; and as it did not intend to make any change, evidences of the "violation" of the ordinance were soon forthcoming. Thereupon the company was brought before the Courts, and fined $300 for alleged exorbitant charges. As the result of this, the directors of the company met, and resolved to make no more contracts in St. Louis until the constitutionality of the ordinance could be tested by the Courts of the State. The city officials propose to pull down the poles and wires in case the service be discontinued, and they have already received a direct challenge in the removal of the instruments from various public departments, including the Mayor's office. A great many of the subscribers, who own that they are getting the worth of their money, are very anxious to have the company continue in business, and have been offering to make up the old amount by donation. The telephone company, however, disdain to do anything that might seem like an evasion of the ordinance, and thus the matter stands at the present time. Now that St. Louis has enjoyed an excellent service for so long it is hard to believe that it will allow the company to be treated in this way, and the probability also is that the ordinance will not be found to be in keeping with the terms of the company's charter from the State, and will therefore be annulled. It is interesting to observe, as I have before remarked, how the conflict between the civic and the telephonic authorities shifts from city to city.

The holding of the conventions this year for the nomination of presidential candidates has afforded an admirable opportunity for the display of the electric light. The northern nave of the Exposition building in St. Louis, where the Democratic official convention has just been held, bringing together some 16,000 people, was illuminated by the Heisler system with very good results, lights of 30 candle-power being used. The big hall in Chicago, where the Republican Convention meets next week, has been fitted up with an equipment of 3,000 Edison lights, and the effect is said to be the finest of the kind ever seen. A notable feature is the illumination of two United States shields, around each of which several hundred incandescents are grouped at each end of the hall. It is said that the results are so magnificent that the conventions will have evening sessions for no other reason than to see the hall illuminated. Another very fine piece of lighting of this character is now being carried out at the Ohio Central Exposition, to be held at Cincinnati. About half a dozen systems, arc and incandescent, will be used under contract. Special arrangements have been made for the display of a number of new electrical effects, and it is said that every evening an electrical performance will take place, when owls will shine out in the darkness, flashes of lightning illuminate rainbows, electric flowers bloom in baskets along the roof, coloured fires glow under the fountains and cascades, crescents and constellations blaze out one after the other, and the whole scene will be lit up by an illumination such as has never been known on land or on sea before. The whole of this special work will be in charge of Mr. W. J. Hammer, who was for some time connected with the Edison Company in Europe.

The investigation which has been going on in this city by the coroner's jury for the last two or three weeks has been brought to a close by a verdict fixing the responsibility upon the local company, and condemning the lighting companies in general for their "parsimonious spirit" in not keeping up the insulation of their wires. The attention of the district attorney has also been called to the subject, and the jury flatters itself that it has done a useful piece of work. In the meantime the Mayor and the Board of Electrical Control have continued their janglings and wranglings over the subject of the wires; and while the Mayor has been persistent in his refusal to do anything with regard to the removal of the poles so long as there was no appropriation for the purpose, the Board is exercising its power to prevent the companies from contracting for new business. It is specially vigorous in its campaign against the local United States Company, which has given much offence by its steady refusal to obey the mandates of the Board on the ground that it was impossible to carry out such orders. One useful result of the whole agitation has been to direct attention to the "tramp" wires—*i.e.*, wires which have been abandoned, or were once the property of companies now defunct. These wires are by no means few; in fact, in a city like this there are probably hundreds of miles of them, and as every now and then they give way they are a source of incessant danger and trouble. I have no doubt that steps will soon be taken to clear them out. It would seem also that there are abandoned poles as well as wires. The attention of the Commissioner of Public Works was called this week to the fact that an iron telegraph pole has been standing at the corner of Broadway and Twenty-third-street for the last ten years, although it has not been in use by any company. It is both an eyesore and a nuisance, but its removal has never been attempted these long years, simply because it was nobody's business. Now, of course, it will go.

The use of electric motors on board men-of-war has already been discussed, but has never before been practically attempted, I believe. I now understand that the Sprague Company has received an order from the Government for motors, which will be put at once on board the new steam cruiser "Chicago," to be used in the training and elevation of the guns. The problems involved are of a very interesting nature, but I have no doubt they will all be most successfully grappled with. Another new use to which the Sprague Company will shortly put one of its motors is that of running a merry-go-round at a seaside resort.

I notice in your paper and others references to the new coulomb-meter recently patented by Prof. Elihu Thomson, and of which mention was made in this correspondence some weeks back. While I have nothing to say as to the questions of priority that have been raised, and which Prof. Thomson will probably deal with himself, it would not be out of place to offer passing comment on the assumption that is made in England, that because Prof. Houston published an article on another similar meter last December, it is singular that Prof. Thomson should have brought out his own so soon after and have had nothing to say about the parallelism. It deserves to be mentioned, I think, that while their names are closely linked in one of the leading systems, the two gentlemen have not, so far as I am aware, done any work together for some years. Prof. Houston resides in Philadelphia, engaged in educational work, while Prof. Thomson lives hundreds of miles away at Lynn, where he is busily occupied in connection with the Thomson-Houston Electric Company, of which he is the electrician. Probably the only gentleman with whom Prof. Thomson has collaborated of late years is Mr. W. Rice, who has charge of all the electrical work that the company turns out. Perhaps it does not add in any material way to the discussion that has arisen, but at the same time I take the liberty of saying for Prof. Thomson that, with all his great genius, he is one of the most modest and unassuming of men—a man as to whose sincerity and straightforwardness the briefest conversation with him would remove any doubt. It may even be that attributing to him the invention of this ingenious meter goes further than he himself would claim; but the fact that he has secured a broad patent on it, applied for months ago from our American Patent Office, is at least strong presumptive evidence in his favour.

While on the subject of co-operative arrangements in inventing, I might mention, on very good authority, what I am assured is not less true than it seems amusing, namely, that Ayrton and Perry are regarded in many parts of this country as being simply a very enterprising and successful firm of instrument

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makers, whose wares are well advertised and in brisk demand; in fact, I am told that the firm who handle here the instruments designed by the two distinguished professors are often in receipt of orders for instruments of "Ayrton and Perry's make."

In the absence of competition, the Western Union Telegraph Company is now making a better balance-sheet than has been the rule during the last year or two. The net revenues for the June quarter are estimated at $1,350,000, and a dividend of 1¼ per cent. will be paid. It is thought that the earnings next quarter, which will include nearly all the activities of the political campaign, will show a net of not less than $1,600,000, and then the dividends may go up to 1½ per cent.

CORRESPONDENCE.

CLARK STANDARD CELLS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having noticed your remarks in No. 520 of *The Electrician*, May 4th, 1888, with reference to Mr. Howell's Paper on "The Maximum Efficiency of Incandescent Lamps," and also the correspondence elicited thereon in your No. 525, of June 8th, I think the following facts not only bear upon the question at issue, but are also of interest to electricians everywhere, since they tend to show how closely independent standards of E.M.F. in the form of Clark cells carefully set up can be relied upon to agree, and that in fact it is only necessary for an electrician to be provided with a standard resistance coil in order to furnish himself through the medium of these cells with all the other electrical units in any part of the civilised world without recourse to special determinations in absolute measure:—

Three Clark standard cells set up in this country at the Edison Lamp Factory, Newark, N.J., under the supervision of Mr. Howell, were supplied to the Edison laboratory last January. They agreed and still continue to agree with each other within 0·00012 volt, or about 0·009 per cent. at the same temperature.

Two standard Clark cells set up in London under the care of Dr. Alex. Muirhead reached the laboratory on the 28th ult. These also agree with each other within 0·00010 volt at one temperature.

The difference between the E.M.F. of the Newark and the London cells is within 0·0004 volt, or 0·028 per cent., all at the same temperature, and the mean difference is about 0·00025 volt excess on the side of the London cells.

Precautions are necessary to maintain the cells at the same temperature during comparison, and it need hardly be pointed out that two Clark cells in close normal agreement, connected together in opposition through a galvanometer and set at different points whose temperatures between 0° and 40°C. are to be compared, constitute a very delicate differential thermometer.—Yours, &c.,

A. E. KENNELLY.

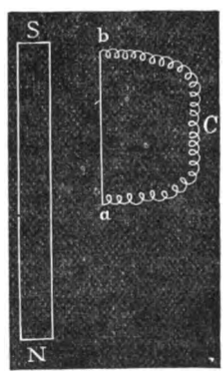
Edison Laboratory, Orange, N.J., 18th June, 1888.

UNIPOLAR INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. de Tunzelmann's interesting and instructive collection of data relative to so-called unipolarism will no doubt demand considerable attention, and it is with no wish to depreciate the value of such that I offer the following criticism. Mr. de Tunzelmann accounts for the phenomena noted by Faraday's law of electro-magnetic induction; but the explanations he gives by the aid of the typical diagram are not so convincing as might be. [The diagram is reproduced for convenience of reference: *a b* represents a section through the plane of the paper of a jacket surrounding the magnet N S] I here refer to the summary at the end of his last article, where, under heading No. 3, he states, that if the jacket and wire remain at rest whilst the magnet revolves there will be no current, because there is neither increase nor decrease in the lines of force cutting the circuit. Now I do not think this is altogether a very satisfactory explanation; no account is taken of the opposing E.M.F.'s that would be set up in the two paths of the current *b* C and *a* C, which are radial to the magnetic axis, and the assumption is that if that part of the circuit marked C were taken outside the influence of the lines of force current would be generated. If Mr. de Tunzelmann had returned his cylinders at one end towards the axis, as shown in the experimental diagrams, the explanation would have been more apparent. Considered in this light we have what are practically two conductors starting from a point near the magnetic axis. At *b* they branch and form circuit by two paths, one by *b* C and the other by *b a* to C, and herein lies the explanation; for with a little thought it will be seen that if two conductors, cut in any portion of their paths by symmetrical lines of force, —*i.e.*, by lines not increasing or decreasing in quantity— emerge from the same starting point in the field to form circuit outside, they must have the same intensity of E.M.F. induced in them, no matter how tortuous their paths may be in getting out, and as these E.M.F's will be opposed, there will naturally be no current.

Referring again to Mr. de Tunzelmann's diagram, it is noticeable that that portion of the circuit marked *b a* will, by



virtue of some of the lines of force cutting it, produce effective E.M.F. along its length, but that this will be neutralised by the opposing E.M.F. set up by the same lines cutting *a* C, so that we have practically only to deal with the lines that pass through and across *b* C and *a* C, which, as before stated, will produce opposing E.M.F.'s. If, however, the portion *b* C *a* of the conductor is stationary and the cylinder *b a* only revolves, as under heading No. 1, we shall then only have to deal with the lines cutting across *b a*, with the consequent production of current, as there will be then no opposing E.M.F. The above maxim would, nevertheless, hold good, as in this case the cut portions of the conductors do not extend beyond the influence of the field. The same reasoning can be applied to all the experimental data presented by Mr. de Tunzelmann, and will be found to be in accordance with the results in every case. In Fig. 8, when the magnets revolve and the galvanometer is placed between the terminals *a*, *c*, no current is obtained, and this is not because the cut portions of the two conductors start from the same point, but because they start from symmetrical positions in the field, or, what is the same thing, from points at equal distances from the poles; hence the E.M.F.'s are equal and opposed. If the cut portions of the conductors do not start from the same point, or from points situated symmetrically in the field, or where equal E.M.F.'s would be produced, current will result and be equivalent to the differences in their E.M.F.'s, always remembering that that portion of the circuit revolving with the magnet will be neutral and not cut by any lines of force.—Yours, &c.,

N. G. THOMPSON.

4, Queen Victoria-street, June 26th, 1888.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The account of a fire caused by lightning at the Narbonne telegraph station last week, as given in a paper I sent you, appears to have been exaggerated. I have obtained

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some information on the subject, and what has happened is what, under similar circumstances, is almost certain to happen. Overhead wires, on entering the telegraph station, were attached, *through spur lightning guards*, to the gutta-percha covered wires leading to the interior of the station, and which were duly earthed during the thunderstorm. Upon a length of a foot, close to the terminals of the lightning guards, the copper wires became hot, and the gutta-percha dropped away but did not ignite.—Yours, &c., P. F. FEYTENS.

Marseilles, June 25, 1888.

[The paper referred to by our correspondent has not reached us.—ED. *E.*]

LEGAL INTELLIGENCE.

Swaby v. Watt and others.

In the Chancery Division of the High Court of Justice, on Friday last, the action by Lewis Swaby against Hugh Watt and others, directors of the Maxim-Weston Electric Company (Limited), came before Mr. Justice Stirling.

Mr. PEARSON, Q.C., counsel for the plaintiff, moved for an injunction to restrain the defendants from forfeiting or cancelling 400 shares of the company held by the plaintiff or allowing any notice, minute, or other entry alleging such forfeiture or cancellation to remain on the register or the minute-book of the board of directors.

Mr. GRAHAM HASTINGS, Q.C., counsel for the defendants, said he had received only on the previous night a long affidavit for the plaintiff.

Mr. PEARSON: It is simply an answer to yours.

Mr. HASTINGS: Very likely; but still I would like to read it.

Mr. PEARSON: But it is absolutely necessary that the motion be taken at once

Mr. HASTINGS asked for delay; but said that in the meantime he would undertake that his friend's client should not be interfered with in acting as a director.

Mr. PEARSON said that on the last occasion there was an undertaking given to produce to the plaintiff certain minutes. He had applied for them again and again, and could not get them produced.

Mr. HASTINGS: I am told a copy was made for you, so that there must have been some misunderstanding on that point.

His LORDSHIP then granted postponement on an undertaking by the defendants over next motion day that the plaintiff should have and exercise all the rights of a director of the company.

PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

8,751. T. J. WILMOT. Waterville. An improvement in the Wheatstone automatic system of telegraphic transmission by which it is adapted for use on submarine cables in connection with the "siphon recorder" and "mirror" system. June 15, 1888.

8,765. W. ROWBOTHAM and W. FOX. Manchester. Improvements in holders for incandescent electric lamps. June 15, 1888.

8,772. W. ROWBOTHAM and W. FOX. Manchester. Improvements in electrical switches. June 15, 1888.

8,784. F. V. ANDERSON and J. F. TAFE. London. Improvements in systems of electrical supply. June 15, 1888.

8,809. H. H. LAKE. London. Improvements in electrical switches (S. Bergmann, United States). June 15, 1888.

8,814. A. TREEBY. London. A new or improved magazine small-arm discharged by electricity, and cartridges for the same. June 15, 1888.

8,836. G. J. PHILPOTT and G. H. ALDERTON. Brighton. Improved safety electrical switch and fuse-box combined. June 16, 1888.

8,864. D. A. AIRD. London. An electric tell-tale or counter mechanism. June 16, 1888

8,871. J. I. RYDER. Matlock, Bath. Improvements in electrical switches, commonly called electrical bell pushes or presses. June 11, 1888.

8,905. H. LAHOUSSE and Co. and C. COLLÉ, of the said firm. London. Improvements in electric batteries. June 18, 1888.

8,912. H. RAISON. London. An electric meter for registering or recording electricity. June 18, 1888.

8,919. J. G. LORRAIN. London. A new or improved type of electric cable, specially applicable for high-tension alternating currents and methods of, and apparatus for, manufacturing the same (La Société d'Exploitation des Câbles Electriques, Système Berthoud-Borel et Compagnie, Switzerland). June 18, 1888.

8,920. J. G. LORRAIN. London. A new or improved type of electric cable, specially applicable to long distance underground and submarine telephony (La Société d'Exploitation des Câbles Electriques, Système Berthoud-Borel et Compagnie, Switzerland). June 18, 1888.

8,950. C. B. BURDON. Birkenhead. Improvements in applying electric traction to pleasure, sporting and business purposes. June 19, 1888.

8,966. E. HOPKINSON and D. APPLETON. London. Improvements connected with or applicable to baths or vessels containing liquids used in electro-plating or dying, or the electrolyte of storage batteries and the like. June 19, 1888.

9,005. F. WYNNE. London. Improvements in dynamo-electric machines. June 20, 1888.

9,032 W. R. MORTIMER and J. HOLLOWAY. London. Improvements in electric arc lamps. June 20, 1888.

9,046. E. COX-WALKER and A. A. C. SWINTON. London. Improvements in magneto-electric bells. June 21, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

June 23, 1888.

10,177. E. L MAYER and H. LIEPMANN. London. Improvements in the manufacture or treatment of porous pots, plates or partitions for electric batteries. July 20, 1887.

11,235. R. HANNAN. London. Improvements in the manufacture of rubber composition strips used in the manufacture of insulated wires and cables (J. J. C. Smith, United States). August 18, 1887.

11,390. J. S. STEVENSON. London. Improvements in the manufacture of elements or plates for secondary batteries or electrical accumulators. August 20, 1887.

11,417. T. A. GARRETT. London. Improvements in and connected with electrical connections with moving bodies. August 22, 1887.

11,502. E. H. H. LAUCKERT. London. Improvements in dynamo-electric and electro-dynamic machines. August 23, 1887.

7,536. B. WILLCOX. London. Improvements in galvanic batteries (T. P. Whittier, United States). May 22, 1888.

PATENTS SEALED.

June 22, 1888.

6,221. A. SHIPPEY (London) and W. J. L. HAMILTON (Herne). A mode of and apparatus for governing or regulating by electro-chemical action applicable to the regulation of motors and of the feed of arc lamps and for other regulating purposes. April 28, 1887.

6,581. E MANVILLE and W. S. MADGEN. London. Improvements in holders for electric lamps. May 4, 1887.

7,265. C. ADER. Paris. Method and apparatus for phonic reception of electrical signals. May 18, 1887.

9,853. H. WATT. London. Improvements relating to dynamo-electric machines. July 13, 1887.

12,017. P. L. VERCHÈRE. Paris. Improvements in the manufacture of carbons for voltaic batteries and certain other electrical apparatus. September 5, 1887.

16,709. T. A. EDISON. United States. Improvements in electrical generators. June 13, 1887.

633. C. COERPER Germany. Improvements in dynamo-electric machines. January 14, 1888.

734. J. NOAD. East Ham. Improvements in galvanic batteries. January 18, 1888

3,483. F. T. SCHMIDT. Bradford. Improvements in electrical switches. March 7, 1888.

3,685, S. SHARP and J. M. V. KENT (London), and H. J. PAYNE (Barnes). Improvements in electrical switches. March 9, 1888.

3,740. A. BERNSTEIN. London. An improved combined cut-out and switch. March 10, 1888.

SPECIFICATIONS PUBLISHED DURING THE MONTH.

7,865, 1887. GEORGE, F. Dynamo electric, &c., machines. (Price 8d.)

9,191, 1887. SCOTT, G. A. Type printing telegraphs. (Price 1s. 6d.)

9,843, 1887. GOOLDEN, W. T., and EVERSHED, S. Compensating electric measuring instruments for temperature. (Price 8d.)

10,606, 1887. GERARD, L. Distributing, storing, &c., electric currents. (Price 11d.)

10,748, 1887. SCHANSCHIEFF, A. Portable batteries for electric light. (Price 8d.)

12,645, 1887. SANDWELL, W. D. Electrical batteries for driving tramway vehicles, &c. (Price 6d.)

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13,005, 1887. VILLIERS-STEAD, F., and others. Electrical automatic boxes for delivering small articles. (Price 11d.)
13,954. IRISH, W. E. Electrical railways. (Price 11d.)
1,851A, 1888. JOHNSON, J. Y. (the Volta Graphophone Co.) Sound-conveying tube for telephones, &c. (Price 8d.)
4,524, 1888. BARBER, STARKEY W. J. S. Portable galvanic batteries. (Price 8d).
6,237, 1888. MILLAR, A. Electric batteries. (Price 6d).
6,416, 1888. HOPPE, L. and G. Galvanic elements. (Price 4d.)
6,481, 1888. LAKE, H. H. (Tesla). Electrical transmission of power, &c. (Price 8d.)
6,502, 1888. LAKE, H. H. (Tesla). Generating and distributing electric currents, &c. (Price 8d.)
2,272, 1881. SWAN, J. W. Secondary batteries. (Price 6d.) Fourth Edition.

COMPANIES' MEETINGS & REPORTS.

London Platino-Brazilian Telegraph Company (Limited).

A general meeting of the shareholders of this Company was held yesterday (Thursday) at Winchester House, Old Broad-street, for the purpose of electing new Directors. In the absence of Sir John Pender, K.C.M.G., who was detained elsewhere, the chair was taken by Capt. Francis Pavy.

The SECRETARY (Mr. William Payton) read the notice convening the meeting, the following being an abstract of the circular:—"The arrangements made by the provisional agreement, dated the 18th day of April, 1888, for the exchange of shares of this Company for shares in the Western and Brazilian Telegraph Company (Limited) (which agreement, as you are aware, has been approved of by special resolution of the shareholders of this Company, passed and confirmed at extraordinary general meetings held respectively on the 27th day of April and the 15th day of May last), have been now practically completed by the shares of the assenting members of this Company being exchanged for shares in the Western Brazilian Telegraph Company, in accordance with the provisions of the above-mentioned agreement. It has therefore now become necessary that new Directors should be appointed in lieu of the present Directors, who are retiring under the provisions of the agreement."

At the request of the Chairman, the Secretary afterwards read the minutes of the last meeting, which were approved by the present meeting and signed by the Chairman.

The CHAIRMAN then said: I need not keep you more than one or two minutes, but there are one or two facts that may be interesting to you. The agreements between the two companies have been carried into effect, and out of the 38,348 shares forming the Platino capital, 33,515 shares have been exchanged for Western and Brazilian Shares, or 4,000 shares beyond the three-fourths requisite to give effect to the agreements. The agreements have been duly registered and lodged at Somerset House, so that matters are now in order, and the exchange virtually completed. It is entirely so so far as the present Directors are concerned. The number of our English shareholders was 345, holding 35,050 shares. Of these 326 shareholders, holding 33,515 shares, have accepted Western and Brazilian shares, leaving 19 shareholders, representing 1,535 shares only. These shareholders are unaccounted for; but these gentlemen have all, save absentees and executors (with one solitary exception of five shares) intimated acceptance of the terms, and will carry them out. As regards the foreign shareholders, there are at Rio 3, at Buenos Ayres 32, and at Montevideo 9. All these we have assurance will concur, with one exception, and that a doubtful one. Under these circumstances, having carried out the agreements, it is now only left, according to arrangement, for the present Directors to resign, and to appoint others in our stead. The solicitors of both companies agree that the best and legal way will be the passing of the resolution which I will now read to you:—

"*The present Directors, viz., Sir John Pender, K.C.M.G., Captain Francis Pavy, and John Hollocombe, Esq., having laid before this meeting resignations of their positions as Directors of this Company, in pursuance of the provisions of the recent agreement of the 18th day of April, 1888, resolved that their resignations be accepted, and that the following gentlemen be and are hereby appointed Directors of this Company, with the positions mentioned below:—W. S. Andrews, Esq., Director; Lord Richard Howe Browne, Director; C. W. Earle, Esq., Director; D. W. Goodsall, Esq., Director; H. Weaver, Esq., Director; and Major Wood, Director.*"

Mr. JOHN HOLLOCOMBE seconded the motion.

The CHAIRMAN; If no one has anything to say, I will put that resolution to the meeting. No shareholder rising to address the meeting, the motion was accordingly put and carried unanimously, the Chairman adding that that closed the business.

Mr. KENNETH ANDERSON, as an old Platino shareholder, said he desired to propose a vote of thanks to the retiring Chairman and Directors of the Company for the skilful and close attention which they had always given to the affairs of the Company. The shareholders all remembered that some time ago the Company was in a very bad plight, but the old Board brought it through its difficulties, and made it a living concern. They must also thank those gentlemen for the skill they had displayed in making the late arrangement, which would enable the shareholders to look forward, under the fostering care of the Western and Brazilian Company, to a bright future.

A SHAREHOLDER briefly seconded the motion.

Mr. W. GRIFFITH: Now that our old Directors have retired and new ones have been appointed, I hardly know to whom I ought to address myself, but probably to the new ones. Under the old *régime* there were some accounts outstanding between the two Boards. The London-Platino entered certain claims for large amounts, which were disputed. Will you kindly tell me what will be the future of those claims—whether they are admitted or still disputed, or in what way they will be arranged?

The CHAIRMAN: First of all I will thank Mr. Anderson for his kind remarks. As it happened, a legacy of a lot of these shares came many years ago into the hands of the Company I am connected with, and we found them of very little value. Aided by the staff, we have worked very hard—nobody knows that better than Major Wood—to get matters into shape, and I think that that is the position now. It has been to our interest to make these arrangements, and I am glad to think that it has been to the interest of the shareholders also. I think I must leave the new Directors to answer the question of Mr. Griffith. The matter is now out of our hands.

Mr. GRIFFITH: It is not yet settled?

The CHAIRMAN: The Company exists as it was, only that it is in fresh hands.

The proceedings then terminated.

The Pilsen-Joel and General Electric Light Company (Limited).

An extraordinary general meeting of this Company was held on Wednesday at the Cannon-street Hotel, Sir Rawson Rawson in the chair.

Mr. W. H. TRENTHAM (the Secretary) read the notice convening the meeting, and also the following requisition to the Directors:—

"We the undersigned shareholders of the Company hereby make a requisition that you convene an extraordinary general meeting of the Company, with the object of proposing to such meeting the following resolutions:—That the instructions to the Directors to sell the property, goodwill, &c., of the Company, given at the meeting held on the 13th of April, 1888, be and the same are hereby adopted, and the Board are instructed to advertise for sealed tenders within a week from this date, for the purchase of the same. That a committee of three shareholders is hereby appointed to act with the Directors in advertising for and in receiving and considering the tenders sent in for such purchase, and to report to the shareholders thereon. That this meeting views with surprise the action of the Directors in making a call of 3s. a share after what passed at the meeting on 13th April, 1888. Dated this 23rd day of May, 1888. Frederick S. Phillips, J. Eglinton A. Gwynne, Andrew Hutton, Arthur P. Blathwayt, Chas. T. D. Crews, Thomas Davis, W. Ellis Willes, James Fyfe, Edwin Gerard, James Gibberd."

The CHAIRMAN said: Well, gentlemen, I have now to proceed to inform you what action we have taken on the resolution passed at the meeting of the 13th April. Our original proposition was made in our notice for the first meeting on the 23rd March, and was, first, that the Directors, with the power vested in them, should make a call of 5s. a share for the purpose of meeting the existing liabilities of the Company and extending installations from their two stations, and in order that the shareholders might divide the profits from such extension, that the nominal capital of the Company should be reduced to the minimum. A small sum was left of £527, simply to make the reduction an even sum for simplicity of calculation. That is the explanation of our not sweeping it away altogether. Well, it was evident at the two meetings that our shareholders were not disposed to advance further capital for the purpose of extending the business, and that was made very clear to us. I had apprised the shareholders in my circular letter of March that the committee that examined into our affairs had stated very clearly that it was indispensable to obtain money to carry on the affairs and to meet the liabilities of the Company, even without any extension. We were as desirous as any shareholder who attended at the last meeting to carry out the views of that meeting, if it appeared likely it would be confirmed at a meeting which it would have been necessary for us to call in order to proceed legally with any action upon the recommendation, direction, instruction, or whatever you like to call it, of the last meeting. The shareholders in general were of course entitled, not only those who were present but all the shareholders were entitled, to know what we were going to do in their interest, and therefore it was absolutely necessary that we should call another meeting to confirm the proposal or direction passed at the last meeting. The Directors, myself and colleagues who were re-elected at the last meeting, were under a very firm conviction that the shareholders in general were not disposed to put an end to the Company; that there were many of them who were more disposed to carry on and to await better times for realising our business, and to obtain some return for the money that has been expended. When that resolution was passed three alternatives presented themselves to the Directors—one, to adopt the view of the last meeting, which was to get rid of the business as fast as possible; the other, to adopt the view advocated, and which we believed a number of our shareholders were disposed to advocate—viz., to carry on and to extend our installations gradually, or to devise some other course which might reconcile the views of the two divisions of our shareholders. Well, when the Board met within about a week of our meeting we found ourselves in this position—that the proceedings at that meeting had become known to parties who had claims upon the company, and who were not only prepared to, but actually did, without giving us a chance of meeting them, take legal proceedings against us. As you are aware our balance at the bank was reduced to the smallest sum; our rentals from installations would not come in for another month, and we were under an obligation to meet our liabilities. Therefore we had no option in the matter; we could not obtain

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the necessary funds without making a call or pledging ourselves—in fact, a pledge to make a call was not sufficient—we could only obtain money by making a call, therefore we were hurried into that necessity, from no action of our own, and certainly from no indisposition to come to an arrangement, had it been possible, by which we could have avoided a call. We found ourselves, therefore, under the necessity of reconsidering our position with regard to the future. Should we maintain our own view of continuing the business, and what we believed to be the view of the influential body of shareholders to continue business, or should we adopt the view of those who carried the motion at the last meeting to proceed to a sale of the business as speedily as possible? The Directors determined to adopt the latter view, and to act entirely according to the desire expressed by the meeting, the difference being that many who voted for that instruction did so in the expectation that there would be no necessity for making a call; but that necessity was forced upon us, we could not avoid it. Therefore the Directors proceeded in the manner which they considered most desirable. There was a disposition expressed by some shareholders to advertise for the sale of the business. The Directors did not consider that in the position of the Company at that time that that was an eligible course. They thought that it was injurious to the interests of the Company; that it would damage the value of their property by adopting such a course, more particularly after the publication of the proceedings at the last meeting. We therefore, acting upon the instruction, which was to consider the best means of disposing of the business—those were the terms—proceeded to enter into those negotiations with those parties who were likely to take the business off their own hands, and to endeavour to effect an arrangement with them. That has been proceeded with, and that has delayed our calling you together to a certain extent, for the negotiations have been continued up to the latest date; but we believe that we have the opportunity of laying before you a proposal which will realise the value of our assets at the present time, obtain as full a value for them as we can get, release our shareholders from any future obligation with regard to calls, and so far meet what we believe to be the wishes of the majority of the shareholders. One of my colleagues will lay this matter before you. I wish to say that I myself have not interfered in this matter at all, inasmuch as it was supposed by some, or suggested, that my judgment might be interested in this matter on account of my son's connection with a firm; therefore I have taken no part whatever in this matter of negotiation. My colleagues have dealt with it, and one of them will explain to you his proceedings. The other point that I have to bring before you is the question of the amount of the call. We originally proposed 5s., with a view of meeting our liabilities, of extending our installations, but when it was obvious that our shareholders were not disposed to carry on the business and desired it to be wound up as speedily as possible, and, of course, with as little expense to themselves as possible, we had to consider what amount would be required to meet the three distinct objects. One was to cover all liabilities existing or likely to accrue from the state of things as it existed at the moment, the other was to provide for a quarter's maintenance of our installations, because we have to furnish our customers for a quarter at least before they pay for them, and we were bound to consider the interest of our customers, in which our own interest was closely bound up in this matter. Then another point was to raise such an amount as would render it absolutely certain that we should not be required, or that any parties taking over the business from us should have to make another call for a small balance. It would have been a very unwise thing for us to make a 2s. call or a 2s. 6d. call if it was likely or possible that we should then have to make another call of 6d. or 1s.; therefore, inasmuch as we should not expend any more of this money than was absolutely necessary, we made a call of 3s. instead of 5s., which would render it certain we should have sufficient to wind up the business, which might take weeks, perhaps many weeks, before we might get a satisfactory offer and come to a final settlement. With regard to the negotiations, I will ask Mr. Whateley, who has been good enough to undertake them, to state what has been done; but I should like to mention what has been the result of our inquiries and the information that has come to me as to the difficulties that this matter presents. With regard to our business, one of our difficulties is that all our arrangements are annual, our contracts with our customers are annual. That affects very much the value of our assets, because it is in the power of those parties to withdraw, and therefore there is an uncertainty respecting the arrangement. Another objection that we have met with is in regard to our plant, that it is not of the latest type, and that it has been improved upon. That is one difficulty. Then with regard to patents, that has been another difficulty. Most of the parties who are lighting in London and elsewhere have their own lamps and patents, and are not disposed to pay for patents for another lamp when they are satisfied with their own or other lamps which are in the market. These are difficulties with which the negotiations have been met. I trust that Mr. Whateley will explain to you our position, which, as I understand it, is one that will be satisfactory to the shareholders generally. I will read the resolution, which the Board has only within the last day or two felt itself in a position to submit. We hope that it will meet your views; at any rate, it will show that we are anxious to meet the views expressed on the last occasion, and I think it will meet the views of the majority of those who are present here to-day. I move

"*That the instructions to the Directors to sell the property, goodwill, and assets of the Company, given at the general meeting held on the 13th April last, be and the same are hereby adopted, and that the Directors be and are hereby authorised to accept payment in cash or fully-paid-up shares of any other company, or partly in cash and partly in such shares as may be arranged, and that a committee of three gentlemen are hereby appointed a committee to consult with and assist the Directors in negotiating for such sale.*"

We are most anxious that the shareholders shall have the fullest security that in any arrangement entered into their interests will be looked after to the fullest extent.

Mr. FELLOWES thought it was not competent to the meeting to consider any such resolution. The resolution passed at the last meeting was *ultra vires*. He thought that they should consider whether the business could be carried on.

Mr. D. PARRISH said that the Directors had acted under legal advice. He understood that the Directors had done their best to sell the business.

Mr. WHATELEY said that when the Board came to the decision, which they did after a great deal of consultation, as to whether it would be better to sell by tender or not, they came to the decision that to offer the affair by tender would be practically selling all their plant for next to nothing. He was told by gentlemen that their plant was not of the most modern type; he did not believe it was, because the bulk of it was made some time ago. The first people he approached was the Grosvenor Gallery, who were doing as much as anybody in the electric lighting way; they positively declined to have anything to do with the Company, on the ground that their plant was out of date. They had also been to the House-to-House Electric Company and to the Anglo-Brush Corporation. They had also had some communication with Mr. Crompton and the Kensington Court Company, but there had been no result. They next put themselves in communication with Woodhouse and Rawson, who took an immense deal of trouble in the matter. He had had several interviews with the head of the firm, Mr. Foot, who proposed to start a syndicate company with £50,000 capital; they proposed to give this Company a fifth of the share capital, and when the syndicate sold the undertaking to a company they were to have a fifth of the proceeds in cash and shares besides a certain royalty on patents they possessed. The Directors would be very glad of the assistance of shareholders to carry out this arrangement.

Mr. JAS. FYFE said that he had signed the requisition for a sale under supervision as the lesser of two evils under the then existing circumstances. The Directors had been instructed by a meeting—which restored them to power for that sole purpose—to sell the business, and he opposed both their restoration to power and the sale at that meeting, as he considered neither was for the benefit of the shareholders. The Directors had also expressly withdrawn at that meeting their announced intention of making the call they were proposing of 5s. The report of the Committee of Investigation was only not read at that meeting for the reason that the majority then present of the shareholders, as they were deciding upon a sale, considered it unnecessary to have a discussion upon the report, disclosing as it did the gross mismanagement of the Directors; but to avoid this discussion a vote of thanks to the committee who had prepared the report was suggested by one of the Directors themselves, and unanimously carried—and to this day the expenses of that report had not yet been paid by the Company. That was the position of matters after the last meeting. But what do the Directors do upon this? Practically they say, "*You have put us back into power formally; we have succeeded in getting the report burked*—but the sole condition and reason for both these facts, viz., that we should sell the business was informally *carried*, and we will ignore it and continue our management," which every shareholder must condemn, and which as stated in the report has received the most emphatic condemnation by the leading papers of the electrical press, who only refrain from still further condemnation because they await what they assume will necessarily follow. He considered that any course would be better than continuing the business under this management, which had in four years worked so much harm—had been doing a largely-decreasing business year by year with an annual increase of expenditure—and, in addition, had in eighteen months squandered about £4,000 invested moneys of the Company. He accordingly joined with other shareholders in a requisition to the Directors to call a meeting, to make that formal which they said was informal, viz., the resolution for sale This was disregarded by the Directors upon a pitiful technical objection they raised, that they had been by the requisition asked to call the meeting for a particular day, to which day they could not suggest any objection however. We were, therefore, put to the trouble of sending another requisition, upon which the present meeting is called. And how do the Directors meet us when they are at last reluctantly forced to do so? Why they say they have been privately negotiating for a sale of the business, which is what they were asked not to do, and they say it has been proposed to them by one shareholder that the Directors who had been acting for a year and a-half improperly—the very year and a-half in which the invested £4,000 Consols were squandered—should have a sum of money voted to them for this signal service to the Company. What they did besides this I know not, because having examined the minute book of this period I find a dreary monotony of the proceedings of each meeting (recorded by themselves, be it remembered) of—"Present the three Directors. Cheques signed for so and so." Nothing else; no business done, or even discussed or considered, only signing cheques—so long as the money lasted. And it will not be forgotten that when the Committee of Investigation commenced its labours there was absolutely not one farthing in the bank. But the real practical question is as to the future of the Company, and as to the policy to be pursued. If the business were to be sold, what is likely to be realised for a business which has been allowed to run four years practically without any profit, which has been so publicly discredited as this has been by its Directors, who issue their circular that its goodwill and patents, lately valued by themselves at £25,000, are now worth only £500? The effect of this sale would be that since the last meeting the Directors have called up further capital of about £3,600 to enable them to sell for about that amount. But I do think it is not in the interests of the general body of shareholders of the Company that there should be a sale at all. Here is a property, the mere goodwill and patents of which were valued last year, and I think moderately, at £25,000, which admittedly is earning even under the present utterly inefficient management over £5,000 per annum from customers of undeniable responsibility, which has central

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lighting stations of almost unique advantages in the electric lighting business, capable of practically unlimited extension for further customers whom the present Directors will not even supply when brought to them, and this at a comparatively trifling outlay. The lamp is admittedly the best arc lamp in the market. The Company have the patents for India, Australia, and Canada, in addition to the patents for the United Kingdom, none of which have been worked or sought to be worked in any part of these territories, during the existence of the present directorate, except England, a full working stock and plant, valued by your committee at £10,000 and upwards, and all these are to be put into the market and thrown away for what anyone will give for it, merely because the Company have been afflicted with a Board of Directors who have grossly mismanaged their business, and who have not in their conduct of it been governed by the most ordinary business principles, or shown any regard for either efficiency or economy. Now, I do not know why the Pilsen Company's business should be dealt with upon any other lines than any other business; and if another business known to be good was managed by persons known to be bad, the owner would, in the ordinary way I suppose, not sell his good business, but dismiss his bad manager. I must say that I think this is the true solution of the difficulty. Invite the Directors to resign the positions in which they can no longer possess the confidence of the shareholders, select at a future meeting three business men from among the body of shareholders to conduct the business of the Company, and I will confidently predict that this company will be as prosperous in the near, if not the immediate, future as it has been unprofitable and almost disastrous in the past. Firmly believing this, and that any sale would be a most mistaken policy, I beg to move the following amendment to the resolutions:—"*That in the opinion of this meeting any sale of the Company's business at the present time is inexpedient; that the proposal to make a payment to the Directors for acting as they did whilst disqualified be not entertained; that the present Directors be requested to resign; and that the Secretary is hereby directed forthwith to convene a meeting of shareholders to elect other Directors.*"

Mr. GWYNNE said that the Company had been mismanaged from the commencement, and moved an amendment in accordance with the terms of the requisition.

After some further discussion, both the resolution and amendment were withdrawn, and on the motion of the CHAIRMAN, seconded by Mr. SCRIVEN, the following resolution was agreed to, viz.:—

"*That the Directors be instructed to consider the best means of disposing of the property, goodwill, &c., of the Company, or, in the alternative, to consider the advisability of carrying on the business, and that the Board be instructed, if a sale be determined upon, to advertise for sealed tenders for the purchase of the business, or to make such other arrangements for the disposal of the business and assets as they and the committee hereinafter named may think fit; that Messrs Phillips, Guynne, D. Parrish, and Fyfe be and are hereby appointed the committee, to act with the Directors in arranging and negotiating such sale subject to the consent of the shareholders being obtained before any proposal for the purchase is finally accepted, or any arrangement for carrying on the business is made.*"

The proceedings then terminated.

The South of England Telephone Company.

Report of the Directors for the year ended 30th April, 1888, to be presented at the fifth ordinary general meeting of the Company, to be held on Friday, the 29th inst., at Winchester House, 50, Old Broad-street, E.C., at 1 o'clock:—

The expenditure on capital account during the past year amounts to £16,457. 6s. 9d., bringing the total of that account to £44,384. 6s. 8d.

The revenue account shows a sum of £12,354. 10s. for subscriptions and rentals, and a net credit balance of £3,905. 12s. 2d., making, with the sum of £1,058. 9s. brought forward from last year, an available balance of £4,964. 1s. 2d.

After providing for the Preference dividends (£1,849. 0s. 6d.), which have been paid, a balance of £3,115. 0s. 8d. remains, out of which the Directors recommend the payment of a dividend on the Ordinary shares at the rate of ½ per cent. for the year, free of income-tax, which will absorb the sum of £1,500. The Directors also recommend the transfer of £500 from the revenue balance to a reserve fund account, in order to commence this fund—as suggested by the auditors—leaving a balance of £1,115. 0s. 8d. to be carried forward.

The completed trunk lines are as follows:—

Brighton—Shoreham.	Dover—Folkestone.
Brighton—Worthing.	Chatham—Maidstone.
Brighton—Lewes.	Norwich—Great Yarmouth.
Margate—Ramsgate.	Northampton—Wellingboro'.

The trunk lines in process of construction are—

Canterbury—Dover.	Lewes—Eastbourne.
Canterbury—Ramsgate.	Wellingboro'—Kettering.
Canterbury—Deal.	

At the 30th April, this year, 1,435 exchange lines and 373 private lines were completed; and 86 exchange lines and 13 private lines were in course of construction.

Telephone exchanges are now open at the following places:—

Brighton	Hastings and St. Leonards	Oxford
Cambridge	Ipswich	Peterborough
Canterbury	King's Lynn	Ramsgate
Chatham	Lewes	Reading
Dover	Maidstone	Shoreham
Eastbourne	Margate	Tunbridge Wells
Folkestone	Northampton	Wellingboro'
Great Yarmouth	Norwich	Worthing

Mr. T. F. Campbell retires from the Board by rotation, and, being eligible, offers himself for re-election.

The shareholders' auditor, Mr. J. Weise, retires, and is eligible for re-election.

Comparative Statement of Exchange and Private Line Business.

	Exchange.	Private.
April 30th, 1886	687	248
April 30th, 1887	1,130	343
April 30th, 1888	1,521	386

United Telephone Company (Limited).

The following is the report of the Directors for the year ended 30th of April last, to be presented to the shareholders at the eighth annual ordinary general meeting of the Company, to be held at the Cannon-street Hotel, on Tuesday, the 3rd prox.:—

Capital Expenditure.—A reference to the capital account will show that up to the 30th April, 1888, the sum of £263,876. 10s. 10d. has been expended upon the works in connection with the Metropolitan District and instruments on royalty in the Metropolitan District and subsidiary companies, being £35,695. 18s. 8d. more than the outlay shown in the last balance-sheet.

Revenue.—The revenue accounts, exclusive of Metropolitan District royalties, show that the receipts of the Company from all sources properly attributable to the year have been £143,134. 18s. 5d., as against £130,704. 7s. 5d. in the preceding year, or an increase of £12,430. 11s., and the expenditure (including snowstorm losses and allowances,

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
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PHOSPHOR BRONZE.
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BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
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WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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£15,653. 8s. 7d.) has been £73,519. 8s. 8d., as against £66,954. 11s. 8d., or an increase of £6,564. 17s.

Working Expenses.—(*Metropolitan District.*)—The working expenses for the year have been £35,724. 12s., as against £30,483. 14s. 2d. for the preceding year, or an increase of £5,240. 17s. 10d.

Dividend.—The balance of net revenue account is £68,697. 4s. 1d., of which amount the sum of £22,377.15s. has been absorbed by the payment of an interim dividend at the rate of 10 per cent. per annum for the first half-year ended 31st October, 1887, and the Directors recommend a further dividend of 10s. per fully paid £5 share and 5s. per part paid share for the second half-year ended 30th April, 1888, amounting to £44,755. 10s., making a total dividend of 15 per cent. for the year, leaving a balance of £1,563. 19s. 1d. to be carried forward.

Reserve Account.—A sum of £14,375, being the amount received during the year as premium on new shares, has been carried direct to the reserve fund.

Directors.—It is with the greatest regret that the Directors have to refer to the decease of the late Mr. E. Dwyer Gray, M.P. To fill the vacancy thus occasioned they have, subject to confirmation by the shareholders, elected Mr. Frederick R. Leyland to a seat on the Board. Mr. John W. Batten and Mr. Frederick R. Leyland retire by rotation, and, being eligible, offer themselves for re-election.

Auditors.—The auditors, Messrs. Quilter, Welton and Co., and Messrs. Price, Waterhouse and Co., also retire.

NEW COMPANIES REGISTERED.

J. AND J. CHARLESWORTH (LIMITED).—This company proposes to take over the business of Messrs. J. J. Charlesworth, colliery owners, &c., carried on at Lofthouse, near Wakefield. Power is also taken to carry on business as electricians and mechanical engineers. It was registered on the 14th inst., with a capital of £500,000, in £100 shares, the following being the first subscribers:—

	Shares.
*A. H. Charlesworth, Chapelthorpe, colliery owner	1
*J. B. Charlesworth, Wakefield, colliery owner	1
Mrs. E. B. Charlesworth, Wakefield	1
*J. Charlesworth, Lofthouse, Wakefield, colliery owner	1
*C. E. Charlesworth, Doncaster, colliery owner	1
Mrs. F. Charlesworth, Doncaster	1
Mrs. E. G. Charlesworth, Wakefield	1

The number of directors is not to be less than 3, nor more than 5; qualification, £10,000 in shares or stock. The first are the subscribers denoted by an asterisk; remuneration, £2,000 per annum.

THE INTERNATIONAL ENGINEERING COMPANY (LIMITED).—Registered by Nores and Pattison, 52, Lincoln's Inn-fields, W.C. Capital £5,000, divided into 5,000 shares of £1 each. Object, to purchase or acquire certain inventions relating to electric motors, and to means for carrying electrical batteries for driving tramway vehicles and for other purposes, invented by William Denton Sandwell; to construct, equip and work light railways, tramways, ships, lines of telegraph, telephone, &c., and to carry on business as manufacturers and suppliers of electrical, steam, or other mechanical or animal or other motive power or electricity or light. The first subscribers are:—

	Shares.
J. Drage, clerk, 26, Osborne-terrace, Clapham-road, S.W.	1
E. A. Rider, clerk, 8, Lugard-road, Queen's-rd., Peckham, S.E.	1
W. B. Pattison, solicitor, 52, Lincoln's Inn-fields, W.C.	1
J. H. Yates, teacher of music, 63, Frith-street, W.	1
C. Wickison, housekeeper, 52, Lincoln's Inn fields	1
J. L. Hofman, clerk, Warwick-road, New Barnet	1
W. Davis, shorthand writer, 420, Edgware-road, N.W.	1

There shall not be less than three nor more than seven directors, and the first shall be elected by the subscribers to the Memorandum of Association. The qualification shall be the holding of not less than £100 in the capital of the company. Remuneration of directors is not stated.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 22nd, 1888, were £4,072.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY.—The directors of this company notify that the coupons, due July 2, on their Five per Cent. Mortgage Debentures will be paid on and after that date at the banking-house of Messrs. Barclay, Bevan and Co., 54, Lombard-street, E.C.

MANITOBA ELECTRIC AND GAS LIGHT COMPANY OF CANADA.—Messrs. Robert A. M'Lean and Co. will pay, on and after July 1, the half-yearly interest coupon on the First Mortgage Six per Cent. Bonds for £62,000 of this company.

TELEPHONE COMPANY OF AUSTRIA.—The directors of this company notify that coupon No. 7 of their Five per Cent. Debentures, due July 1 next, will be paid, less income-tax, on and after July 2, by Messrs. Martin and Co., 68, Lombard-street.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The coupons due the 30th inst. on the debentures of this company will be paid by Messrs. Barclay, Bevan and Co. The coupons must be left three clear days for examination.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 22nd, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,385.

CRICKET.

EASTERN TELEGRAPH COMPANY v. SUBMARINE TELEGRAPH COMPANY.

This annual match was played at Nunhead on Saturday last, and was favoured with splendid weather. The Eastern Company won the toss, and decided to go in, Messrs. Seymour Wells and M'Millan taking the bat. Both gentlemen batted well, and made 49 runs before the latter was caught for a very useful 29. Mr. Wells's batting was remarkably steady, and his wicket-keeping deserves special mention. The Submarine could make no stand against the excellent bowling of the Eastern. Mr. M'Millan baffled the batsmen completely, taking four wickets at a cost of only three runs. Mr. A. Jack captained the Eastern Eleven, and Mr. Collard that of the Submarine Company. Messrs. Shanks and Gregory were the umpires. Score:—

EASTERN COMPANY:—Mr. M'Millan, c Breedon, b J. Spicer, 29; Mr. Seymour Wells, c Cross, b Robinson, 36; Mr. Chisholm, run out, 14; Mr. A. Jack, b Cooper, 18; Mr. Couper, b Cooper, 10; Mr. W. Macdonald, b Breedon, 4; Mr. Richardson, b Cooper, 2; Mr. R. Donaldson, c Collard, b Breedon, 12; Mr. Grigor, c Cooper, b Breedon, 0; Mr. W. Donaldson, not out, 2; Mr. J. White, absent, —; Byes 10, leg byes 3, no ball 1, 14. —Total, 141.

SUBMARINE COMPANY:—Mr. Breedon, c Chisholm, b M'Millan, 1; Mr. Cross, run out, 4; Mr. Wright, b M'Millan, 0; Mr. Collard, b Chisholm, 9; Mr. Muzio, run out, 0; Mr. Cooper, b Chisholm, 7; Mr. Robinson, b M'Millan, 0; Mr. Robinson, b Chisholm, 0; Mr. J. Spicer, b M'Millan, 3; Mr. Gee, run out, 0? Mr. R. Spicer, not out, 0; Byes 7.—Total, 31.

Dr. GASSNER'S PATENT **BRY BATTERY** Dr. GASSNER'S PATENT

FOR

TELEGRAPHIC WORK, ELECTRIC BELLS, AND MEDICAL USE.

Possesses all the advantages of a Leclanché Cell, and none of its deficiencies.

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MAYFIELD, COBB & CO., LTD., 35a, QUEEN VICTORIA STREET, LONDON, E.C.

THE NEW BURGLAR ALARM CONTACT (Patent applied for); cannot get out of Order. Rubbing Contact, and Wetproof.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, June 27, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending June 27, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	36 37	3 14 3	Jan., Apr., July, Oct.	36	35⅞
2,614,820	Stock	10/0	Do. Preferred	59½ 60½	4 10 11	,, ,,	60¼	59⅞
2,614,820	Stock	nil.	Do. Deferred	11⅛ 12	...	February	11⅛	11⅛
130,000	£10	3/0	Brazilian Submarine	12⅜ 12⅝	4 15 0	Mar., June, Oct., Dec.	12 9/16	12 7/16
16,000	10	8/0	Cuba Submarine	13 13⅛	5 18 9	February and August	...	...
6,000	10	10/0	Do. Preference	18½ 19½	5 2 6	,, ,,	...	...
12,931	5	4%'87	Direct Spanish (£4 paid)	3⅝ 4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference	8½ 9½	5 5 3	April and October	...	...
60,710	20	2/0	Direct United States	8¼ 8½	4 14 2	Jan., Apr., July, Oct.	8¼	...
380,000	10	2/6	Eastern	11⅛ 11⅞	4 12 7	,, ,,	11⅛	11⅛
70,000	10	3/0	Do. 6 per Cent. Preference	14⅝ 15¼	3 19 0	,, ,,	...	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	110	109½
250,000	10	5/6	Eastern Extension	12¾ 13	5 0 0	Jan., Apr., July, Oct.	12⅛	12¾
22,050	10	8/3	German Union Telegraph and Trust	9 9½	7 7 4	January and March	...	...
179,177	10	2/0	Globe Telegraph and Trust	5⅛ 5⅜	5 9 8	Jan., Apr., July, Oct.	5 1/16	5 1/16
178,992	10	3/0	Do. 6 per Cent. Preference	13⅞ 14	4 5 9	,, ,,	14	13⅞
150,000	10	7½% '87	Great Northern	14 14½	5 3 5	Jan., July, and April	14⅜	14⅛
17,000	25	37/6	Indo-European	36 38	6 11 9	April and October	...	...
38,348	10	3%	London Platino Brazilian	5⅞ 6¼	...	May and November	6	...
9,000	8	4/0	Reuter's	7⅛ 8	5 0 0	April and October	7 1/16	7⅛
338,225	Stock	15½%	Submarine	140 150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America	6½ 6⅝	6 9 0	January and July	6¾	6⅝
150,000	100	8%	Do. Debentures	112 117	6 16 9	June and December	...	...
88,321	10	nil.	West India and Panama	⅞ 1⅛	...	...	...	...
34,563	10	*10/0	Do. 1st Preference	10⅜ 11	8 12 8	April and October	10⅞	...
45,181	15	9/0	Western Brazilian	9¾ 10⅛	6 5 11	March & September	10	9⅞
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	⅝ ¾	5 0 0	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	½ ⅝	8 13 6	...	...	...
80,000	5	5/0	United	13½ 14½	4 11 3	June and December	14⅝	13⅞
50,000	5	2/6	United River Plate	5¼ 6	...	April and October	5⅞	5¼
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb.'86	Anglo-American Brush (£4 paid)	2½ 3	...	...	...	...
23,692	5	nil.	Do. (fully paid)	3⅝ 4	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2½	...	...	2½	2
312,000	¼	5% '86	Maxim-Weston	1/16 1/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39½ 40½	5 18 4	March and July	40¼	39½
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 3	February & August	17⅝	17 3/16

* On account of arrears of dividends.

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CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

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2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the duties of the family solicitor.

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GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 529.—Vol. XXI. FRIDAY, JULY 6, 1888. Price 4d.

NOTES.

On Monday morning, after an adjournment of four weeks' duration, Mr. Justice Kay once more resumed the hearing of "Edison and Swan Electric Light Company *v.* Holland and others." The learned judge had already for some days been in possession of the report drawn up by Prof. Stokes, P.R.S., upon the experiments carried out in his presence by experts on either side. This report was not read in court, but the full text will be found in our present issue. To the satisfaction, we presume, of nearly everyone concerned, great and unexpected progress has now been made. The speeches of counsel, instead of extending over several days (as was fully anticipated) were concluded in as many hours, and we have now only to await the judgment.

The case of Gaulard and Gibbs *v.* Ferranti, which is now occupying the attention of Mr. Justice Kekewich in the Court of Chancery, requires, perhaps, a few words of explanation as regards the legal status of the parties to the suit. Notwithstanding that Messrs. Gaulard and Gibbs figure as plaintiffs, the suit is really initiated by Mr. Ferranti, who has filed a petition in the Court of Chancery for the revocation and annulment of Patent No. 4,362 of 1882, of Messrs. Gaulard and Gibbs, on the ground mainly of want of novelty in the subject matter, and also of a lack of utility. When a suit of this character comes before the Court the patentees possess the right to open the case, and hence, for the sake of convenience, they are distinguished as the plaintiffs and the petitioner becomes the defendant. Meanwhile we are informed that Messrs. Gaulard and Gibbs have instituted proceedings against Mr. Ferranti and the Grosvenor Gallery Company for infringement of their patents. We take it, however, that the issue of the present trial will virtually decide the cross-action also. It may be as well to explain, further, that since the commencement of the present suit Messrs. Gaulard and Gibbs have obtained the permission of the Controller of Patents to amend their original specification. In another column we print the specification, showing the difference between the original and the amended form upon which the case is being fought out.

Owing to the sudden interruption of both the Java-Port Darwin cables on 30th June, Australia is temporarily cut off from telegraphic communication with this country. The Eastern Extension Company's repairing vessel "Recorder" is now at the position of the break, and it is expected that repairs will be effected quickly. Below we give some particulars of previous interruptions to the communication, in order to correct inaccurate statements which have been made public. Direct telegraphic communication between England and the Australian Colonies was established in October, 1872, and from that date until 1880, when the company duplicated their system between India and Australia, the cable service to Port Darwin (Northern Territory of South Australia) was only totally interrupted on two occasions, viz., in 1877 for 38 days, and in 1879 for 18 days. Since the duplication of these cables in 1880, telegraphic communication has only twice been interrupted for an aggregate period of 13 days. The South Australian land line between Adelaide and Port Darwin has been interrupted from time to time, but the interruptions have seldom lasted for many hours, the longest on record not exceeding five days.

In order to provide as far as possible against a similar interruption the company have promptly decided to lay immediately another cable between Banjowanjie and Beagle Bay, Western Australia. The breakage of the existing cables was apparently due to some convulsion at a depth exceeding 1,000 fathoms, and is another illustration of the difficulties which have to be encountered by the comparatively new enterprise of cable-laying and repairing in deep seas. The Eastern Telegraph Company had a similar experience three years ago, about 140 miles from Aden, when both of their cables broke in the same neighbourhood in 800 fathoms of water during a cyclone. The Eastern and South African Telegraph Company had a singular experience with their section between Zanzibar and Mozambique. For five consecutive years the cable broke in the same locality off the Rovuma River, all the interruptions occurring in the months of March or April. Elaborate soundings were taken but no cause for the breakage could be found; and as no better or more regular bottom could be desired, the company resolved to lay a duplicate line far outside the neighbourhood of these breaks; and that being done they shifted the original cable close to the shore, so that they have one cable in very deep and another in very shallow water; and since then, now three years ago, there has been no interruption of any kind. It is hoped the cable companies may some day understand more about these convulsions, and be enabled to lay cables so as to avoid the localities where they occur. It is, however, satisfactory to know that cables can be so readily repaired, even in distant seas, although the companies are obliged at great cost to have tanks with spare cable and repairing steamers available at many points to maintain the great network of submarine lines, which now exceed in length 110,000 nautical miles.

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The conditions under which electrolytic decomposition may be effected by an alternating current is a subject upon which very little has hitherto been made known. Considering the very great scientific interest which attaches to the question, in addition to the practical importance which it may possibly assume, it is a little surprising that it should have been neglected for so long a time. In our last issue, however, we gave a translation of a recent Paper by MM. MANEUVRIER and CHAPPUIS, in which certain definite conclusions are set forth; and next week we hope to publish an article on the same subject by Prof. AYRTON. We understand that Prof. AYRTON's investigations have led him to conclusions of a somewhat different character from those arrived at by the French observers.

MEANWHILE, M. NEYRENEUF, writing in the *Journal de Physique*, describes some results of a remarkable character obtained by the use of aluminium electrodes. In a voltameter of this description filled with dilute acid and traversed by an alternating current, the author finds that pure hydrogen is evolved at both electrodes. What becomes of the oxygen we are not told, but no doubt the plates are simultaneously oxidised. When, however, one electrode is of aluminium and the other of mercury, and the liquid is distilled water, much more extraordinary results ensue. *The current passes in one direction only*, and the arrangement forms what the author calls an electric valve. The current which gets through is, moreover, in the reverse direction to that which would be due to the mercury-aluminium couple itself. Furthermore, the addition of some drops of acid to the distilled water notably *diminishes* the current. The aluminium may be replaced by other metals with results of the same general character, but the apparent resistance of the cell is much greater. Nickel and zinc cause the current to pass in the reverse direction. The author does not tell us what relation the phenomenon bears to the E.M.F. of the alternating current, nor does he give any idea as to the E.M.F. employed. These are points upon which we shall hope in due time to receive further information.

THE Electro-Technical Society of Vienna, following the illustrious example of our own Society of Telegraph-Engineers and Electricians, some time ago appointed a special committee to consider what precautions should be taken in the installation of electric lighting plant. The result of the labours of the committee has now been made public, and while the greater part runs upon stereotyped lines to which no exception can be taken, we yet meet with several innovations which will scarcely commend themselves to English electricians. For instance, one of the rules sets forth that the maximum current density in the conductors shall not exceed three amperes per square millimetre (1,875 amperes per sq. in.) for covered wires, while for bare wires a density of four amperes per square millimetre (or 2,500 amperes per sq. in.) is permitted. Since the labours of Prof. FORBES in 1883 we had thought that it had been a matter of common knowledge that a covered wire can take a higher current density than a bare wire of the same diameter for the same rise of temperature. Copper of 80 per cent. conductivity is allowed. The insulation resistance is to be 5,000 times the conductive resistance—an awkward rule for series circuits. When transformers are used the difference of potential at the terminals of the *primary* coils is not to exceed 200 volts; parallel working is therefore ruled out of court. But though 200 volts may be used at the transformers, not more than 150 is permitted at the terminals of the dynamo. In fact, we are afraid that these rules are a sorry jumble; and, seeing that English capital is largely employed on electric lighting enterprise in Austria, it is much to be hoped that no executive authority will attach to them.

ON the subject of capital punishment by electricity an eminent correspondent writes to us from the other side of the Atlantic as follows:—"As an electrician you will be interested in hearing that the State of New York has extended the domain of your science by passing an Act for putting murderers to death by electricity instead of hanging. I think there ought to have been a clause providing that the murderers should put *us* to death by electricity, instead of poisoning us or blowing out our brains."

OUR correspondent's suggestion goes to the root of the matter, just as did Talleyrand's "Let the assassins begin," when he was asked to abolish capital punishment altogether. For offences against society either we have a right to punish or we have not. If we have not, then detention of the offender in safe and pleasant retirement is all that society for its own protection can fairly do in the case. To claim the right to punish and yet shrink from inflicting punishment is at once illogical and effeminate. And if society has grown so squeamish as this, we strongly object to its disagreeable duty being transferred to the shoulders of science. Especially do we object to its being put upon electrical science: first, because electrical science does not lay itself out for the business of capital punishment, and might not succeed at it; secondly, because we do not care to be associated with the vocation of Mr. Jack Ketch; and, lastly, we object from a business point of view to being identified with a transaction so extremely deadly in its operation as capital punishment is, or ought to be.

WE should be sorry to say anything calculated to add to the apprehension which already prevails on the question of a foreign invasion; but, on the other hand, when the question under discussion is one of practibility, as it was in the House of Lords last Friday evening, it is desirable that the actual facts should not be disguised. This Lord SALISBURY assuredly did in respect to the reliance to be placed on the Channel cables in the event of a sudden and secretly planned invasion from the coast of France. If the cables were simultaneously interrupted, says his lordship, we should be warned. Probably; but whether in time is a matter open to dispute. And when he goes on to assert that if they remained intact we should be informed as well as warned the statement is simply absurd. If the French contemplated an invasion we may be perfectly sure they would take timely possession of all the channels of telegraphic communication, and work them to suit the occasion. We did the thing ourselves in Egypt very successfully more than once, and this in a hostile country.

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Saigon.—French firms are reminded by the Mayor of Saïgon that tenders have been invited for the electric lighting of that town.

Iron Pipes Melted by Lightning.—During a severe thunderstorm at Lytham a house was struck by lightning, and several iron gas pipes were melted by the discharge.

Gravesend.—The Urban Sanitary Authority of Gravesend are prepared to receive proposals and tenders for lighting the town by electricity. Further particulars may be found in our advertisement columns.

Torgau.—A short time ago the water supply of the town was seriously interfered with owing to a flash of lightning striking a poplar tree near the reservoirs, and on investigation it was found that one of the mains was seriously damaged by the lightning.

Berlin.—A few nights since, owing to the breaking of a cable, all the arc lights supplied from the Friedrichstrasse central station at Berlin were suddenly extinguished. Immediately after the telephone central exchange received 300 calls for communication with the electric light company.

Lighting of Bentley Priory.—The new residence which has just been completed at Bentley Priory is fitted throughout with the electric light. Power is supplied by a Marshall engine and boiler driving an Elwell-Parker dynamo, which supplies current for charging twenty-seven D and G cells.

The Eastern Extension Company's Australian Cables.—The Eastern Extension Telegraph Company notifies the interruption of its two cables between Java and Australia. A repairing steamer leaves Singapore immediately to effect repairs, and it is expected that communication will be restored in about ten days time.

Newton Abbot.—The extensive mills of Messrs. Vicary, tanners, Newton Abbot, have recently been fitted with the electric light. The dynamo, a 100-light machine, is driven by the large engine used for the machinery. There are 82 lights in the mill, 20 of which are of 50 candle-power, and the remainder of 16 candle-power.

Edinburgh.—At the last meeting of the Edinburgh Town Council, in reply to Mr. Ritchie, the Convener of the Streets and Buildings Committee said that any concession the Town Council proposed to give the Anglo-American Brush Company was not in the nature of a monopoly, and would not prevent other electric light companies supplying light in the city.

The Anglo-French Cables.—The *Matin* of July 3rd stated that an agreement between England and France has just been signed for the direct working by the British and French Governments, in joint and mutual account, of the submarine cables uniting the two countries, the arrangement to come into force on January 1st, 1889. The *Matin* adds that the tariff is to be reduced to 20 centimes per word, and that a direct line is to be established between Havre and Liverpool.

The Lighting of the Lower Austria Jubilee Exhibition.—This exhibition, which was opened on the 14th June, covers an area of 87,000 square metres, and is lit by 250 arc lamps and from 2,500 to 3,000 glow lamps. The machine room takes up 2,500 square metres, and contains 15 boilers and 12 engines, giving a total of 1,200 horse-power. There is a considerable variety of plant, the engines and boilers being supplied by 15 different firms, and dynamos by Messrs. Siemens, Gülcher, and Kritzik.

Final Conference on Technical Instruction.—A final conference on technical instruction will be held at the Technical College, Leonard-street, City-road, E.C., on Wednesday, July 11th, at 8 p.m., when Sir Albert K. Rollit, M.P., will preside. This conference is the last of a series of conferences which have been held during the present session. At the former conferences technical education was discussed mainly in relation to the training of artisans in the different trades. At this conference, which will be an open one not restricted to any particular trade or group of trades, discussion will be invited upon the proposals for technical instruction now before Parliament.

London Platino-Brazilian Telegraph Company.—In virtue of an arrangement which is likely to prove very beneficial to the shareholders of this company the management of the concern has been taken over by the Western and Brazilian Telegraph Company. The shares of the former company have been exchanged for those of the latter, and, as a consequence, a formal resolution accepting the resignations of Sir John Pender, Captain Parry, and Mr. John Hollocombe, and appointing as directors Mr. W. S. Andrews, Lord Richard Howe Browne, Mr. C. W. Earle, Mr. D. H. Goodsal, Mr. H. Weaver, and Major Wood was agreed to on the 28th June. A report of the proceedings appeared in our issue of 29th June.

Nottingham.—At the last meeting of the Nottingham Town Council it was stated that letters had been received, addressed to the Urban Sanitary Authority and to the Vestry of Nottingham, from Messrs. W. T. Glover and Co., of Salford, informing those bodies that application was intended to be made on or before the 21st December next, by memorial to the Board of Trade, in pursuance of the Electric Lighting Act of 1882, for a provisional order, to be confirmed in Parliament in the ensuing Session, whereby it was proposed to authorise Messrs. W. T. Glover and Co., or a company to be formed for the purpose of supplying electricity for any purposes within the area of the jurisdiction of the Urban Sanitary Authority or of the Vestry of Nottingham.

Electric Launches at Henley.—The Henley-on-Thames Royal Regatta of 1888 should be historically memorable for the first appearance on this occasion of the electric launch. On Monday Messrs. Immisch and Co's. floating charging station was towed up from Kew, accompanied by the electric launch "Malden," and also the small electric skiff which is used as a tender for the station. From Chiswick to Teddington the towing was effected by the "Malden" herself, which was able to make a good five miles an hour, even with this heavy load. At Henley the charging station is moored nearly opposite the stewards' barge, and after dark an effective display of arc and incandescent lighting is made. We shall have more to say about the "Malden" in an early issue.

New Transformers.—A certain Herr Doubrava, who appears to do business in the neighbourhood of Brünn, Austria, has brought out a new direct-current transformer. There are two conductors, one of small capacity, A, and the other of larger capacity, B. A is first switched on to the mains and charged, and then discharged into B. B is then switched on to the house mains, and A is again recharged, this series of operations being kept going continuously by a small motor actuating the necessary switches, worked from the high potential mains. The same worthy gentleman also expects great efficiency from his alternating-current transformer, in which the high E.M.F. mains are connected to two plates which work inductively on two other plates connected to the house mains. If we mistake not this latter device has already received the protection of the Patent Office in this country, the first true and original inventor thereof hailing from the banks of the Clyde.

The Van Rysselberghe System.—We have already referred to the fact that the Van Rysselberghe system has not given entire satisfaction in Switzerland, and has, indeed, been abandoned on some of the principal lines. (See *The Electrician*, May 18, p. 33.) M. Van Rysselberghe now writes at considerable

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length in the *Journal Télégraphique*, asserting that he has been sacrificed to the interests of certain financiers. He continues as follows:—"The Lausanne-Geneva and Bâle-Zurich lines were constructed by Messrs. Mourlon and Co., good working being guaranteed, payment only to be made if the system worked to the complete satisfaction of the authorities. Payment has been made, and the goodness of the service has been testified to after several official trials." To this M. Rothen, assistant-director of the Swiss Telegraphs, answers:—"I am authorised to give a formal denial to these assertions. The reasons which led the Department to pay Messrs. Mourlon and Co. without demur, in spite of the usatisfactory working of the lines, are to be looked for simply in our desire to avoid litigation and other difficulties."

Dublin.—At the last meeting of the Dublin Town Council Mr. Healy gave notice that at the next meeting of the committee of the whole house on electric lighting he would move—"What progress had been made by the committee, the date when an order was given to apply for a licence, if that licence were obtained, and if not to explain the cause of delay, and as the committee had been sitting from time to time from the 2nd of May, 1887, if it would not be desirable to show more energy in the matter."—The Town Clerk said that a letter had been received from the Gas Company informing the Council of their intention to apply for a provisional order authorising them to supply electricity within the municipal boundaries of the City of Dublin. The Parliamentary agents, Messrs. Badham and Gore, had written suggesting that the representatives of the Corporation should attend in London last Tuesday to meet the representatives of the Gas Company in conference. Mr. Robinson moved "That the Lord Mayor, M.P.; Alderman Peter M'Donald, M.P.; and Messrs. Robert Sexton, Mayne, M.P., and Robinson, and the Town Clerk be requested to attend the conference." The resolution was adopted.

Barraclough and Co.'s Catalogue of Electric Wire Strand and Cable Machinery.—Of all the various trades and industries which have originated or have been largely extended by the great electrical developments of the last decade, it is safe to say that no industry has benefited more than the manufacture of insulated wires and cables. This prosperity has necessarily been shared to some extent by the makers of special machinery for stranding and covering insulated wire, and in order to keep pace with the times numerous improvements have from time to time been introduced in this class of machinery. Amongst those who have been actively engaged in this direction, the firm of Thomas Barraclough and Co. (of Manchester), whose latest catalogue lies before us, occupy a prominent place. The machines made by this firm are not, we believe, the cheapest in the market, but for excellence of design and careful workmanship, it is doubtful whether they are to be surpassed. The manufacture of insulated wires is a business in which the very best appliances are necessarily the cheapest in the long run. The catalogue before us describes machinery of well-nigh every description used in the trade, including the covering of single or stranded wires with cotton, silk, flax or jute yarns, braiding machines, horizontal taping machines, wire winding, stranding and cabling machines, sheathing machines, yarn tarring, and tanks for applying compound; also lead covering machines, hauling gear, &c., &c.

A Remarkable Lightning Discharge.—The following particulars of the effects of lightning are supplied to us by Mr. A. B. Tonkin, superintendent of the Direct Spanish Telegraph Company at Bilbao:—"During the afternoon of the 19th June lightning had been noticed several times, but the discharges were unimportant. At 5 o'clock the storm appeared to be gathering directly overhead; at the Ovienas Railway Station the Morse telegraph line and the telephone wires were put to earth. Immediately after this had been done there was a very vivid flash, which apparently entered by the Morse wire, exploded at the commutator with a loud noise, and, according to those present, taking the form of a sheet of flame, left the building by an open door. The discharge then crossed the siding for a distance of about 70 yards, and struck a young pine tree surrounded by a score of others. The pine was about 15ft. high, and apparently received the discharge at about seven feet from the ground, the trunk being completely severed, and, with the branches uninjured, the upper part of the tree was tossed a distance of several yards. The discharge then sought earth through the trunk, seven feet of which was broken in splinters, some of the latter over a foot long being thrown a distance of 60 yards, while others lay scattered about the foot of the tree. All that now remains of the tree is a piece of trunk, standing four feet out of the ground, split from top to bottom, the split being parallel with the railway station. The lightning on entering the ground opened a hole in the sand a foot deep all around the tree. A smaller pine standing a yard or two from the one destroyed is marked (bark stripped off) at four feet from ground, but otherwise uninjured."

The Proposed Central Station in Birmingham.—The *Birmingham Daily Post* of Monday last says:—"The preliminaries for bringing the electric light into general use in Birmingham are assuming more definite shape. The following official notice was served upon the Town Clerk on Saturday:—'To the Mayor, aldermen, and burgesses of the borough of Birmingham, acting by the Council, being the local authority for the borough of Birmingham within the meaning of Section 4 of the Electric Lighting Act, 1882, and to Edward Orford Smith, their town clerk.—On behalf of our clients, Messieurs Arthur Chamberlain and George Hookham, of New Bartholomew-street, Birmingham, electrical engineers, we beg leave to give you notice that it is the intention of the said Arthur Chamberlain and George Hookham, during this present year (1888) to apply to the Board of Trade for a provisional order authorising the said Arthur Chamberlain and George Hookham and their assigns to supply electricity for public and private purposes within the district of your authority. Dated this 30th day of June, 1888.—BARLOW, SMITH AND PINSENT.' Should the order be obtained, we understand that a month may elapse before the promoters will be required to specify the area for which the powers are required.

The Electric Lighting Act.—We have received a copy of the following letter, which has been addressed by Lord Thurlow to the "Executive Committee of the Electric Lighting Act Amendment Bill":—

"SIR: In thanking you for the valuable support and assistance you have extended to me as Chairman of the Electric Lighting Act Committee, without which support it would have been useless for me to have attempted to move in the matter, it affords me great pleasure to inform you that the Bill amending the Act of 1882, framed on the lines recommended by your Committee, and introduced by me into the House of Lords this year, has now passed both Houses of Parliament without material modification, and only awaits the Royal assent to become law.

"Under this Bill 42 years are substituted for 21 as the life of a provisional order, and 10 years for 7 for that of a license. More favourable conditions are also prescribed in the event of compulsory purchase by a local authority at the end of the term.

"I sincerely hope that this successful termination of our efforts during the last three years may render it possible to

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attract the necessary capital to enable the electric lighting industry to advance without further delay on its career of utility, beauty and economy.

"My own opinion is that, with the alterations in the Act now effected, and with good management, no reason exists why electric light undertakings should not now prove commercially and financially successful, and become a well-recognised investment for capital, at least as profitable as gas shares or other equally popular securities.

"With reference to our Committee, I should propose that it be not dissolved, but continued in existence, so that it may from time to time be called together for deliberation and consultation as occasion may require. On this point I shall be glad to have the benefit of your opinion.—Yours, &c.,

"THURLOW.

"Anglo-American Brush Electric Light Corporation (Limited), 112, Belvedere-road, Lambeth, S.E., 26th June."

Messrs. Robey and Co.'s Exhibits at the Royal Agricultural Show.—At this show Messrs. Robey and Co. exhibited one of their well-known compound Robey engines, which are largely used in electrical installations and for driving machinery where steady running is required, for which work they are specially well adapted. This engine is very powerful for the space occupied, it works with perfect regularity with very varying loads, and is extremely economical in fuel, consuming under 2lb. of best Welsh coal per indicated horse-power per hour. The working parts are perfectly balanced so as to run safely at high speed, and having large wearing surfaces, it runs cool with heavy loads. It is well lubricated for long runs. The boilers of these engines are made to work with 150lb steam pressure; they are wholly of Siemens-Martins steel, and are carefully made by the most perfect machinery. Every rivet-hole is drilled in position by special tools, the horizontal seams are butt-jointed, and plated inside and out with double riveted strips. The mountings are all suitable for the high pressure at which the engine is worked, and every part of both engine and boiler is fitted and finished in the best style. Messrs. Robey and Co. also show a horizontal fixed engine fitted with Richardson's and Rowland's trip-gear. When steam engines are of large size and work with steam of high pressure, the working of the slide valves becomes an appreciable part of the load upon the engine, and to obviate this various kinds of equilibrium valve gear have been introduced, the best known among them being the Corliss with rotating valves, and the Sulzer, with Cornish double beat valves, a variety of which is also known as the Proell gear. All these gears are manufactured by Robey and Co., and can be fitted to their engines when required; but their own experience has led them to produce a "trip expansion" gear which is simple, effective, easily worked, and gives most satisfactory results. The cost of an engine fitted with this gear is necessarily greater than those with slide-valve gear, but the extra outlay is compensated for by the lessened wear and tear and greater efficiency; this is the more noticeable in the larger sizes. The trip gear can be fitted to all sizes, from 10 horse-power upwards, but is specially recommended above 30 horse-power nominal. The same firm exhibits a horizontal engine, medium stroke, which is made self-contained on one massive cast-iron foundation, with which are cast the main bearings. The crank shaft is bent out of a solid bar of steel and is especially strong, so as to resist heavy strains without risk of bending. It can take the fly-wheel on either side, as by this means the strain and wear are more equally distributed. When required, the fly-wheel can be on one side and a driving pulley on the other. This class of engine is specially useful where space is limited, or where the foundations are not good, as being self-contained they do not get out of truth with any settlement of foundations. It can be also placed upon an upper floor, and merely requires bolting to the joists. The engine is governed by automatic expansion gear controlled by Richardson's patent automatic governor, so that economy in steam and regularity in running is maintained with very varying loads. The cylinders are fitted with a liner of specially hard metal surrounded by steam jacket, suitable adjustment and efficient lubrication supplied to all working parts, and the whole engine is of the highest workmanship and material. We have lastly to mention a vertical engine of new design, erected on a massive cast-iron standard, which also forms the bed-plate, carrying a bent crankshaft, and admitting of a fly-wheel or pulley on either side. The engine is fitted with Richardson's patent spring governor, which is most powerful and sensitive in its action, and which, acting direct through a slot link and die, automatically controls the steam admission to the amount required for the work being done. All wearing surfaces are large, and fitted up with the most perfect accuracy and fit by special machinery for the purpose. Every part is made to template, and only the best materials and workmanship are used throughout.

Earth Current and Magnetic Observations at Greenwich. The annual report of the Astronomer-Royal, which has been issued, contains the following:—"The earth-current wires, which were damaged by the snowstorm of December 26, 1886, were not completely repaired till August, 1887, when it was found that the earth-plate at Angerstein Wharf had been stolen, another earth-plate being then supplied. A renewal of the earth-current wires concurrently with the telegraph wires on this portion of the South-Eastern Railway was arranged, in concert with Mr. Leonard, but this has not been carried out, owing to a rise in the price of copper. Five measures of resistance of the earth-current wires have been made since the last report, but the results are not satisfactory, owing presumably to the bad condition of the wires. On the line from Angerstein Wharf to Ladywell, 7½ miles in length, the measures of resistance range from 220 to 285 ohms, and on the Blackheath to North Kent East Junction line, five miles long, the measures range from 230 to 262 ohms. Under these circumstances it seems hopeless to attempt to express the measures of ordinates on the earth-current sheets in terms of the electrical units until the conditions of the circuits have been improved. A further difficulty arises in discussing the small diurnal inequality on the earth-current registers in consequence of the circumstance (to which attention was first drawn by Mr. A. J. S. Adams, of the Post Office Telegraphs) that there is a slight dislocation in the Angerstein Wharf to Ladywell trace shortly after sunset with sudden return to the original position shortly before sunrise, representing an increased current from Ladywell to Angerstein Wharf, or a diminished potential at Angerstein Wharf during the night hours. Possibly this may be connected with the electric lighting in the vicinity of the earth plate. It appears to have commenced in 1883, becoming more pronounced in 1884. The following are the principal results for the magnetic elements for 1887:—

Approximate mean declination	17° 47 W.
Mean horizontal force	3·9419 (in British units) 1·8175 (in metric units)
Mean dip	67° 25′ 45″ (by 9in. needles) 67 26 20 (by 6in. needles) 67 27 13 (by 3in. needles)

In the year 1887 there were only three days of great magnetic disturbance, but there were also about twenty other days of lesser disturbance for which tracings of the photographic curves will be published, as well as tracings of the registers on four typical quiet days."

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UNIPOLAR INDUCTION.—V.

BY G. W. DE TUNZELMANN, B.SC.

(Continued from page 234.)

The subject of so-called unipolar induction has for some time past attracted the attention of a considerable number of physicists, and it will, I think, be of interest to consider their methods of treating it, and more particularly the theory advanced by Edlund for the explanation of the phenomena, as it has excited a good deal of interest, and his more important Papers have been translated and published in the *Philosophical Magazine*. The method, originally due to Faraday, of seeking for the explanation of electrical phenomena in the action of the media surrounding the conductors, in spite of the splendid manner in which it has been developed mathematically by Sir William Thomson and Clerk Maxwell, has as yet been adopted by very few of the Continental physicists, who, as a rule, still remain content with investigating electrical phenomena by mathematical methods which only take account of the actions in the conductors, and entirely ignore those in the surrounding media, a course which often places them at a considerable disadvantage. Thus, in the case we are now considering, the rotation of a cylindrical magnet about its axis, the field, as far as it can be expressed as a function simply of the distance from the axis, is unaltered by the rotation, and therefore a discussion as to whether the lines of force remain fixed, or rotate with the magnet is entirely without meaning, as long as we confine our attention to the distance actions between the magnet and the conducting circuit, and take no account of what takes place in the intervening medium.

In 1877 E. Riecke (Wiedemann's *Annalen*, Vol. I.) published an investigation of the phenomenon of unipolar induction, founded on the consideration of the E.M.F. produced by a magnetic pole in a conductor moving relatively to it, and, as he started with the assumption that the E.M.F. was a function only of the relative linear velocities and of the distance of the pole from an element of the circuit, he naturally arrived at the conclusion that the rotation of a magnet about its axis would produce no effect in any case, except that due to the translatory motion of its peripheral relatively to its central portions, and therefore at the same result as Faraday and Plücker, that a statical electrification would be produced on the surface of the magnet.

In the same year Edlund (Wiedemann's *Annalen*, Vol II.) published a paper on the relation between electro-magnetic rotation and unipolar induction. When a battery is included in the circuit of the wire *a c b* (Fig. 12 of Article III.), the current is sent through the jacket, and the latter is made to rotate. Edlund points out that it follows from the mechanical theory of heat that the heat produced by the current through the jacket will be less, by an amount equivalent to the work required to produce the rotation, than if the jacket were kept at rest, and that this would involve the production of a current by the rotation in a direction opposite to that of the current producing it, and it follows immediately that the strength of the current due to the rotation must be proportional to the product of the magnetic moment of the magnet into the angular velocity of rotation, divided by the resistance of the whole circuit, or the E.M.F. produced must be proportional to this product and independent of the resistance. In the same Paper he propounds his theory which is more fully developed in his "Researches on Unipolar Induction, Atmospheric Electricity, and the Aurora Borealis," published in the *Kongl. Svenska Vetenkaps-Akademiens Handlingar*, Vol. XVI., and translated in the *Philosophical Magazine*, fifth series, Vol. VI., 1878. In these Papers he points out that when a current is passed through the wire and jacket the magnet remains at rest, and the magnet can therefore be turned about its axis without any resistance due to action between the current and the magnet. It therefore follows that no current would be produced in the circuit by the rotation of the magnet, a result which we have already seen to be true, and which has been explained on the assumption that the magnetic field rotates with the magnet. He then proceeds to point out that when the magnet and cylinder are rigidly connected the magnet is carried round with the cylinder. He then infers that the action of the magnet on the rotating cylinder is the same when it revolves with it as when it remains at rest, so that a magnet can, he asserts, produce unipolar induction in a conductor with which it is fixedly united. Edlund here, like Faraday and Plücker, overlooks the fact that there is another possible explanation, namely, that when the magnet and cylinder rotate together the induction arises, not in the cylinder, but in the fixed portion of the circuit.

He then recalls the known fact that a metal ring surrounding a magnet and traversed by an electric current, will if movable, transport itself along the magnet. If the current in the ring is in the same direction as the molecular currents in the magnet, it will remain in stable equilibrium at the equatorial portion of the magnet, but if the current in the ring is in the contrary direction to the molecular currents, it will be in stable equilibrium at the centre of the magnet, and if displaced in either direction it will move towards the nearest pole and continue moving away from the centre until it passes beyond the poles of the magnet.

Now if the electric current be assumed to consist be the translatory motion of a fluid in the positive direction, or of two fluids in opposite directions, then, when the cylinder is made to rotate the fluid or fluids will rotate in the same direction, and form currents circulating horizontally round the magnet, and of intensities proportional to the velocity of the rotation. If there are two fluids these currents will differ from ordinary currents in that both fluids will move in the same direction, while in ordinary electric currents they move in opposite directions. If there is only one fluid there will be no distinction between the currents due to rotation and ordinary electric currents. Now, according to the usually received ideas, the action of the magnet upon the negative current would be the same as its action on a positive current in the opposite direction. The action of the poles of the magnet upon these currents will therefore, from the experiment with the rings previously described, cause the cylinder to receive an excess of positive fluid at the extremities and an excess of negative fluid at the centre, or, according to the author's view, an excess of ether at the extremeties and a deficiency at the centre, or *vice versa*, according to the direction of the rotation and the position of the poles. It will follow from this theory that a current will be produced in a wire having one extremity in contact with the part of the cylinder adjacent to a pole of the magnet, and the other in contact with the part adjacent to the centre.

Edlund then shows that the E.M.F. produced in the cylinder will on this theory be proportional to the product of the strength of the magnetic pole into the angular velocity of the cylinder as required by the mechanical theory of heat.

He then proceeds to apply his theory to the experiment illustrated in Fig. 11, Art. II., the plate being rotated, while the magnet remains fixed, and shows that it leads to the conclusion that there exists a certain circle on the disc *a*, concentric with the disc, which he calls the neuter circle, such that for a given direction of rotation the electric molecules situated outside it will be directed by the magnetic force towards the periphery of the disc, while those which lie inside it will be directed towards the centre, the radius of the circle depending on the length of the magnet, and the distance of the disc from the nearest pole. If the points of contact *c* and *d* are outside this circle the current will flow from the centre of the disc to the periphery, while if they are within the neuter circle the current will be in the opposite direction, and if the points *c* and *d* are on opposites sides of this circle they can be selected so that no current will be produced. These phenomena have been obtained experimentally by Felici (*Annales de Chimie et de Physique*, third series, Vol. XLIV.). They follow at once, quite independently of Edlund's theory, from the consideration of the lines of force of the magnet, for near the centre of the disc the largest number of lines of force from the nearest pole will pass through the disc in the direction away from the pole, while near the periphery of the disc, if it is large enough, more lines will pass in the opposite direction, these being the former lines coming round towards the more distant pole of the magnet. There

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must therefore be a circle concentric with the axis of the disc, such that an equal number of lines pass through the area enclosed by it in opposite directions, and this will be the neuter circle of Prof. Edlund, and will clearly account for the phenomena observed by Felici. Edlund applies his theory to several other of the experiments already described, and also describes two new ones which he considers, in addition to the existence of the neuter circle described, tend specially to confirm his theory.

The first of these was made with the apparatus shown in Fig. 18. *a b c d* is a rectangular framework, composed of two brass bars, *a b* and *c d*, joined at the ends by brass cylinders, *a c* and *b d*. These cylinders are movable, and can be fixed at any desired distance from the line joining the centres of the bars *a b* and *c d*, and either on opposite sides or on the same side of it.

The centre of the bar *c d* is in contact with the magnet, and to the centre of the bar *a b* a cylinder *o* is soldered surrounding the centre of the magnet. This cylinder is connected by means of a contact spring, *t*, with the galvanometer wire *l*. The other galvanometer wire *l'* is connected with a mercury cup attached to the magnet at *s*. Edlund then made a series of observations of the strength of the current in the galvanometer circuit when the apparatus was made to rotate, and he found that the current produced at a given speed of rotation was independent of the position of the brass cylinders *a c* and *b d*, and also remained uncharged when one of them was removed, as was required by his theory, bearing in mind that the resistance of the circuit would not be sensibly altered by removing or altering the position of either one of the cylinders, since the resistance of the brass work would be an infinitesimal fraction of the total resistance of the galvanometer circuit.

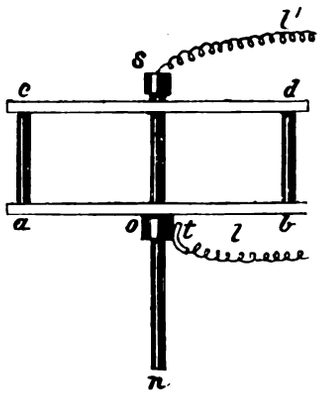


FIG. 18.

n s, cylindrical magnet; *c d*, brass bar in contact with magnet; *a b*, brass bar insulated from magnet; *o*, cylinder soldered to bar *a b* and surrounding equatorial portion of magnet; *l l'*, galvanometer wires connected with rubbing contact spring *t* and mercury cup at *s*; *a c* and *b d*, movable brass cylinders.

He does not state definitely in the Paper whether the magnet was rigidly attached to the brass rectangle, and revolved with it; but I should infer from his description that it was so. On his theory the rotation of the magnet would have no effect on the induction produced in the brass rectangle.

The results of these experiments follow at once from the theory which I have endeavoured to show must be the true one, that the lines of force revolve with the magnet, for the area of the circuit increases continually during the rotation, and the increase at each revolution of the number of lines of force passing through it is equal to the total number of lines proceeding from the magnet which cut both the moving and the fixed portions of the circuit. The same current will also be produced if the magnet remains fixed; but in this case the induction will take place in the brass rectangle, while in the former case it was due to induction in the fixed galvanometer circuit.

(To be continued.)

The Cruto Lamp.—A Cruto lamp factory has recently been started in Paris by the Société de Soudure Electrique des Métaux, and 200 lamps a day can at present be turned out.

THE GAULARD AND GIBBS PATENT ON SECONDARY GENERATORS.

The following is the full text of the amended specification of Messrs. Gaulard and Gibbs, which is the subject of the action which is now before the Court of Chancery. The words which stood in the original specification, but which have since been deleted by permission of the Controller of Patents, are printed in smaller type. Words which have been inserted or substituted in the same way are printed in italics:—

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Lucian Gaulard and John Dixon Gibbs in the Great Seal Patent Office on the 13th March 1883.

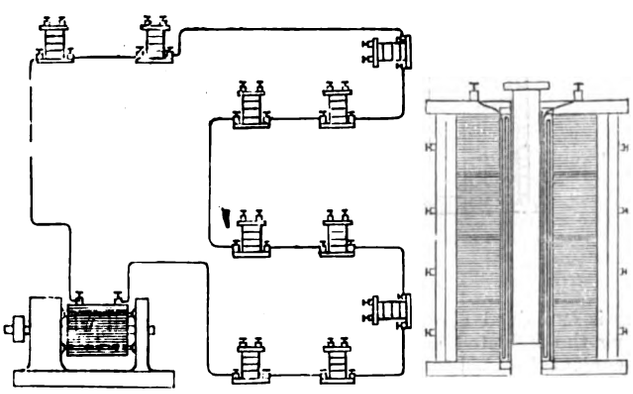
Lucian Gaulard of Montague Place Bedford Square and John Dixon Gibbs of Bury Street St James both in the County of Middlesex A new system of distributing electricity for the production of light and power"

This system consists of the employment of an alternating current produced by an electro dynamo machine and determining by its passage through an unlimited *a* number of electrical generators of special construction the formation of induced currents of which the quality and the value depend only on the construction of the secondary coils of the said electrical generators.

The currents generated under these conditions are utilised either by lamps to produce light or by magneto machines to produce motive power.

The principle which is the basis to this system of distribution is the following.

When an electric current approaches to or recedes from a closed circuit of solenoidical form it determines in this latter an induced current without the value of the primary current being in any way modified; experience shows that the alternation of a primary current gives rise to an induced current under the same conditions as the passage and interruption of the said current.



FIGS. 1 AND 2.

In further explanation we would compare the phenomenon just mentioned to that produced by the working of magneto-electric machines. In effect in these latter the induced current is produced, the value of the magnetic field remaining constant by the approaching of the bobbins to and their receding from the magnetic poles and experience shows that the value of the current produced is in exact proportion to the speed of passage or rotation.

In the machine of Pixii which was the first constructed the current was generated by the rapidity with which the poles were alternatively brought before the bobbin.

In utilising alternating currents the phenomenon produced in our induction machines may be compared to that produced by the machines of Pixii.

This explained it is easy to understand the working of our system.

We take an alternating current dynamo machine constructed in such a manner that the resistance of the inducted system ("induit") is greater than that of the external circuit uniting its two extremities, *but we do not use or desire to use alternating dynamo machines that produce currents other than currents of high tension as hereinafter firstly claimed.*

Let us suppose the length of this circuit equal to 50 kilometres we place (see Figure 1) upon it at every 500 metres for instance a secondary generator constructed in the following manner.

The secondary generator may be constructed as represented in Figure 2.

Upon a central exciting core of soft iron wire is rolled a copper wire of about 3 millimetres diameter and perfectly insulated in 3 rows of superposed spires. On the cylinder thus formed are placed bobbins on which a cable is wound composed of 6 copper wires of half a millimetre in diameter each strand being insulated by means of paraffined cotton. The ends of the cable of each bobbin are so placed as to allow of their being grouped for quantity or tension.

These bobbins constitute the secondary coil to the poles of which are fixed the apparatus of consumption. The first wire, on the other hand, through which the initial current circulates constitutes the primary coil.

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A more powerful generator may be formed by means of several columns of bobbins arranged in that case vertically in parallel rows.

The secondary coils of these columns are connected with one another by a central commutator.

Or preferably the following construction is adopted.

A cable (see Fig. 3) is composed of a central copper wire of 4 millimetres diameter perfectly insulated around which are placed parallel to its axis and completely surrounding it 6 cables each composed of 12 copper wires of half a millimetre diameter individually insulated with paraffined cotton or other insulating material.

This cable is rolled on a hollow cylinder made of wood, for example 50 centimetres long and 6 centimetres in diameter and each layer of spirals is separated from the other by 2 cylindrical segments of iron 2 millimetres thick and without contact in order to avoid the creation of heating Foucault currents.

The extremities of the six fine wire cables are united to a commutator which allows of their being grouped either in tension or quantity.

The object of this disposition is to utilise the radiating inductive action of the inductor formed by the wire of 4 millimetres placed in the centre of the cable and to prevent the reaction of the spirals composing the inductor on one another.

The columns formed as above described may be placed vertically on a platform in the number proportionate to the power it is desired to give to the machine thus constructed and the extremities of their inductors are connected with a commutator so as to allow the passage of the primary current through one or more of the columns.

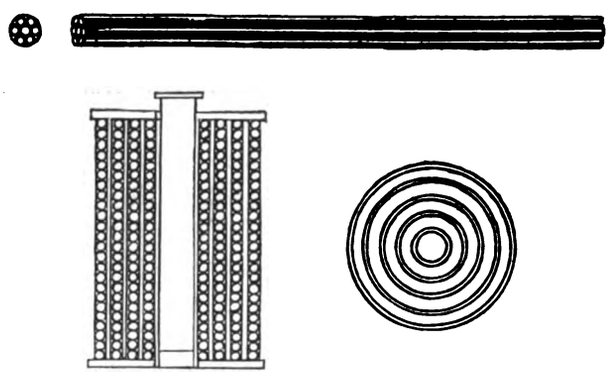

FIG. 3.

As is explained above the extremities of the small wires composing the inducted system ("induit") and on which is gathered the current destined to be employed are grouped in tension or in quantity so as to vary the tension according to the requirements of the consumer. Lastly, in the centre of the columns, exciting cores enable the graduation of the potential of the current generated on the induced system ("induit").

Now the primary current in passing through this primary coil is subject to no other modification than that caused by the resistance of this said primary coil hence the currents generated by the hundred secondary generators placed upon the circuit will have changed the value of the primary current only in proportion to the sum of the resistances of their primary coils which resistance will be compensated in the construction of the inducted system ("induit") of the primary generator.

Under these conditions it is easy to understand that the number of secondary generators may be indefinitely multiplied upon the circuit, and that according to the theory explained above the value of the currents generated (the initial alternating current remaining constant) will depend only on the construction of the secondary coils of the secondary generators.

From which it results that secondary generators of similar construction will give absolutely identical currents capable of being advantageously employed in telegraphic systems and thus the problem of the suppression of batteries for telegraphy is solved.

To sum up We claim in accordance with the law.

First. The privilege of exclusively working our process of distribution characterised by the following points as above explained. The employment of an alternating current of high tension for the generation on an unlimited a number of secondary generators of induced currents individually utilised either for the production of light or motive power.

Second the system of electric distribution such as is laid down in the foregoing statement.

Third. The special construction as described of secondary generators designed to produce this result

In witness whereof we the said Lucian Gaulard and John Dixon Gibbs have hereunto set our hands and seals this twelfth day of March in the year of our Lord One thousand eight hundred and eighty-three.

L. GAULARD (L.S.)

J. DIXON GIBBS (L.S.)

EDISON AND SWAN ELECTRIC LIGHT COMPANY v. HOLLAND AND OTHERS.

It will be remembered that at the last hearing on the 31st of May, an adjournment was agreed to in order that certain experiments might be carried out. Prof. Stokes, P.R.S., was afterwards requested to witness these experiments, and to make an independent report to the learned judge. The report has not been read in court, but the full text will be found at the end of the present report.

This case was resumed before Mr. Justice Kay, at the Royal Courts of Justice, Chancery Division, on Monday last.

The plaintiffs' counsel were as follows:—The Attorney-General (Sir R. Webster), Mr. Aston, Q.C., Mr. Moulton, Q.C., and Mr. Bremner; and the defendants', Sir Horace Davey, Mr. Finlay, Q.C., and Mr. Graham.

Before Mr. Finlay commnced his speech for the defendants,

Mr. JUSTICE KAY said that he had received two letters from Prof. Stokes, who had been appointed to report on the experiments made in the presence of both parties, in which he set out a memorandum from the defendants' counsel that no experiments should be made by witnesses connected with the case. His lordship asked Mr. Finlay if the defendants still insisted upon that objection. He was surprised, and he should not have listened to such an objection for a moment.

Mr. FINLAY replied that he did not insist upon the objection.

Mr. JUSTICE KAY went on to say that Prof. Stokes was prepared to put himself in the witness-box to give any explanation that was desired, but he did not think that it was necessary to call the Professor. He might remind learned counsel that this case had been on for twenty days, and it had been well argued out in the witness-box, and therefore it was unnecessary to go into elaborate arguments, and he hoped they would keep their speeches within reasonable limits.

Mr. FINLAY then commenced his speech for the defendants. He proposed to make observations, first upon the Edison patent, and secondly on the Cheesborough patent. First, with regard to the Edison patent, attention was directed to the fact that a judgment had been given in the Court of Appeal upon this patent; but before calling attention to the form of that judgment, he might say that the evidence now had put the facts of the case in a very different light from that in which they stood at the time that judgment was pronounced. In the first place the Court of Appeal decided the former case under the belief that this patent of Mr. Edison's had been the cause of a great outburst of incandescent lighting, and that there was some advantage in the high-resistance lamp *per se*, taking it as an individual lamp and not merely for the purposes of an arc light. Consequently the Court of Appeal believed on the case as presented to them, that the lamp F J B 1 was the only lamp of any importance which Mr. Swan had prepared; that F J B 1 was a mere experiment, and an abandoned and an unsuccessful experiment; and the Court were not in possession of the facts as to what Mr. Swan had done with reference to incandescent lighting. The Court of Appeal, as well as Mr. Justice Butt, who was the judge in the first instance, were led to believe that the lamp F J B 1 (Mr. Swan's lamp) was formed after carbonisation, that the carbon had been rubbed down into the shape which it presented in the lamp. From the judgment of the Court of Appeal it appeared that the sufficiency and utility of the process described in the Edison patent were practically admitted by the Woodhouse and Rawson case on all these points, but he submitted that the present case stood in a different position from the Woodhouse and Rawson case. In the first place, with regard to the impression which the Court entertained there that this patent had been the cause of a great outburst of incandescent lighting, and that there was some advantage in high resistance for the purpose of a lamp taken by itself, he very shortly desired to call their lordships' attention to the facts as they now presented themselves. It was now undisputed that no Edison lamp was ever seen until long after the date of the patent now in question. It had been proved by witness after witness that the first Edison lamp that they saw in Europe was in September, 1881, at the Paris Exhibition, and the first time that they saw an Edison lamp in this country was at the Crystal Palace Exhibition in the autumn of 1882. Sir F. Bramwell, who was the first witness called for the plaintiffs, said that the only lamp which in the present instance was cited as a specimen made under this patent was made of parchmentised thread; and he very frankly said that the thread had been subjected to the process known as parchmentisation. At every stage of the course of manufacture secret processes were used by the plaintiffs. That was confirmed by Dr. Fleming and Dr. Hopkinson. So far from it being the case that this patent was the cause of the outburst of incandescent lighting, there was no evidence whatever that a single lamp made according to this specification had ever been sold; and it was now undisputed that no thread lamps unparchmentised had ever been manufactured by the plaintiffs, except for the purpose of litigation. No tar putty lamps had been sold, and the six Edison lamps which were referred to by Dr. Fleming as having been given to him by Mr. Johnson in 1880, contained horse-shoe paper filaments, and these were made by a subsequent patent to that which his lordship's attention was directed. The two lamps given to Dr. Hopkinson, also by Mr. Johnson, in March, 1880, were made in the same way. He thought there was no evidence of anything further being done with the Edison lamps after these six lamps given by Mr. Johnson to Dr. Fleming early in 1880, and the two

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given in March, 1880, to Dr. Hopkinson, until the Paris Exhibition in September, 1880. If the plaintiffs' view, which prevailed in the Court of Appeal in the former case, were correct, that Edison's specification in this patent solved this difficulty, which had hitherto impeded the march of electric lighting, it was a most extraordinary fact that in the course of this case, which had lasted over he was ashamed to say how many months, and in which no expense had been spared, the plaintiffs had given no evidence whatever of lamps made either here or in America just after this so-called solution of the problem; and the Edison Electric Light Company was registered in March, 1882. One exhibit was produced in the course of the case by Dr. Franklin, marked E F 1. It was given to him by Mr. Edison's agent in 1882, and Prof. Thompson told his lordship that the Edison lamps at the Paris Exhibition were like E F 1. That lamp, E F 1, differed from Edison's specification in ten different respects, to which Prof. Thompson called attention. Prof. Thompson called attention to subsequent patents that Mr. Edison himself had utilised in the manufacture of those lamps. That circumstance by itself, coupled with the absence of all evidence of manufacture of lamps under this specification, would be sufficient to dispose of the claims of the former case, that this patent was a cause of the outburst of incandescent lighting, and must, therefore, have been of some great benefit. But they had further evidence in the present case. There was no better judge than Mr. Swan if the difficulty had been solved, for Mr. Swan had been studying the subject for some considerable time. Mr. Swan said that the specification of this patent made very little impression upon him, and the only novelties to him when he read it were with regard to matters of detail; and then he specified what those matters of detail were, namely, the tar putty, the method of mounting, the use of very thin platinum wires, the use of camphor and oxide of zinc, and the use of the word "filament." Mr. Swan said that he did not suggest in November, 1879, that there was any novelty in an incandescent lamp consisting of a glass bulb, exhausted, with a carbon conductor and leading-in wire, and he said there was no novelty in making the carbon of any particular size. He (the learned counsel) submitted that this circumstance in the evidence of the present case effectually disposed of the claim which was set up in the previous case, in which the Court of Appeal gave judgment to the effect that this patent marked an epoch in the history of electric lighting. The true history of electric lighting was before his lordship, as it was not before their lordships in the previous case. That claim was entirely unfounded when all the evidence was examined.

In the second place, the Court of Appeal decided that case under the impression that F J B 1 was the only lamp of Mr. Swan, that there was a failure, and that Mr. Swan abandoned it as an unsuccessful experiment. He wished to call attention to the salient features of the present case, which would put a new light upon it altogether. His lordship had the evidence of Mr. Proctor, Mr. Heaviside, Mr. Mayfield, Mr. Patterson, Mr. Mess, Mr. Blackburn, and Mr. Swan, and his coadjutor, Mr. Stearn, which showed very plainly the continuous work done by Mr. Swan in co-operation with Mr. Stearn; and the admission made by these two last named gentlemen showed that the assumption to which he had referred had proved to be entirely erroneous. Mr. Swan admitted that towards the end of 1879 he made his hairpin-shaped Carré carbon lamps, and he said that he had ordered those lamps from Messrs. Carré in the spring of 1879. J W S 1 was produced as an exact model of this carbon, and the diameter was $\frac{1}{32}$th of an inch. Some difficulty was experienced in mounting these Carré carbons, but the fact that these carbons were used in the summer of 1879, at a date considerably anterior to November, 1879, when the provisional specification was taken for Edison's patent, was put beyond doubt by Mr. Swan's own admissions. Mr. Swan said that he made a parchmentised-thread lamp in the middle of 1880, and he made a considerable number of them in the autumn of 1880. Mr. Thompson said that Mr. Stearn's house was lighted with those lamps in the autumn of 1880. It was not suggested now that Mr. Swan and Mr. Stearn in what they were doing at the date of this patent owed anything to the patent of 1879. In 1880 they made lamps of parchmentised thread; but until he heard the reply on the part of the plaintiffs he would not believe that they were indebted to Mr. Edison for the patent now in question. The date of the various exhibitions of lamps was proved by several witnesses. The exhibition of Swan lamps at the Institute of Civil Engineers took place on the 30th November, 1880. Mr. Spottiswoode's house was lit up with Swan's lamps in December, 1880. Prof. Perry tested a number of Swan lamps in May, 1881. Swan lamps were exhibited at King's College in July, 1881, and at the British Association in August, 1881. They were exhibited further at the Paris Exhibition next month, in Sept., 1881, and that Exhibition in Paris was the first occasion on which the Edison lamps were seen, according to his clients' witnesses, apart from the specimen which was given by Mr. Johnson at the date that he had already mentioned. In 1881 there were 1,000 Swan lamps running at the Savoy Theatre, and the first Edison lamps seen in this country was at the Crystal Palace Exhibition in 1882. E F 1 was presented by Mr. Edison's agent to Dr. Frankland, who spoke, along with other witnesses, to the fact that that E F 1 exhibited was not made according to the patent now under consideration; and that was put beyond doubt by the evidence of Prof. Thompson. With regard to the Swan lamps which were exhibited in Paris in September, 1881, Prof. Thompson pointed out that they were like F J B 1. In material respects they differed in having smaller carbons and in the leading wires coming out at the same end of the globe. To the straight conductor as used (F J B 1) Prof. Thompson explained there was no objection at all, and that was shown by the fact that the plaintiffs themselves made such lamps. The learned counsel then called attention to two patents that Mr. Swan took out in 1880. On the 2nd January, 1880, he took out the patent, No. 18, for running on the pumps, as it had been called, on the importance of which he need not say a word. On the 20th January, 1880, he took out a patent for two purposes: No. 250 for preventing cracking and leakage of the gas bulbs by heating of the leading wires, and for parchmentising paper. On the 27th November, 1880, he took out a patent for parchmentising thread (4,932), and on the 2nd December, 1880, he took out another patent (5,014), which differed from the patent of the 27th February, 1880, in containing directions for packing the thread to be carbonised with charcoal powder. He submitted that, taking the evidence in this case, to the salient points in which in this connection he had endeavoured to direct his lordship's attention, it was now plain that, so far from Edison's patent marking an epoch in the history of incandescent lighting, it was merely one stage in the process—by no means an important one—which contained nothing new in principle, and which did not reveal any process which had been used for practical purposes. Mr. Swan and Mr. Stearn were working at the subject, and they were working with results which led to the formation of Mr. Swan's company, and to the subsequent amalgamation with Mr. Edison.

In the third place, Mr. Justice Butt and the Court of Appeal in the last case were led to the conclusion that the lamp F J B 1, which Mr. Swan produced, had been formed by rubbing or cutting the carbon after it had taken the form of carbon in the shape it assumed in the lamp. In the opening speech of the Attorney-General before Mr. Justice Butt this impression was conveyed. The Attorney-General said:—"I ask your lordship to let me pause for a moment to say that the main discovery of Mr. Edison in this connection was the utilisation of filament or thread of carbon, meaning thereby a substance which is made into a filament or thread, or may be made into a filament or thread before it is carbonised. I shall show that attempts to light by cutting down blocks of carbon, by sweating them down from a thick piece to a thin piece, had been thought of and had failed, and even now failed with all the knowledge that we have at the present time. But the point, the touchstone of the invention which he discovered, which has made the thing from being a mere laboratory experiment into practically useful article, was the use of a filament or thread; that is to say, something which is made of thread or made of filament before it is carbonised." Sir Richard Webster further said this, "In addition to that, there is the most important thing which I ought perhaps to have put first, the capability of shaping your bridge before you carbonise—that is to say, you can twist into the spiral shape or any other shape, as Mr. Edison says, and that you can do before it is carbonised. In other words, it will turn out that the idea of making a lamp first, or making the shape of the conductor and then carbonising, was the root of the discovery which led to the success of Mr. Edison's lamp." In support of that, evidence was given on the former trial by Sir Frederick Bramwell and Dr. Hopkinson, and Mr. Swan was in court whilst that case was going on, and Mr. Swan knew the facts; and because it was suggested that he had been subpœnaed by the other side he felt himself cut off from his friend, and allowed the Court to decide the case with the idea that the lamp F J B 1 had been so formed. The facts were now before his lordship, and it was unnecessary that he should comment upon them.

In the fourth place, the Court of Appeal had decided in the former case that the sufficiency and utility of the processes decided in this patent of Mr. Edison's were practically not disputed. Now, he desired to say a few words on the construction of this patent by Mr. Edison, and he would then, so far as his lordship thought it desirable, call attention to the judgment of the Court of Appeal in the former case. The first claim was for

> "An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance made as described and secured to metallic wires as set forth."

The true construction of that was that the lamp was there used to denote the light-giving portion of the lamp. The word lamp, he submitted, was not used as a general term to describe the whole apparatus, including the bulb, but used to denote what gave the light in the lamp, and this was strongly corroborated by the light thrown upon the use of that word lamp in the provisional specification, where his lordship would see that the word lamp was clearly used to exclude the bulb. The second claim was the

> "Combination of a carbon filament within a receiver made entirely of glass, through which leading wires pass, and from which receiver the air is exhausted for the purpose set forth."

He submitted that according to the ordinary rules of construction that must be read in this way as meaning the combination of a carbon filament, made as described, with a receiver made entirely of glass, through which the leading wires passed, and so forth; that it would be enlarging the scope of the claim unduly to consider it as doing anything more than this—to say, "I have described in my first claim that I claim the manufacture of the light-giving portion of the apparatus, which I there call lamp, in a particular way. In my second claim I refer to the fact that I combine that light-giving portion of the lamp with a receiver made entirely of glass, through which the leading wires pass, and from which receiver the air is exhausted for the purpose set forth, and that combination I claim." He submitted that that second claim should not be read as a claim for a carbon filament, except such a carbon filament as was referred to in the first claim "made as described." There were two other claims which he need not particularly describe, but he proposed to call attention to the judgment of the Court of Appeal as to how far that judgment was binding upon his lordship in the present case.

The learned counsel, having cited the judgment, went on to say it was known that there were advantages in previous patents, that high resistance could be got by diminishing the sectional area as well as by increasing the length of the conductor. The previous patents had been taken, and the wires had been used for conductors for small sectional area, for this very purpose. Could it be said that if an inventor came forward and said, "Oh, I diminish the sectional area of the carbon conductor,"

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that that principle was a good matter for a patent? He submitted that there was no novelty or subject matter of a patent in such a claim.

Mr. JUSTICE KAY: You say that Edison was the first person who had made a commercial success of the lamp?

Mr. FINLAY: Yes; and Dr. Hopkinson puts it "that Mr. Edison's merit was in using a smaller cross section, and in the way in which he shows you how to make it." With regard to the point, of which so much was made in the previous case, the forming filament paper carbon, he need only remind his lordship that all the Carré conductors were first formed and then carbonised. That was one of the admissions of the case, and Mr. Swan knew that perfectly well. What were the limits of Mr. Edison's patent? Was it a patent for carbon conductors of high resistance? He submitted that when a man took out a patent he ought to set up boundary marks to enable the public to know when they were trespassing, and which was forbidden ground. There were really no limits here. Mr. Edison did not say I claim the carbon conductors of less than a certain sectional area, but the claim now put forward was a vague claim to all carbon conductors of high resistance. The absence of any definition as to when you became a trespasser was sufficient to vitiate such a claim. With regard to the use of the lamps manufactured by Mr. Swan, he said that he did not make a thread lamp before the middle of 1880, and that they were always parchmentised. He also said that during 1879 he was not making any horseshoe carbon lamps. Mr. Swan must be mistaken in that, and he said that for dates he depended entirely upon the correspondence. Mr. Stearn said that he made no thread lamps before January, 1880.

Mr. JUSTICE KAY: Were these experiments between Swan and Stearn?

Mr. FINLAY: Mere experiment I should not rely upon. But there was no secrecy in the matter; publicity was given to it by being shown to various persons.

Mr. JUSTICE KAY: Do you mean to say that Mr. Swan could not have taken patents out afterwards.

Mr. FINLAY: That, of course, my lord, is the test. It is very important from another point of view—the continuity of Mr. Swan's work.

Mr. JUSTICE KAY: All these gentlemen were running a race.

Mr. FINLAY: I will not go through Mr. Stearn's evidence, but I shall just refer to the names of the witnesses who were called as to the lamps of Mr. Swan and Mr. Stearn—Mr. Proctor, Mr. Heaviside, Mr. Patterson, Mr. Mayfield, Mr. Ridley, Mr. Meas, Mr. Blackburn, Mr. Turner, and Mr. Allen.

Mr. JUSTICE KAY: They were assisting; that would not be enough.

Mr. FINLAY: I agree with that. I will call your lordship's attention to Sir Frederick Bramwell in answer to Mr. Lane-Fox.

Mr. JUSTICE KAY: Sir Frederick Bramwell says Mr. Lane-Fox knew a great deal more about it than Mr. Edison had any idea of.

Mr. FINLAY: Yes; and he also says this: "That the only point which he suggests between the provisional specification of Mr. Lane-Fox and Mr. Edison's patent is that which he calls his luminous bridge, proposed to make of a compound material, namely, carbon of some non-conducting material finely ground and mixed together; but there is no suggestion of carbonising after the material is so mixed and the bridge is formed to shape. There is as regards mixture and mode of material an important distinction. He submitted that this specification of the previous patent, really apart altogether from the lamps of Swan and Stearn, prevented there being any novelty in respect of which the claim had been made.

The learned counsel then passed to another head of the case, namely, the insufficiency of the description of the processes. That might be put either as insufficiency or non-utility. They were not charged with the infringement of a process. But he submitted that even if the second claim be read, if the processes given or any of them were insufficient, that the patent was bad. This case had been going on from July, 1886, and they had deliberately abstained from giving the Court the advantage of Mr. Edison's evidence. If Mr. Edison, in a case of such importance, could not find the time necessary to protect the interests of his own company, why had they not taken his evidence in America? He submitted there was one explanation, namely, that Mr. Edison found the process as indicated in the patent of November, 1879, in practice, really useless, and the first time that he got hold of the process to work in practice was when he embodied it in the patent of March, 1880, where it was described as in the horseshoe form. Why Mr. Edison was not called he left it to his lordship to decide.

Now, the first observation he made was one which did not require dwelling upon, and that was the undoubted fact that no lamps had been made under the patent of 1879 except for the purpose of litigation. And, secondly, that no man who would answer the description of the skilled working man had produced lamps under this process; they had been made by experts, who were in a different position for dealing with processes of this kind from the skilled working man, who was calculated to be sufficiently instructed by this specification to enable him to conduct the manufacture. And, further, in all the lamps which had been made, those who made them had the advantage of the subsequent experiments and patents which had been going on ever since November, 1879. Taking all that together, and looking to the evidence and report of Prof. Stokes, he submitted that it was sufficiently established that a workman, however intelligent and however familiar with the subject (according to the standard of knowledge in November, 1879), with the manufacture of lamps, could not have conducted the manufacture according to the process described by Mr. Edison in this patent. The learned counsel said he did not know whether he should read the report of Prof. Stokes.

Mr. JUSTICE KAY: I have read it twice.

Mr. FINLAY: Then I need not do so. Prof. Stokes deals with the manufacture of the tar putty filament, and the professor explained the difficulty of gentlemen of eminence on one side who found no difficulty in making tar putty filaments, whilst others found it impossible. The mixture of lampblack and coal tar in order to yield these results must be worked for an hour and a-half. What is the description in the patent?

"I have also discovered that carbon filaments may be used by a combination of tar and lampblack; the latter being previously laid in an enclosed crucible, and afterwards moistened until it assumes the consistency of butter."

The manipulation of an hour and a-half has the effect of making the substance into a thick putty—it becomes more like gutta percha, and is of such a consistency as would never be reached by any workman who set to work under the light of this patent. Our witnesses did their best, and these gentlemen knew how they succeeded, and they never told us, and we had not the slightest idea how they could succeed in making this. They must have had directions on this subject, and although we had not the advantage of Mr. Edison's instructions a great deal of experimenting has gone on to show how to manipulate this tar putty to yield that result.

The second point to which I desire to draw attention is to the subject of carbonisation as dealt with in Prof. Stokes's report. Prof. Stokes's report seems to show this—that with regard to the filaments made out of tar putty so manipulated, they may be carbonised in an iron box without any patent, and that they are not consumable. Some care seems to have been taken in the regulation of the temperature. There was a bit of silver introduced, and the melting of the silver wire was observable. With these precautions the use of the iron box is one of the features of the patents in March, 1880, and which certainly would not have been conveyed to the mind of any workman in this patent. With these precautions, and with a great deal of heating, it does appear that filaments made out of the tar putty may be carbonised without combustion taking place. That was a mere laboratory experiment. These were not the conditions of commercial manufacture of those filaments, and the experiments by the experts of the plaintiffs in the presence of Prof. Stokes are sufficient to justify the observation which we suggested to your lordship in the course of the case, that anything that could be done in this way was a curious experiment for the laboratory rather than a matter of practice. With regard to the filaments made out of substances other than the tar putty, it appeared from Prof. Stokes's report that packing is wanting, and he says that at Ponder's End they succeeded in carbonising without combustion with charcoal. "We were also shown the carbonisation of various fine vegetable fibres, Mexican fibre, bamboo, and others, which was done in the rectangular box packed, in one experiment, with charcoal, in another with sand, in another with kaolin. Some of the more springy fibres were kept in the horseshoe shape by elongated loops of thin copper wire, into which the ends were inserted. On opening the box after it had been fired in the furnace, and had got sufficiently cool, the fibres in each case were found to be carbonised, and not reduced to ash." However, I presume that the time is the same, and that will be half an hour. The use of charcoal packing is a matter which we say is necessary, and with regard to which Mr. Swinburne described his early experiments.

Mr. JUSTICE KAY: None of these processes could be carried on for 11 or 14 hours as it is now.

Mr. FINLAY: Exactly. What is claimed for this patent is commercial utility, and those experiments do not specify the conditions in which it is admitted that the manufacture is carried on. They themselves carried it on for 15 hours, I think.

The third point to which I call attention in Prof. Stokes's report is with regard to the coating of non-combustible material upon the filament. "We were also shown the coating of tar putty filaments with other material. The first shown was asbestos powder, used as purchased. The glass plate being covered with white blotting paper, a small quantity of the powder was put on quite thin, and the filament being laid on the paper was rolled backwards and forwards through a small space only with the upper glass tool. The finished filament was somewhat higher in colour, and on being viewed through a pocket lens was seen to be studded with particles of asbestos, between which the dark surface of the tar-putty showed itself. The other substances used were silica (in the form of kieselguhn) and kaolin. As the treatment did not differ from that used in the case of asbestos, it was not thought necessary that I should actually see it."

His lordship had seen what the results of the experiments made at Mr. Crookes's laboratory were, in the presence of Prof. Stokes. In the first place my friends may rely upon the fact that the ordinary earthenware crucible on testing with water was found to be to a certain extent porous. It was not disputed that this was the ordinary earthenware crucible. If my friend says it was necessary to point out iron he should have specified that it was something different from the ordinary crucible. It could not be expected that we were to go outside of the ordinary earthenware crucible for the purpose of obtaining the carbonisation of those filaments. The only workman who has at all spoken was produced by the plaintiff, namely, Mr. Edward Gimingham. I do not wish to go through Mr. Gimingham's history in detail, but Mr. Gimingham has received a training very far superior to that of an ordinary working man; and he cannot be considered as a specimen of the workmen of to-day, and certainly not of the workmen in 1879. He has had a very scientific experience, and the past training of Mr. Gimingham has really made him an expert of a somewhat high type; and even with that Mr. Gimingham's results do not show that these were good and workable processes. With regard to the question of carbonising generally, of course the carbonisation of filaments was absolutely unknown.

Mr. JUSTICE KAY: The carbonisation in packing.

Mr. FINLAY: I need not discuss the reference made to the question of charcoal burning and the manufacture of charcoal for the purpose of gunpowder.

Mr. JUSTICE KAY: There is no commercial proceeding in which this kind of thing was done.

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Mr. FINLAY: And the workmen from their own knowledge of charcoal for any purpose before would really have been misled, because in some books, as cited by some of the plaintiffs themselves, the making of charcoal is described as a process of partial combustion. Mr. Swinburne gives an account of his early experiments at the Swan Works, at Newcastle, and if that stood alone it would be sufficient to say that the ordinary skilled workman of 1879 could not have made lamps according to the plaintiffs' processes.

The learned counsel then called attention to the numerous subsequent patents taken out by Mr. Edison himself for various processes, and Mr. Swan's subsequent patents. With reference to Mr. Swan's second patent of December, 1880, this very process of packing is described and made a point of, and when Dr. Tidy was cross-examined by his friend Mr. Aston the point of his cross-examination was that every working man would have known that packing was necessary. Now, the point made is that packing is not necessary. I do not propose to refer to the laboratory experiments made by Mr. Imray, and with reference to Mr. Gimingham's evidence I would point out that he admits that sand has never been used commercially; and I suggest the effect of the evidence is that it is only a special kind of sand of particular purity that will answer the purpose of packing at all; that for filaments under commercial circumstances it is shown that packing is absolutely necessary, and that the only packing is charcoal; and that if sand is used at all it must be under laboratory conditions and with sand of special purity. Of course it would have been necessary, except for Prof. Stokes's report, to have gone into it at much greater length as to the insufficiency of the processes; but having regard to the fact that the evidence is in your lordship's recollection, and that Prof. Stokes has made his report, I think I may conclude what I have to say with regard to the Edison part of the case.

Now I propose to say a few words with regard to the Cheesborough part of the case. The claim made by the Cheesborough patent is in respect of the process known as "flashing." In the first place I submit that there is no novelty about it, and if there be any novelty, that we have not infringed it. And there is another point which rises out of the Cheesborough patent, and it is this, that the non-conducting and non-carbonising materials vitiate this patent and vitiate a part of the process of the Edison patent. First, the claim of the Cheesborough is for the production of carbons by deposit of carbon from hydro carbon in which the conductor is being heated by the electric current, the effect being decomposition and the deposit of carbon in a particular form upon the conductor. I submit that that is a mere application to a particular purpose of the process which was described long before by Deprez and published in this country. What I am going to submit is this that if there is patentable matter at all it is merely in the use of Deprez's process for the purposes mentioned here, and all that we have done is to use Deprez's process for another purpose, therefore there is no infringement. The effect of the evidence is this, that so far as the structure of carbons goes, they are not really improved, except very occasionally; by this process, they are rather on the whole deteriorated. The point is really before your lordship, and I submit that here there is no infringement of Cheesborough's patent.

Then, further, I submit the objection with regard to the non-conducting and non-carbonising material is fatal to this patent. On these grounds I submit that the Cheesborough patent is not good.

The ATTORNEY-GENERAL (Sir R. Webster) then replied upon the whole case. He said: I propose to address your lordship upon my learned friend's objections to the Edison patent, and in the first place in regard to his main attack that Mr. Edison's specification is only a reduction of the size of the cross-section of the carbon conductor. I humbly submit to your lordship that that is absolutely concluded by the Court of Appeal. Exactly the same point was taken in the Court of Appeal in the last case. I had opened that case by stating that a bulb of glass, leading platinum wires, and a carbon conductor were old, that they were all put together in Swan's lamp exhibited in Newcastle, in December, 1878, and that so far from that having led to the discovery of Edison's patent, no single practical step was taken until after Edison had published his invention. Your lordship is in a remarkable position of advantage in this case. It is said that Mr. Swan had worked it all out for himself. It is most remarkable that, the claim having been published in December, 1878, during the whole of 1879 Mr. Swan was going wrong He says it himself. Your lordship is aware of Mr. Swan's ability and research, and throughout the whole year 1879 down to the fire in 1880 he was working away at those broken lamps. And now what is the commentary that I make upon such a state of things as that: that so far from the cleverest men being led to the Edison lamp—the most skilled man in England was working that F J B 1. And what was he doing? He was putting in coils in order to conduct the heat, he was placing something which would be inconsistent with the simple platinum wires, which were to lead direct to the platinum burner. I ask your lordship to observe that during the year 1879—and I do not think I need use much argument to excite Mr. Stearn's and Mr. Swan's distinct recollection upon the point—they were working at these failures, which they had to abandon. In 1885 Mr. Stearn was trying to make the best case for the Swan as against Edison. He described the various stages of what he had done. Mr. Swan's first lamp was in 1877 and his third lamp was in 1878. Mr. Swan's fourth lamp was July, 1880. Therefore Mr. Stearn, acting for Mr. Swan and wishing to make the fullest statement that he could, in perfectly friendly warfare, describes the Swan invention and does not describe the lamp as approximating to the Edison until the fourth lamp is made. More experiments of 1879 go no further than Mr. Swan's lamp of 1878, F J B 1. So far from leading Mr. Swan in the right path, it was leading him absolutely away. What I say is this, that Mr. Edison was the first person to tell the world that they could boldly rely upon a mere efficiency of carbon without any strengthening, and of such minute cross-sections as never occurred to anyone else.

The next point is insufficiency of specification, and I say that a more unworthy attack upon the specification has never been made by any gentlemen who have been engaged in the same pursuit. We have Mr. Sellon and practical men engaged in this matter, and they did not venture to attack this specification—they left it to the professors. I asked Mr. Crookes, "What are the main points of attack which you make?" and he said that it was "the impossibility of carbonising the filaments." I produced to him those filaments in a box, and I must say that it is difficult to speak with sufficiently moderate language to condemn such evidence as was given by the Professor. He told me that by playing tricks those filaments could be produced. He swore that they could not be produced in sand—it was an absurdity. He said by playing tricks somebody might produce those filaments, and he told your lordship, wishing your lordship to understand that he had done his best to carry out the specification, that he had reduced everything to burnt ash. What appears to be the fact?

Prof. Stokes has told your lordship that though they were carbonised in all ways, in sand and charcoal, and without any powder stuffing, he never saw any burning or reducing to ashes at all. Mr. Crookes goes through the same farce again; he uses a crucible which is so porous that the water runs out of it; and if the water would run out the hot air would go in, and in that he burns up the filaments. Your lordship will be surprised that the only witness who has come here and condemned this patent is the witness who does not see it in the crucible. You do not wonder now that Prof. Dewar—that a witness who had been accustomed to carbonisation—could not explain this. But Dr. Frankland was called on behalf of the defendants, and I cross-examined him. I asked him whether at the previous trial he had been one of the witnesses in Woodhouse and Rawson's case, and whether they had made the same attack on the specification; and "Did you say one word about the defect of carbonisation?" Well, so far from saying that it could not be done at the last trial, he produced a filament lamp, and he said that he himself had made it from Pulvermacher's specification, which is one spiral surrounding another. I said, "Were you not surprised that Crookes failed?" and he said "Yes; and I told them that I could not make them out." What do Dr. Frankland and Prof. Thompson do? Did they come and test the crucible? No, they wanted to get a failure, and having desired that, they were satisfied, without any further examination, as to what was the cause of the failure. They have never taken pains to inquire into the cause of failure. Your lordship knows from Prof. Stokes's report and from the admissions that ordinary commercial tar and lampblack were made into filaments, and these filaments have been burnt for a series of hours, and nobody pretends that a proper lamp cannot be made in this way.

I understand to-day my learned friend has suggested to your lordship that during this trial we have made some communication to Mr. Edison as to how those things are made, and, therefore, you are to assume that it is a dishonest experiment, and that your lordship is not to trust to it. What is the good of the report? You send down a perfectly intelligent gentleman, and you wish to be informed as to the result of an honest working out of the specification.

Another thing, the only reason why the defendants say that they failed is that they did not knead the putty up. I believe that the words are that the carbon filament is to be moistened and kept until it assumes the consistency of thick putty. That is exactly what has been done. It was kneaded over half an hour, and on all subsequent occasions for a few minutes. What is the state of things? The defect is the cracks.

Well, when a man kneads putty and finds it cracks he kneads it a little more. I should like to refer your lordship to that case of Handcock *v.* Goodyer, in which exactly the same objection to the manipulation of india rubber or gutta percha was taken, in which you are told to knead the india rubber, and the Court found as a fact that where the workman was told to knead india rubber he would go on a little longer trying it. It is another instance, said Sir George Jessel, of the brandy-and-water argument:—"If you find it is not strong enough add a little more." I think that these competent gentlemen, if they wished to succeed, would have kneaded the putty a little longer. It is admitted that they do succeed when they knead it sufficiently. This extraordinary compaint was made: They say we have practised another fraud upon the defendants because we have not explained to their witnesses why they have failed.

The learned ATTORNEY-GENERAL then said he must leave the case in Mr. Moulton's hands to read the cases that he himself had intended to cite.

Mr. MOULTON, Q.C., then referred to a case in the House of Lords of aniline dyes, in order to establish that it was not necessary that all the the processes described in the specification should prove equally successful or of equal commercial value. The fact was that parties had got to try them in order to determine which was the best, and if the patentee does not know at the time, it did not militate against the validity of the patent. They said that F J B 1 broke down, not because the conductors broke down, but because the joint, being the weakest part, broke down first. It was quite true that F J B 1 was a wonderful approach to the problem, but we submit that that was not a solution that had been found successful, and that was the solution described in the second claim which the plaintiffs now sued on, and probably one of the most important suggestions was that tar-putty point. Mr. Edison described a great many substances, and that common mode of joint, and it produced a firm joint electrically and mechanically. The form of the filament was an immense step. They submitted that Edison had rendered practicable that which so many had approached to, and his was one of those first and true inventions which is not vitiated or diminished by the approach that has been made by other inventors. He submitted that Mr. Edison had abundantly made it clear that he meant an exceedingly fine conductor by his patent, and it was quite impossible for him more accurately to describe that which, in his opinion—in the opinion of the world—was the essential and important

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part of this discovery, namely, that there should be a carbon filament as the conductor of the incandescent lamp. At Ponder's End the mixing of the tar with the camphor, which was said to be absolutely fatal, was shown to produce lamps, and these lamps were made from hard carbon, which conducted very well indeed. If they had been submitted to the test of commercial manufacture, as to which there was so much severe criticism, it would not be of such great value. The experiment which Prof. Stokes had described was abundantly supported, and it was enough to say that those various methods all led to lamps which could burn for a more or less long life.

The learned counsel next took the case of the Otto gas engine, and he submitted that the law might be in this way—a man could not claim a patent broadly unless he was the person who made the invention.

Mr. JUSTICE KAY: If he describes three or four, some of which are perfectly useless, what then? That is the point against you.

Mr. MOULTON: I quite feel that.

Mr. JUSTICE KAY: You must take the test which Sir Frederick Bramwell put. He says that Edison made the first commercial lamp. If some of these are not commercial lamps, then it is an argument against you. A patent with so wide a claim as this patent, according to your construction, cannot be supported.

Mr. MOULTON: It is possible that a large number of them have not got those properties which would enable them to be so far commercially the best as to hold their own in the market in competition with others disclosed in the same specification. An attack has been made upon these lamps, because they use a larger amount of electricity than the lamps now in the market. According to that a patentee would invalidate his patent if he gave three or four different methods some of which were worth more than others, because the best ones would drive the others out, and the others would have no commercial utility. The House of Lords pointed out that commercial utility had not got anything to do with patent law. The question was "Is that which has been produced that which would be under circumstances which might occur useful to the public?" The fact that something else has entirely cut it out, because it is more useful, does not in the least militate against the utility in the point of value of the patent laws.

Mr. JUSTICE KAY: The argument is this, that if you have described that particular mode of making filaments—if one of your modes was one which never could be commercially useful, have you a right to say that no one else shall be able to make it commercially useful?

Mr. MOULTON: I submit that my case meets that.

Mr. JUSTICE KAY: But Lord Herschell's judgment is against you.

Mr. MOULTON: I submit that Mr. Edison was the first to publish this invention, which was the only form in which commercial lamps could be made.

Mr. JUSTICE KAY: But the publication of an idea is nothing.

Mr. MOULTON: That is my first step. I submit that on the evidence none of these lamps are shown to be such that they could not be commercial lamps. There is no process here which your lordship will see is one which will not lead to a practical lamp. Take the tar putty with the asbestos rolled around. Take the camphor and the zinc. We have proved that we have made lamps of all kinds, and the experiments at Ponder's End have proved that we have been successful. To that extent we have shown that they are all capable of leading to commercial lamps; I do not mean that now they would be able to hold the market. They would have to have the modern improvements, and our ideas of what lamps ought to do have been moulded by those modern improvements, and it is difficult now to consider what would have been sufficient to have been practicable in 1879. We have proved cases where our lamps have run from 50 to 150 hours, and that is abundant proof to make practically useful lamps.

The learned counsel, having referred to Mr. Edison's first and second patents, submitted that no extraneous evidence could be taken to give an interpretation to those patents, and that it was for his lordship to construe the document.

Mr. JUSTICE KAY: If Mr. Edison had been in the witness-box we should have asked him the question—to interpret his patent, and as he was not here I shall take his own patent as to what was in the first and what was in the second.

Mr. MOULTON: What a patentee says is not evidence. His patent is a public document, and must be construed without any extraneous evidence.

Mr. JUSTICE KAY: I must take it that no tar putty lamp was ever sold in America or England, and no lamp, according to the particular directions in this patent, was sold either in America or in England.

Mr. MOULTON: I dissent from that.

Mr. JUSTICE KAY: It was for you to prove the case; but you have not a single lamp either in England or America.

Mr. MOULTON: If your lordship excludes bamboo.

Mr. JUSTICE KAY: There is no evidence of any lamp of bamboo; and they are made on that subsequent patent.

Mr. MOULTON: This case covers that; and it is found to be the case that a better method of doing it was discovered immediately afterwards. In Bremner *v.* Livingstone they sued upon a patent on which nothing had been sold.

Mr. JUSTICE KAY: But here we have an interval of a year in which nothing is done under your patent.

Mr. MOULTON: But lamps which were produced to your lordship were actually made in January or February, 1880. That is before the complete specification comes out—it is between the provisional and complete specification. Besides, of course, in this case it was an American patentee, and, naturally, there would be some longer time; but Mr. Edison certainly sent over the lamps within a couple of months of his patent having been made. Those made in this country were made under the second claim, but by different processes. There was no claim to this particular manufacture. These were the only practical methods for carrying it out, and, if practical, it made no difference whether any were sold at all. Those were the cases with regard to utility that he intended to quote.

Mr. JUSTICE KAY: I must say that the Court has not been treated fairly in this case. I have given twenty-one days of public time to this case, and now at the last moment the reply is broken into two, and I am asked to hear two replies. This is not the mode in which the Court should be treated; and if you do not make your reply as brief as possible I shall refuse to hear you. I think the Court has very great reason to complain of the kind of treatment it has been subjected to.

Mr. MOULTON (continuing) said he wished to cite one or two cases on the sufficiency of specification. It had been said that the directions must be such that a competent workman would be able to follow them. In this case, as was sometimes the case in patents which marked stages which for the first time rendered any manufacture commercially practicable, there was at the times when they were published no trade established and no workman accustomed to the work. Supposing that they took the first telephone company. Nowadays there were people who had a regular business to make those, and it might be said that it ought to be described sufficiently to explain it to every workman. He doubted whether the law had gone so far as that. But in this case there was this admission on both sides, that there was no body of workmen engaged in this trade.

Mr. JUSTICE KAY: That is not a reason for making the specification less explicit, but more.

Mr. MOULTON: It will be addressed in this case to electricians.

Mr. JUSTICE KAY: I never heard of such a case as addressing the publications to a particular body of people.

Mr. MOULTON: In the aniline dye, it must be taken that the specification of dyeing was addressed to skilled chemists. There are terms of art which to the ordinary public would not be intelligible.

Mr. JUSTICE KAY: Then they ought to be explained.

Mr. MOULTON: With all due respect that is never held. You may pre-suppose a certain amount of skill in them.

Mr. JUSTICE KAY: There might be a patent, then, which would be utterly unintelligible addressed to electricians, to prevent the ordinary man from making a patent. That is entirely against the essence of the patent law.

Mr. MOULTON: Patents have been taken again and again to consider to whom they are addressed.

Mr. JUSTICE KAY: I quite understand that a branch of trade, as in Arkwright's case with the spinning jenny, and in the dyeing case, where there is a trade largely established, the patent may be addressed to the public in that trade. But there was no trade or occupation in existence when this patent was taken out of electric lighting.

Mr. MOULTON: The point does not arise except in the question of carbonisation. But I shall submit with regard to that that the persons who could be connected with electric lighting would be at that time electricians. There had been many attempts, but there had been no commercial success. I should submit that carbonisation is a known thing, which a great number of people would probably not have any knowledge of, and if they find the use of a term of art there it is for them to find out what that means before they applied the patent; and to such a class in 1879 as that was addressed to he should submit that there was nothing in that patent which would give rise to difficulties.

As to the question of anticipation, he submitted that there was no evidence of publication of any patent, although some of them approached very near to Edison's. F J B 1 was only an experiment, and it was not an experiment which enabled the public to make that kind of lamp, which was claimed in the plaintiffs' second claim.

As to the Cheesborough, what the plaintiffs said was what they used it for was not for the purpose of making the filament, but to make it have a proper resistance. That which was valuable in the deposit was to have the right resistance. What the defendants added was exactly what the Cheesborough did.

Mr. JUSTICE KAY: How can you support the patent as to the material?

Mr. MOULTON: With regard to the material, that was a point which came before the Court of Appeal on the last occasion. The material is novel, and it is applied by means of a process for correcting any defects, and especially producing a close-grained carbon, admirably suited for this purpose. We suggest that that material certainly never was in England before. Even if Deprez had got the material he was abroad. The papers of Deprez were published, I know, years before.

Mr. JUSTICE KAY: Do you mean to say that anybody could have followed the instructions of Deprez and patented the material?

Mr. MOULTON: I submit that he could not have followed the instructions exactly. I submit that this claim for material is really a claim for process.

Mr. JUSTICE KAY: No; he claims process separately.

Mr. MOULTON: Supposing that Deprez has not sufficiently published his process. There cannot have been a publication of material.

Mr. JUSTICE KAY: He tells you what happens if you use a certain heat passing through carbon.

Mr. MOULTON: Yes; but to obtain Cheesborough's results it must be done in a particular way. They admit that they leave it in doubt whether he puts it through the carbon or exposes it to the electric arc. No one has shown a practical method of making this carbon. Deprez would not have made it practicable. It would have been in a form absolutely useless for the purpose of illuminating conductors, because you could not have manufactured illuminating conductors out of it so as to be useful for electric lamps; we were the first to show that.

This concluded the speeches in the case.

Mr. JUSTICE KAY then announced that judgment would be reserved.

Up to the time of going to press the case had not again been mentioned in Court.

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TEXT OF PROF. STOKES' REPORT.

My Lord: Having accepted the office of Independent Reporter on Experiments made in conformity with the order of the High Court of Justice in this case, of date 1st June, 1888, I have the honour to report as follows:—

The places chosen by the two parties for conducting their respective experiments were—

By the plaintiffs—The works of the Edison and Swan Company, at Ponder's End;

By the defendants—The laboratory of Mr. Crookes, at his house, 7, Kensington Park-gardens.

The two experts on the side of the plaintiffs were Prof. Dewar and Dr. Hopkinson, and those on the side of the defendants were Mr. Crookes and Prof. Silvanus Thompson. It was agreed between the two parties that the counsel on both sides should also be present.

We met at Ponder's End on June 11, 12, 14, and 15, and at Mr. Crookes's house on June 18, 19, and 21. The first process shown us at Ponder's End was the preparation of the so-called "tar putty," which formed the foundation of most of the filaments used in the lamps made in the repetition of the experiments.

The ingredients of tar putty are coal-tar and lampblack, of each of which we saw a barrel just as purchased. The coal tar is used in the state in which it is procured; the lampblack was calcined in a covered crucible placed in a brass furnace, and when taken out was preserved in stoppered bottles. I saw a good-sized earthenware crucible filled with raw lampblack, its cover luted down, and the whole put aside for the luting to dry preparatory to ignition. It was not, however, deemed necessary that I should actually see the ignition, which is a very common laboratory process; and it was agreed on both sides that the black powder used should be taken as calcined lampblack.

The putty was made by a strong-looking, youngish man named Plum. It was made on a table, on which a flat piece of hard-looking wood had been screwed down as a fixture. Some calcined lampblack was first triturated a little in a mortar, and then poured on to muslin, which was tied into a bag. A suitable quantity of coal-tar was poured on the board and dusted with charcoal, by shaking the bag over it. The two were then incorporated by using a rigid iron or steel tool, shaped much like a chisel, but not ground to a sharp edge. The charcoal was repeatedly added by small quantities at a time during the process, each fresh charge being incorporated before the next was added.

When the work had progressed some way, and the putty was beginning to get stiff, Plum evidently used considerable force. Holding the end of the tool in one hand, he strongly pressed the tool against the table with the other hand applied towards the other end of the tool, nipping a small portion of the putty lump and then drawing it out into a thin layer by a horizontal motion. The lump was thus nipped bit by bit till the whole was spread out, when the putty was scraped up with the tool, rolled into a lump by the fingers, and the process repeated.

The quantities of tar and lampblack used were not weighed; the workman judged by experience when a suitable quantity had been added. The first piece we saw made took an hour and ten minutes in the making; it was somewhere about as big as a hazel nut. When rolled into a ball the putty may be squeezed between the thumb and fore finger without cracking at the edge, and hardly blackens the fingers.

Various batches of tar putty were made during our visit, and the operation does not generally take so long as above mentioned. It was suggested that the operation might be facilitated by passing the putty between two cylinders almost in contact, which were made to revolve with very unequal velocities. This suggestion was tried next day with a slight modification, an instrument being employed which had been used for a different purpose, and which contained two brass cylinders, almost touching, movable round their axes, which were parallel, one cylinder being turned by a winch, the other left free. On trial, the putty was forced through in a sheet, with powerful shearing, inasmuch as the free cylinder was jammed by the pressure till the lump had been forced through. The putty used in the actual experiments was, however, hand-made, as heretofore.

The first process shown us in applying the tar putty was that of rolling out. Fifteen grains of the putty were weighed out by Mr. Gimingham, and given to a boy to roll. A piece of plate glass, ground on the upper surface, which lay on the table, was covered with fresh white blotting paper, which was kept from slipping by turning the edges under the glass. The weighed ball having been placed upon the paper was rolled with a tool formed of a smaller piece of plate glass, ground dull underneath, and provided with a wooden handle. This was moved backwards and forwards till the ball was rolled out into a cylinder of the prescribed length of 6in. This was then divided into lengths of 1in., and these rolled in succession just as before to a length of 6in., and divided into 1in. lengths. These were rolled out to the length of 5in. to make the final filaments, the rolling being done as before, with the exception that the under glass was used bare, and that a spatula might occasionally be used to effect a local thinning. The total length of filament, if undivided, would thus be 15ft.

The filaments prior to roasting were bent into different shapes, sometimes that of a plain, elongated horseshoe, sometimes that of a spiral.

The chamber used for the firing of the horseshoes was a rectangular box of cast iron, with a loose lid of the same material. The box was about 6in. by 3in., and 1½in. high.

It held six or seven horseshoes resting on the bottom, and was first shown us without packing, *i.e.*, with nothing but air over the filaments in the box. The lid was luted down, and set on top of the furnace to dry, and get moderately hot. It was then inserted, put into the furnace, a bit of silver wire put on the lid for a test, and the mouth of the furnace closed. After 26 minutes the furnace was opened, the silver was found to have been melted, and the box was taken out, and placed on an iron slab to cool. It was opened about 15 minutes later, and the filaments while carbonised were found not to have been burnt. They were taken out, and handed to a girl to shorten slightly to a measured length and mount. By mounting is meant attaching the ends to platinum wires, so as to secure both mechanical and electrical connection. The wires had previously been sealed into one end of a glass tube which was left open at the other.

In mounting, the girl bent the ends of the wires to the proper distance apart, to fit the width of the base of the horseshoe. She then, with a hair pencil, put on the ends of the wires small quantities of a mixture of coal-tar and lampblack, applied them to the ends of the horseshoe, and added, with the pencil, a little more of the mixture when the filament had been taken up. A minute jet of gas, blown by air, lay attached to the table, and the girl put the wire transversely into the jet, so that the heat conducted along the wire volatilised the hydro-carbons in the mixture without burning the filament. Minute additions of the mixture were made, if deemed required, to ensure contact, and were heated as before. The roasting was completed by a momentary introduction of the lump into the edge of the flame.

In a subsequent experiment one leg of a filament after mounting or partial mounting was accidentally snapped just above the carbonised mixture. It was easily mended by application of a little of the mixture, which was carbonised a little beyond or at the edge of the flame.

Another process for carbonising the junction which was shown us consisted in holding the filament at the end of the glass tube over a small disc of cast iron, which was heated from beneath by a blast of gas and air.

Naturally these carbonised filaments are tender, and require careful handling. Of the six filaments in the first box three survived, so as to be placed mounted in the hands of the glassblower for insertion into lamps.

The carbonising of the filaments in the furnace takes half an hour or so, and a contrivance was shown us for economising time by roasting three layers of horseshoe filaments in a box instead of one only. For this purpose cast-iron plates or trays are provided with short feet in the corners, and a short projection in the middle on the upper surface to lift by. There is room for two trays in a box, which thus holds 18 or 20 horseshoes. A box full of filaments thus arranged were carbonised before us.

Three other processes were shown us for carbonising the filaments in the rectangular iron box, or, rather, another process in three varieties. In this process the box instead of being left empty was filled with a packing powder of some kind. A little was first strewed on the bottom, then a layer of filaments laid on, then more packing powder put in, then another layer of filaments, and then the box was filled with the powder, closed with the lid, and luted. After drying and warming on top of the stove it was put in and fired as usual, after due time taken out, placed on the iron slab to cool, and when cool enough, or at any subsequent time, opened.

In opening, the lid was first taken off, then a sheet of paper put over, and bent over the sides; then, the paper being held against the sides of the box, the whole was turned upside down on a table, the box lifted rather gently, so as to avoid as far as might be a rush of powder, and then the heap cautiously searched for filaments.

When the box of filaments was left empty the carbonised filaments were almost always found whole, and could be easily taken out; when packing was used there seemed to be more liability to breakage, whether it were in the slipping down of the powder into a slant-sided heap, or in the subsequent search. There was usually a certain amount of loss this way.

Experiments were shown us with three kinds of packing, viz., powdered wood charcoal, kaolin, and silver sand. The process was just the same in the three cases, and in each case the filaments came out carbonised and not reduced to ash, of which I may here say once for all I saw no sign in the experiments made at Ponder's End.

The filaments of whatever kind and shape were usually connected mechanically and electrically with the platinum wires by the process already described; but we were shown also a different process as applied to horseshoe filaments. In this the ends of the filaments were connected with short platinum wires by means of little bits of tar putty rolled between the thumb and forefinger. The filaments were roasted as before in a rectangular iron box with charcoal packing. The carbonisation of the connecting bits of tar putty was thus effected simultaneously with, instead of subsequently to, that of the filaments. The platinum wires which went in bright came out dull, but the change appeared to be merely superficial, and the wires were not rendered brittle, but could be bent without breaking. The platinum ends were connected with the ends of the wires that had been sealed in glass by small brass clamps, consisting of short hollow cylinders with a side screw.

Another form of filament of which numerous examples were shown us was that of a spiral. To make spirals, the 5 inch filaments had first small bits of tar putty attached to their ends by rolling a little with the finger. These were destined merely to serve as weights for a temporary purpose. To form spirals, the weighted filaments were wound round bobbins, consisting usually of short sticks of pipeclay ware, with a strip of paper wound two or three times round the middle. Different kinds of paper were used to vary the experiment. The weighted filament having been placed astride the bobbin was coiled around it, generally with two turns, the weighted ends hanging down at the two sides of the cylinder, which was held approximately horizontal. There was room for two spirals on one bobbin.

The spirals were roasted in pots of cast iron, shaped like galley pots, about 3in. high by 2½in. wide. They were cast with upright projections inside terminating in Y's in which the ends of the bobbins rested. They had lids to fit, and the fitting was so good that luting was dispensed with except in two or three cases near the end of the experiments, when old pots were used in which the iron had sealed.

The warming and roasting were done just as before. When the pots were opened it required careful handling to separate the carbonised fila-

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ments from the *débris* of the paper and take them off from the bobbins. Many came to grief in the process.

Another process shown us for the management of the spirals involved the use of a helix of thin copper wire. A suitable length of helix was taken, the spires pulled out slightly, so that they were the fiftieth of an inch or so apart, and the helix slipped over the paper-covered bobbin. The weighted filament was then rolled on so as to lie between the spires. After roasting, the carbonised spiral and copper helix were cautiously slipped off from the bobbin together, and the copper which had served as a support to the filament during this process was then dissolved off by nitric acid, and the carbonised filament was washed with water and dried.

A few filaments were tried without weights. They came out of the furnace misshapen and unsightly, but in other respects I am not aware that there was any particular difference.

Some sticks of chalk tapering a little, prepared for writing purposes, happened to be lying on the table, and one on the defendants' side suggested that they might be tried without a paper covering, as affording an unyielding support Some were cut accordingly to the proper length to rest on the Y's, and weighted filaments wound on on the bare chalk. After roasting in the furnace one came out broken, but the rest were slipped off the chalk with ease and safety.

Some tar putty filaments were rolled out a good deal finer than those above mentioned, the same or a slightly less weight of tar putty being rolled into 36 portions of 12 instead of 5 inches length. The fine filaments, measured under a microscope, proved to be about 0·0066in. diameter; allowing for the difference of length, this makes the thicker first mentioned about 0·01in. diameter. The fine filaments were cut to a suitable length, bent into horseshoes, and carbonised in the empty iron box as before, and the subsequent treatment calls for no special remark.

We were also shown the coating of tar putty filaments with other material. The first shown was asbestos powder, used as purchased. The glass plate being covered with white blotting paper, a small quantity of the powder was put on quite thin, and the filament being laid on the paper was rolled backwards and forwards through a small space only with the upper glass tool. The finished filament was somewhat lighter in colour, and on being viewed through a pocket lens was seen to be studded with particles of asbestos, between which the dark surface of the tar putty showed itself. The other substances used were silica (in the form of kieselguhr) and kaolin. As the treatment did not differ from that used in the case of asbestos, it was not thought necessary that I should actually see it.

Another material used for filaments was a mixture of tar putty with oxide of zinc; 80 grains of tar putty and 20 of oxide of zinc were weighed out and given to Plum to incorporate, which was done in a manner similar to the incorporation of the lampblack in the process of making the tar putty itself. The finished material appeared to be somewhat less plastic than the tar putty. 25 grains were rolled out, as before, and made into 36 one-inch lengths, which were rolled again to 5in. A fine thread, rubbed with coal tar, was stretched beside the filament when it had attained, or nearly so, its proper length, and the two rolled together with the upper glass tool. This, presumably, was designed to render the subsequent winding safer; but filaments of tar putty with zinc oxide were also used without thread, and thread was sometimes incorporated in plain tar putty filaments, sometimes having been previously rubbed with coal tar and sometimes not.

Another mixture we saw used was tar putty and camphor; 80 grains of tar putty were incorporated with 20 grains of camphor. The finished material seemed to be more plastic than the tar putty, and was readily rolled out except that the filaments seem rather disposed to stick to the glass, which had to be cleaned occasionally with spirit or some hydrocarbon.

We were also shown the carbonisation of various fine vegetable fibres, Mexican fibre, bamboo, and others, which was done in the rectangular box packed in one experiment with charcoal, in another with sand, in another with kaolin. Some of the more springy fibres were kept in the horseshoe shape by elongated loops of thin copper wire, into which the ends were inserted. On opening the box after it had been fired in the furnace and had got sufficiently cool, the fibres in each case were found to be carbonised, and not reduced to ash.

The operations of the glass blower in inserting the mounted filaments into the globes destined to form lamps need not, I presume, be described. The globe at the opposite end opened out into a tube, a thinned portion of which was intended to be sealed to the Sprengel exhausting pump. Each lamp was sealed in an upright position to the top of a vertical tube belonging to the system of the Sprengel, and just below the place where the lamp was sealed was a circle of small jets of gas, the hot air from which warmed the lamps during exhaustion. Asbestos muffs were put round the lamps and circle of jets, to assist in the warming. When the operator was satisfied with the amount of exhaustion, the tube was melted near the bulb, and the lamp taken off as finished.

The lamps when measured were taken into the testing room to be measured for candle-power, current, and voltage. The condition in which they were measured was that in which the current was such as to give what was judged by the eye to be about the proper brightness to the filament. I saw 19 lamps thus treated, of which, however, two gave way. The lamps were then run for duration. During the three or four hours I was there, after the running commenced, one gave way after a life of 2 hours 25 minutes. I have received a list, dated June 21st, and signed by Dr. Hopkinson, on part of the plaintiffs, and Mr. Sellon on part of the defendants, giving the results up to date; 17 lamps had died after an average life of 12·7 hours, and 12 were still running after an average run of 32·6 hours.

The experiments shown us at Mr. Crookes's laboratory related chiefly to (1) the preparation of tar putty; (2) the carbonisation of vegetable fibres and tar putty filaments in crucibles; (3) the effects of calcination in charcoal packing on the platinum ends of filaments mounted before carbonisation; (4) the effect of passing a current through a filament coated with fire clay.

1. The coal tar used had been purchased at a neighbouring shop; it seemed rather more fluid than that used at Ponder's End. The lampblack was purchased at the same shop, and had been calcined in a covered crucible for about three hours a couple of days before it was used, and when sufficiently cold had been put into a stoppered bottle. A small quantity of coal tar was taken and weighed; it weighed 82 grains. A sufficiency of calcined lampblack was put into a small bottle and weighed, in order to ascertain in the end, by difference, how much had been used in bringing the tar putty up to the proper consistence. The two were incorporated on a table, by the use of a spatula of elastic steel; one spatula was 3in. broad, the other barely an inch; the broader one was chiefly used. After about 17 minutes' work the tar putty was deemed to have attained the prescribed consistence, which was judged of by comparison with common putty, of which two lumps, of different stiffness, lay on the table. A little more lampblack had been added in this case about a minute and a-half before finishing.

Some more tar putty was made next day in a manner in the main the same, being chiefly worked on this occasion with the broad spatula. I will call the tar putty made as described in this and the preceding paragraph, "tar putty A," or simply tar putty.

Some tar putty was also made by persons on the defendants' side in imitation of the process they had seen at Ponder's End. The mixing was done on a ground glass plate, with a chisel instead of an elastic spatula, using much force in pressing down the chisel on the putty and spreading out the putty on the plate. The operators relieved one another in the work, which was continued for full an hour and a-half. I will call the putty thus made "tar putty B."

A portion of "tar putty A" was rolled into a ball, and squeezed between the thumb and fore finger. It developed cracks at the edge, and strongly blackened the fingers. The tar putty we had seen at Ponder's End on being squeezed came off from the fingers, leaving hardly any stain of lampblack. On rolling a good sized piece of "tar putty A" between the two hands so as to form a thick roll, holding the two ends of the roll with the fingers of the two hands, and drawing it out a bit, it could be pushed back for some way with hardly any force, behaving in this respect like a chain and resembling common putty, which shows the same thing, though less strikingly. The roll of tar putty on being squeezed became more shiny on the surface of the part where thickened, indicating the oozing out of a more fluid portion of the mixture.

Prof. S. Thompson rolled out a filament of tar putty. The rolling was done on ground glass by means, partly of a spatula, partly the finger, the latter being chiefly trusted to when the filament became thin. The filament was made pretty uniform by rolling any part which seemed thicker than the rest. The rolling was continued till the thickness seemed to the eye to match a figure contained in the Edison specification. The finger was dipped into lampblack to keep the tar putty from sticking.

Attempts were made to form coils with this tar putty by winding it round copper spirals formed in imitation of a drawing in the specification; but cracks were developed, and evidently the material would not hold together.

Ten grains of this tar putty were incorporated with two grains of camphor, the two being worked together with a spatula on a table. The mixture passed into the condition of a sticky fluid, and therefore some more lampblack was added and incorporated, to make it suitable for working.

Later on a filament was made from tar putty B, and wound round a copper spiral. The winding was accomplished without difficulty, and cracks were not developed, though the diameter of the spirals was considerably less than that of the bobbins that we had seen at Ponder's End. Moreover, this tar putty on being squeezed hardly soiled the fingers, and on being a good deal flattened hardly developed cracks at the edge.

2. In Mr. Crookes's laboratory, the carbonising was done in ordinary earthenware crucibles of a size to hold three or four fluid ounces. This sort of crucible is, of course, to a certain extent porous, and to test the porosity a fresh one was filled with water and set on four thicknesses of blotting paper. After an hour the paper was wetted over a circle about the size of a crown piece; after four hours the wet patch looked more than three inches in diameter.

100 pieces of vegetable filaments or strips, consisting of card, paper, dark paper, chemically prepared cellulose, wood shaving, thin cotton, thicker cotton, were put into an empty crucible, luted down, the luting dried, the warm crucible put into a furnace, where it was left for an hour and a-half. On taking out the crucible the heat was found to have been sufficient to melt copper as well as silver wire. On opening the crucible when cold nothing was found but white ash.

A similar crucible was similarly filled, with the exception that the vegetable substances were embedded in sand packing. This was fired for an hour only. On opening, a portion, believed to be the card, was found reduced to white ash; another portion was carbonised, but not reduced to white ash. It was not thought necessary to repeat the experiment, because it was not disputed that under the circumstances of the experiment the vegetable substances would have been reduced to ash had the firing been continued for a couple of hours.

A third crucible contained three tar putty horseshoes, and a fourth with platinum ends, and was packed with charcoal. On firing and opening all came out broken, and studded all over with charcoal. On attempting to clean them with a camel's hair pencil the pieces broke up still further. They were, in fact quite unmanageable.

A fourth contained a single spiral of threaded tar putty, wound on a carbon stick of 2mm. diameter. On firing and opening it was broken in taking out, and could not be separated from the core.

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A fifth contained two horseshoes of camphorated tar putty. After treatment as before these were taken out whole. Most of the charcoal that stuck to them was brushed off with a camel's hair pencil.

As I have mentioned platinum ends, I may say here that the short platinum wires were attached to the ends of filaments in much the same way as we had seen at Ponder's End, only a mixture of coal tar and plumbago was used, instead of a mixture of coal tar and lampblack. When it was desired to keep the ends of a horseshoe the proper distance apart during the firing in the crucible, a thread of melting glass was passed round the platinum ends.

3. The ends of the spiral in the fourth crucible had been provided with platinum wires. These came out altered in appearance but the memorandum in my note book is "Platinum not much dulled." In one case shown us the action on the platinum ends had gone so far that the wires were rendered quite brittle; but I cannot recollect for certain whether this was one of those fired in charcoal packing during our visit or before.

4. The effect of coating a filament with an earthy substance was then tried. Fireclay was rubbed in a mortar, mixed with much water, and the finer parts separated by levigation and collected on a filter. The word "mud" will hereinafter be used to denote the material thus prepared.

Tarred thread was rolled with a little lampblack, between glass and glass, then more tar put on, and the thread rolled with lampblack, so as to form a sort of tar putty made on the thread. Four horseshoe filaments were painted with mud, allowed to dry, painted again, and so on till the diameter was two or three times that of the original filament. When dry they were fired as usual in a crucible with charcoal packing.

To mount mud-cased filaments of this kind the ends of the platinum wires sealed in glass were bent into minute rings, into which the legs of the horseshoe were inserted, and attached by the coal tar and plumbago mixture, which was in contact with both the platinum and the core of the filament; the more effectually as regards the latter if the mud coating happened to be broken off near the end of the horseshoe. The cement was heated, as usual, with attachments to carbonise it.

Two lamps were made with uncoated, and three with mud-coated horseshoes. These lamps were sealed in succession on to the Sprengel pump and exhausted. The bulbs were not heated during exhaustion; the action of the pump was continued till the gauge was sensibly level with the barometer. It was then stopped and the current allowed to pass.

Lamp No. 1 was of uncoated thread. When the current was let on a bright paint appeared at the junction of one leg with the base; an interruption of continuity was almost immediately formed, giving an arc discharge, which was known by the appearance of two very brilliant points, at first almost coincident, and in three minutes the lamp went out, showing a gap of about the 20th of an inch between the end of the leg and the base.

Lamps Nos. 2, 3, and 5, were of mud-coated, tar-puttied thread. These were exhausted in succession, the pump stopped, but the lamp not sealed off from it, but the current let pass while the bulb was still open to the gauge.

When the current was let on to No. 2 it was raised to redness. As soon as the current (0·1 ampere) and the resistance were measured, the current was increased till the lamp got to full brightness, but it died in about two minutes after the current was first let on. The bulb was discoloured.

In the case of No. 3, with a current of 4·7 amperes and resistance of 34 ohms, the horseshoe was red. There was a crack in the mud coating extending over about one-third of the whole length. The core seen through the crack was much brighter than the coating. There was a slight depression of the gauge, the bulb remained clear. The pump was worked for a bit to bring the gauge to match with the barometer nearly, and the current was then raised to 6·6 amperes. The bulb now began to be a little discoloured, and at twelve minutes from the first letting on of the current an arc discharge was formed, which was known by the formation of bright points which crept along the horseshoe. The lamp went out at nineteen minutes from first letting on the current. The gauge was found to be very sensibly depressed at the end, half an inch or so. Mr. Crookes mentioned that he had called our attention to the fact that the gauge went down before the arc was formed. I cannot speak to this from my own knowledge, as my attention was taken up with watching the changes of the filament, and making memoranda.

A lamp (No. 4) similar to No. 1 was exhausted, but on letting on the current there was a momentary spark and the lamp was destroyed.

Finally a lamp (No. 5) similar to No 2 was exhausted, and the current let on. With a current of less than 0·25 ampere the horseshoe was red, the brightness not uniform. The current was increased till an arc discharge began, when two very bright points appeared, one near the base of one leg, the other travelling up the leg. Before that the lamp had been fairly bright, but not nearly of the proper brightness. During the life of the arc the gauge went steadily down, the depression measured at the end, 11 millimetres, indicating a pressure of gas amounting to about 1·70th of an atmosphere in a volume equal to that of the bulb, *plus* that of the space above the mercury in the fall-tubes and gauge of the Sprengel, not taking account of the narrow connecting tubes.

I have the honour to be, my Lord, your obedient servant,

28th June, 1888. G. G. STOKES.

THE EASTERN TELEGRAPH COMPANY.—This company announce that subject to final audit the accounts show, after placing about £75,000 to reserve fund, a balance available for dividend sufficient to pay at the general meeting on 19th July next the fixed dividend of 3s. per share, being at the rate of 6 per cent. per annum, on the Preference shares; and a final dividend of 2s. 6d. per share, with a bonus of 2s. per share, free of income-tax, on the Ordinary shares, making, with previous payments on account, a total dividend of 6 per cent. per annum on those shares for the year ended 31st March, 1888.

REVIEWS.

Traite Elementaire d'Electricite, avec les Principales Applications (Elementary Treatise on Electricity, with its Principal Applications). By R. COLSON, Captain of Engineers. 2nd Edition, 220 pp. (Paris: Gauthier Villars.)

The title of this little work would have been more in accordance with its contents if it had been called a short summary of electrical phenomena and of their principal practical applications. The summary is very well drawn up; but we fear that it will hardly answer the purpose set forth in the preface of enabling practical men to understand the principles of the science. For example, we should hardly think it possible that a reader without previous knowledge of the subject could learn anything of the principles of the science by reading mere statements of the laws of Ohm, Joule, Lenz, Ampère, Coulomb, and others, without any information as to how they were obtained. Again, we find statements made about quantities of electricity and units of quantity, but nowhere is any proof given that what we call electricity is something which can be measured quantitatively at all.

Aide-Memoire de l'Ingenieur Electricien, 1888. By MM. G. DUCHÉ, E. MEYLAN, D. MARINOVITCH, and G. SZARVODY. (Paris: Bernard Tignol, 45, Quai de Grands-Augustins.)

This is probably the most elaborate work of reference that has hitherto been compiled for the use of electrical engineers. In the space of 420 octavo pages we find a vast amount of information both on pure science and on the industrial application of electricity. The authors evidently entertain no misgivings as to the probable mathematical attainments of those for whom the book is intended, and, on the whole, the theoretical portion seems to us more useful than the practical. Very excellent summaries are given of Frœlich's theory of the characteristic, and of Drs. J. and E. Hopkinsons' recent Paper on the magnetisation of iron. Most French writers are fully content with the teaching of M. Marcel Deprez on these points. The practical information on secondary batteries is meagre, although the theory is elucidated by means of a highly interesting differential equation. Unfortunately we have never yet come across a secondary battery whose performance was reasonably in accordance with calculation. Perhaps this is one of those things which they manage better in France. However, notwithstanding a pronounced tendency to theorise on the slenderest basis, the book will form a useful addition to the library of practical electricians.

Electricity versus Gas. By JOHN STENT. (London: Swan Sonnenschein and Co.)

This is a little sixpenny book of 80 pages, and we have no hesitation in saying that we have read it with a good deal of pleasure. The author is possessed with a most laudable enthusiasm for electric lighting, and is so genuinely and unaffectedly bewitched with the beauty and the mystery of the thing that it is impossible to be very angry when he makes a technical slip, or even when he shows a tendency to generalise, as he sometimes does, on a scale of unlimited grandeur. "Electricity," we learn on page 23, "is a product of nature, free, direct, perpetual." Gas and oil, it appears, are also products of nature, "but they are indirect, the result of vegetation, which in geologic eras was overthrown," from which the incontestable superiority of electricity is at once and for ever demonstrated. In a book of this nature, intended only to arouse an intelligent interest in electric lighting and impart a few rational ideas on the leading features of electrical science, it is needless to object to a little of this sort of writing. Nevertheless, in statements of a more avowedly technical character, the author, who "is no expert in electrical science," would have done well to get an electrician to look over the proofs, so as to keep him out of serious errors. Such a statement as that on page 44, that an arc light which is equivalent to "a group of three hundred incandescent lights must require a correspondingly large cable," is so utterly wide of the mark as to show that Mr. Stent has still to master some of the most elementary details of the subject.

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ANSWERS TO CORRESPONDENTS.

G. Colebourn.—*Griscom's motor is described and illustrated in the second edition of Prof. S. P. Thompson's work on "Dynamo Electric Machinery." We may mention that a third edition of this book will be out in a few days. "The Electrical Transmission of Energy," by G. Kapp, may also be consulted on the same subject.*

C. Jacques.—*The book referred to is not out yet; it will form one of the "Specialist" series, published by Messrs. J. Whittaker and Co.*

THE EARLY HISTORY OF THE ALTERNATE-CURRENT TRANSFORMER.

The latest, and certainly not the least important, chapter in the history of the alternate-current transformer is to be found in the proceedings which are recorded in another part of this issue, and with which the attention of the High Court of Chancery has been occupied since Friday last. To comment upon a matter which at the time of writing still remains *sub judice* is very far from our intention; neither do we wish at this moment to place any interpretation of our own upon the earlier stages in the evolution of the apparatus which forms the present bone of contention. It is also quite possible, and even probable, that our knowledge of the early history of the invention may be

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corrected and amplified when time has been given to compare and digest the evidence now before the Court. Nevertheless, it will, we think, conduce to a more intelligent apprehension of the case on the part of a large section of our readers if we take this opportunity to give a brief outline of the earlier patents relating to the utilisation or distribution of electrical energy in a manner more or less similar to that which was first successfully worked on a commercial scale by Messrs. GAULARD and GIBBS. Before doing so, however, we cannot omit once more to pay tribute to the remarkable zeal and energy with which, amidst almost universal discouragement, the plaintiffs in the present action forced upon the attention of the electrical world this method of electrical distribution. It is fully and cordially admitted on all sides that whatever may be the degree of merit of the particular apparatus which they adopted, and whatever may prove to be the legal status of the claims introduced into their patent specification, to Messrs. GAULARD and GIBBS belongs the honour of inducing the world at large to recognise the commercial possibilities which underlie the principle of alternate-current transformation. So much as we have already said is not in dispute.

The earliest existing patent dealing with this principle—at any rate the earliest patent to which attention has been called—is that of PAUL JABLOCHKOFF in the year 1877. M. JABLOCHKOFF describes a series of induction coils, through the primaries of which intermittent or alternating currents are to be sent, and from which secondary currents were derived for employment with the Jablochkoff candle. Perhaps the most remarkable feature in this case is the fact that in a patent dated a few months afterwards the inventor expressly states that when alternate currents are employed he prefers "to complete the magnet circuit," and he describes and illustrates an induction coil or transformer designed in accordance with this idea. For further information upon this point the reader may consult *The Electrician* of March 9, 1888, p. 481, in which the drawings in question were reproduced. Some doubt appears to have arisen as to the exact purpose which M. JABLOCHKOFF intended his induction coils to fulfil. It seems to us that a very obvious advantage attends their use in connection with the Jablochkoff system—and one which has somewhat unaccountably been overlooked. By the aid of the induction coils he was enabled to dispense with the necessity for an automatic cut-out in the event of any individual lamp failing to ignite or prematurely going out. That the same object may be better fulfilled by other means is no doubt true, but that this was the feature which commended the system to the inventor's mind we have little doubt. The second half of the year 1878 was singularly prolific in inventions—or at least in patent specifications—relating to the employment of the induction coil. The two patents which come first on the list for this year are those of C. W. HARRISON (No. 3,470, 1878), and of Sir CHARLES BRIGHT (4,219, 1878). Both are very similar in general character to that of JABLOCHKOFF, but in neither of them is the precise method of working so fully disclosed. In the latter patent there are two sentences of a somewhat ambiguous character, and to the interpretation of which it is possible to conceive that some importance may attach. These are as follows:—"The size and length of the primary wire and secondary wire coils are adapted to the number of lights employed;" and, secondly, the coils "are connected to a metallic main conductor common to all." Opinions may easily differ as to whether this implies a series or a parallel connection, or whether it includes them both.

In November of the same year provisional protection was granted to Messrs. E. EDWARDS and ALPHONSE NORMANDY for "Improvements in methods of and apparatus for producing light, heat or motive power by means of electricity" (No. 4 611, 1878). In this specification the use of induction coils traversed either by intermittent or alternating currents of electricity, and the employment of secondary induced currents is set forth in clear and fairly precise language. But whether the language is precise enough or clear enough to invalidate subsequent patents is a matter upon which we can express no opinion. With regard to the construction of the induction coils, we find that the inventors describe the apparatus as consisting of "a coil or series of coils of insulated metallic wire or ribbon (preferably surrounding a bar or wires of soft iron). . . . . Round, or adjacent to, each coil of insulated wire described we form one or more secondary coils of insulated metallic wire or ribbon, arranged so that the passage of the rapidly intermittent current of electricity, as described through the primary coil or coils, generates a corresponding current of electricity in each of the secondary coils." This patent, as we have intimated, was never carried beyond the stage of provisional protection.

Before the expiration of the year 1878 two more patents dealing with the same subject had found their way to the English Patent Office, in the form of "communications received from abroad." Mr. J. B. FULLER, of New York (No. 5,183, 1878), follows the same general idea of distribution by induction, but here for the first time we come across a regulating device. "A pivoted arm regulates the light, by strengthening or weakening the magnetic field" of the coil. The second patent, that of M. DE MERITENS (No. 5,257, 1878) is very similar to EDWARDS and NORMANDY'S, and, although tolerably complete in itself, it does not seem to contain any feature of importance which had not already been disclosed in its predecessors. With these particulars before them our readers will be able to appreciate the main points in dispute which are now being argued before Mr. Justice KEKEWICH.

PROTECTION OF BUILDINGS FROM LIGHTNING.*

BY PROF. OLIVER LODGE, D.SC., F.R.S.

(Continued from page 236.)

EXPERIMENT OF THE BYE-PATH.

We have seen that a conductor is more efficient in carrying off a discharge and preventing side-flash in proportion as its self-induction is lessened; say by spreading it out into a thin sheet, or cutting it up into a number of wires, or otherwise. But no conductor is able to prevent side-flash altogether, unless it is zigzagged to and fro so as to have practically no self-induction; in that case the side spark is nearly stopped. But so long as a conductor is straight (and a lightning conductor must, of course, be straight), so long will there be some tendency to side-flash, however thick it be made. It may be a foot or a yard thick, and yet not stop it.

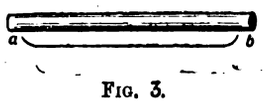

FIG. 3.

One may easily try the following experiment:—Take a yard of stout brass or copper rod an inch thick, arrange it in the path of a Leyden jar discharge, and then arrange, as a sort of bye-path or tapping circuit, some very fine wire, such as Wollaston platinum wire (Fig. 3). It may seem absurd for any portion of the discharge to leave the massive rod and take the hair-like wire by preference, especially if an air-gap exists at A or at B, or at both. Nevertheless a portion *does* choose the fine wire path, and you get a little spark at A or at B about the sixteenth of an inch long. One may vary the experiment by trying to get a shock by holding two different parts of a thick copper rod through which a discharge is passing. The mere difference of potential between conductor and earth must, of course, be avoided. It is not easy to get an appreciable shock from a few yards of very stout conductor; still it can be done. Holding two points of a stout open spiral, consisting of about five yards of No. 1 copper wire, connected to earth, a faint shock can be felt with wetted hands whenever a Leyden jar is discharged

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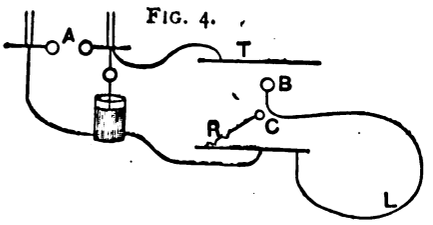
through the copper. No doubt with a very large condensor the shock would be quite noticeable, and a man touching a lightning conductor, however well earthed, might perhaps receive a shock sufficient to kill him. At all events, I should not care to try the experiment with a real lightning flash.

Experiment of the Side-Flash.

Let me illustrate the tendency to side flash by a more directly applicable looking experiment. Fig 4 shows a couple of tin plates or tea trays fixed a foot or so apart, one earthed the other insulated. They obviously represent, one a charged cloud, the other a layer of thoroughly good conducting earth. A lightning conductor, B L, is provided, L consisting of a considerable length of stout copper wire or rod. At C a possible side path is provided so that, if the flash chooses, some of it can spit off through an inch or so of air, and through an interposed resistance, R, to earth. A side flash, C, is found to occur unless the sparking distance is made too great; and the effect of increasing R is not to stop the side flash, but to weaken it. Thus, even with the liquid resistance of nearly a megohm at R, an inch spark still passes at C for every flash at B, though the C spark is now very weak.

Fig. 4.



How can this tendency to side flash be further diminished? At the end of the last lecture I hinted at a partial remedy—elasticity. To stop a pipe full of water from being burst by a blow given to the water, you will make the pipe elastic. An elastic cushion will ease off the violence of the shock of a water-ram.

Electric inertia was known by the other name of self-induction; electric "elasticity" is known by the other name of capacity. Increase the capacity—not the thickness or conducting power, but the electrostatic capacity of your conductor—and it will be able to carry off more.

This phrase, "the capacity of a conductor," when used by the old electricians, commonly signified merely its conducting power, this being the sole thing most of them thought of; but, using it in its modern signification, let us see what advantage is to be gained by increasing the capacity of a conductor—say, by connecting to its two ends the coatings of a Leyden jar.

Take the No. 18 wire round the room and use it as an alternative path, as in Fig. 1, first without a jar connected to its ends, then with a jar. Length of spark at A, 5·35-tenths of an inch; corresponding critical B spark-length:—

Iron wire without jar, 6·5;
Iron wire with jar, 5·0.

Not a very great difference. Not so great a difference as would be gained by diminishing the self-induction by flattening the wire out into foil. Still, it is in the right direction, and we see what we have to do: diminish self-induction as far as possible, and increase capacity whenever convenient. One may also try the experiment by attaching a jar to the conductor B, in Fig. 4: the side flash C is somewhat shortened.

But of an actual lightning conductor how is it possible to increase the capacity? There is no sense in surrounding it with an earth tube, because that, after all, would only act as an additional conductor, and might as well be so considered from the first. Neither does a great series of polarisable voltmeter plates seem a feasible suggestion. No; the only practicable plan is to expand it over as much surface as possible. A lead roof, for instance, affords an expansion of fair capacity which may be easily utilised; and there should be as little mere rod projection as possible before some extent of surface begins. Flat sheet for chimneys is better than round rod—it has at least *some* more capacity and much less self-induction.

For tall isolated chimneys I would suggest a collar of sheet metal round the top, and at intervals all the way down; or a warp of several thin wires instead of a single rod, joined together round the chimney by an occasional woof; or any other plan for increasing capacity and area of surface as much as possible.

Liability of Objects to be Struck.

Now try experiments on the liability of things to be struck. Is a small knob at a low elevation as liable to be struck as a large surface at a higher elevation? Is a badly conducting body as liable to be struck as a well conducting one? In other popular words, does a good conductor "attract lightning?"

* Lecture II. of the Dr. Mann lectures, delivered before the Society of Arts, March 17th, 1888.

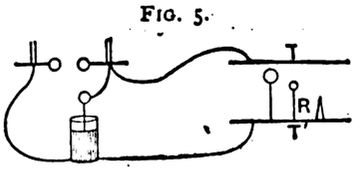
In answering this question experimentally, we must draw a careful distinction between the case of a flash occurring from an already charged surface, which has strained the air close to bursting point before any flash occurs, and the case of a flash produced by a rush of electricity into a previously uncharged conductor too hastily for it to prepare any carefully chosen path by induction. The two cases are—1st. Steady strain; 2nd. Impulsive rush. Take them separately.

First, with Steady Strain.

First an experiment on the liability of things to be struck when the air above them is in a state of steady strain gradually increased. I take the two tin plates arranged one over the other, and stand between them three conductors, one ending in a large knob, a second ending in a small knob, and the third ending in a point (Fig. 5).

The experiment consists in working up the charge of a jar attached to the top plate until discharge occurs, and in adjusting the three conductors so that they may be indiscriminately struck. One finds that the point, even when very low, prevents discharge altogether. It may, indeed, be too low to be effective; or, again, it may be insufficient to cope with the supply of electricity; but we see here the well-known function of a point—prevention of discharge. Remove or cover up the point now, and attend only to the large and small knobs. If the knobs are negative and the plate above them positive, brush discharge goes on from the knobs, and it is not easy to get a long flash; but by reversing the connections the tendency to brush is greatly lessened, and we now get flashes some three or four inches long. But always to the small knob. The small knob has to be pulled down about three times as far from the charged surface as the big knob is, before it ceases to protect the big knob; and the latter is then for the first time struck. This occurred, for instance, when the distance of the big knob from the top plate was 9, and the distance of the small one 29½, tenths of an inch. They were then either of them struck indiscriminately. If the little knob was any taller than 29½, it alone was struck.

Fig. 5.



Now what is the effect of resistance upon the protecting power of the point or small knob? Scarcely any. Instead of connecting the small knob direct to the bottom tray, connect it through the liquid megohm, R, and it gets struck just as easily as before.

Here are distance readings when they get struck with equal ease:—Large knob distance, 7·5; small knob distance, with high resistance, 22·0. The point protects both up to distance 60·0, until covered up by a thimble.

Thus the flash actually prefers to jump three times as much air, and encounter a megohm resistance, rather than take the short direct path offered by the bigger knob. The sizes of the knobs in this experiment are:—1·27 inch diameter for big knob, and ·56 inch for small knob.

Of course, the cause of this is well known. It is merely that the air breaks down at the weakest point, viz., on the surface of one of the knobs, and the tension on the small knob is much greater than that on the big one, for a given difference of potential. The fact that the discharge begins in the air above the conductor explains why it is that adding resistance—even enormous resistance—to a conductor makes no difference to the length of the spark which strikes it. The path is prepared inductively in the air, and the resistance of the path which the discharge must ultimately take makes no difference, provided it is not so nearly infinite as to prevent the free adjustment of the static charges and inductions set up as the machine is worked. But though high resistance makes no difference to the length of the spark, it does affect its noise and violence. The discharge striking the small knob has now only a soft velvety noise. Its energy, or heating effect, is much the same, but its suddenness, and, therefore, its noise and violence, are enormously lessened.

This water resistance is equivalent to a shocking bad earth; and its effect is, we see, to make the spark gentle. But it is an evident advantage to have a discharge take this quiet and manageable form. The worse a conductor is the quieter will be the flash, and, up to a certain limit, it will protect just as well apparently. Hence, surely, a bad earth is an advantage. But wait a bit; we have not yet considered the other case— the impulsive rush.

Second, with Impulsive Rush.

Let us now modify the experiment to try the second form of the experiment—the impulsive rush.

Fig. 6 shows the connections. There is no difference of potential between the trays up to the very instant of discharge. The jars

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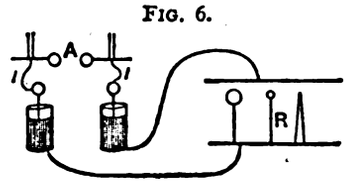
gradually charge up (they stand on the same wooden table), and ultimately discharge at A ; a violent rush then takes place into the two plates, and the conductors between are struck. Adjust them till they are all struck with equal ease, as before ; we find the conditions utterly different. No longer does the small knob protect the taller big knob ; no longer does the point exert any special protective influence. All three bodies—large knob, small knob, point—are equally liable to be struck if at the same height, and no one is more liable than another ; simply the highest is struck if they are at all equally conducting. It is easy to get all three struck at once. *Now* make one bad conducting, and its protective virtue is gone. Put the liquid megohm into any one of the three conductors, and that one is no longer struck. It ceases to protect the other two even if taller than they ; nay, even if it be raised so as to *touch* the top tray, thus establishing direct conducting communication of a poor kind between cloud and earth, still next to none of the flash chooses that path, and the other two conductors get struck with apparently just the same ease as before. This is the real objection to a bad earth ; it cannot protect well against these sudden rushes.

FIG. 6.

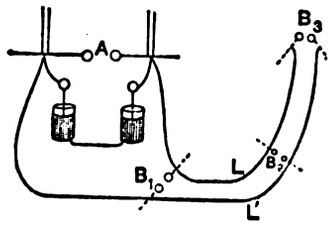


Sudden rushes are liable to occur ; the clouds spark first into one another, and then, as a sort of secondary effort or back kick, into the earth. For instance, two clouds one above the other ; the top cloud sparks into the lower, and this at once overflows to the earth. In these cases the best conducting and highest objects are struck, quite irrespective of any question of points and knobs. Points are no safeguard against these flashes, as you see. The point gets struck by a vivid flash, exactly of the same character as that which strikes one of the knobs ; it has no time to give brushes or glows ; its special efficacy in preventing discharge exists only in the case of steady action, where the path is pre-arranged by induction. In the case of these sudden rushes, the conditions determining the path of discharge are entirely different. No doubt they have to do with what is called the "impedance" of the various conductors.

EXPERIMENT OF THE RECOIL KICK.

It will have been noticed that in the experiment of Fig. 1 the spark obtained at B is longer than the spark at A. And the question arises why this should be so. Plainly, what is happening is this : the discharge at A sets up electrical oscillations, and the charge of the jars is rapidly reversed. The difference of potentials of the inner coats changes from, say, +V to nearly −V, and back again ; the difference of potential of the outer coats changes, therefore, from 0 to nearly 2V, and hence the B spark may be expected to be nearly twice as long as the A spark ; and so it is.

FIG. 7.



These electrical oscillations are of considerable interest, and have sundry practical bearings ; let us proceed to make them more conspicuous. Fig. 7 shows a couple of long leads, L and L', reaching round the room (No. 18 wire in two 95ft. lengths was actually employed), insulated from one another and from the earth, but attached to the two poles of a machine ; the machine having also a couple of Leyden jars attached to it in the customary manner when supplied by the maker. A discharger, B, can be arranged to bridge the gap between these leads, either near the machine, as B_1, or about the middle, as B_2, or at the far end, as B_3. Now, of course, sparks can be obtained either at A or at any of the B knobs, and all about the same length ; but supposing the A knobs to be brought nearer than the B knobs, the spark would be expected to occur at A only. Nevertheless, on trying the experiment, one finds that every time a spark occurs at A a longer spark occurs at B ; it is, as it were, precipitated with a rush, and the longest spark of all is obtainable at the far end, viz., at B_3.

Here are some figures, in the obtaining of which, however, for convenience of manipulation, the B length remained constant in each position, and the least length of the determining spark A was the thing observed :—

Nearest position	Spark length, A	3·20	4·15	5·12
	Corresponding spark length, B_1	3·22	4·80	6·18
Middle position	Spark length, A	1·92	2·37	2·70
	Corresponding spark length, B_2	3·22	4·80	6·18
Furthest position	Spark length, A	1·60	2·2	2·45
	Corresponding spark length, B_3	3·22	4·80	6·18

The electricity in the long wires is surging to and fro, like water in a bath when it has been tilted ; and the long spark at the far end of the wires is due to the recoil impulse or kick at the reflection of the wave. Evidently there are quantitative relations to be specified here, and there will be some best capacity of the jars corresponding to a given length of conductor, and to a given arrangement of main discharge circuit, A. The nearer the length of the conductors corresponds to a half-wave length, or some multiple of a half-wave length, of the oscillations produced by the discharging jars, the more perfect will be the synchronism between the pulses, and a longer recoil kick may be expected. The arrangement may, in fact, be compared to a resonant tube excited by a tuning fork or reed, to Melde's experiment with vibrating strings, or to any other case of forced vibration.

The following numbers will just serve to show some difference of effect caused by different sizes of jars. Using two pint jars in series, and fixing the A spark at 4·5, the B_3 spark at the far end just ceases when the knobs are pulled out to 7·8. But replacing the pint jars by gallon jars, the B_3 spark does not cease till the knobs are separated to 10·9, the corresponding spark in the position B_1 being only a trifle longer than the A spark, viz., 4·7.

It is not to be supposed, however, that by increasing the capacity of the jars still further a still better effect will be obtained ; for on replacing the two-gallon jars by the very large condenser of alternate glass and tinfoil sheets, we find the spark at B_3 fails when the knobs are only 5·9 tenths of an inch apart, the length of the A spark remaining 4·5, as before.

There is, as I say, a quantitative relation, and it is a relation which the modern theory of electricity makes known. I cannot go into it here, but I may just say that, very approximately, the wave-length of the electrical oscillation of a discharging jar is 2π times the geometric mean of the static capacity of the jar and the electromagnetic inertia of the discharger.

The capacity of the two-gallon jars in series (this being the capacity which gave the best result wth 95ft. of leads) was about ·002 microfarad, or, say, 1,800 centimetres ; hence, supposing the wave length of their discharge through the A knobs to be something like 190ft. or 200ft. (twice the length of the leads), we should calculate the self-induction of the circuit formed by the jars, short connecting wires, and A knobs, as something like five metres, which is a reasonable enough value.*

Repeating the experiment (Fig. 7) with the two-gallon jars in series, but insulated this time from the earth, a still longer spark at B_3, the far ends of the long wires can be obtained, viz., A $=4·45$, $B_3=14$; and even when the knobs of the discharger are separated beyond this distance, a brush still passes between them for every spark at A.

Removing the discharger altogether, and making the experiment in the dark, a very interesting effect is seen; the further end of each wire glows with a vivid brush light, showing the exceedingly high potential to which they are raised by the recoil. I do not see the effect with thick No. 1 wires, but with No. 18 wires it is very marked. The glow on each of the two wires is independent of the position of the other ; thus, if the connections are made so that the wires run opposite ways right round the room from the machine, the distant end being insulated, it is still the end of each furthest from the machine that glows, although they are separated from one another, for most of their length, by the whole width of the room. With the two-gallon jars the wires glow over fully three-fifths of their entire length. With jars of much larger or much smaller capacity the length of glow is conspicuously less.

Connect a small pint jar to the ends of the wires, and all these effects cease. The increase of static capacity reduces their potential below the brushing point. Arranging the jar so as to leave an air space between it and one of the wires, a spark passes into it at each A spark ; but the jar is not the least charged afterwards—proving that the spark is a double one, first in and then out of the jar, a real recoil of a reflected pulse ; hence it is also that the appearance of the brush is the same on the two wires, one is not able to say which is the positive and which the negative wire, for each is both.

EXPERIMENT OF THE SURGING CIRCUIT.

What seemed to me, when I first made it, a curious illustration of these electrical surgings or oscillations going on in a conductor which is being suddenly discharged at one end, is afforded by the following extremely simple experiment.

*Since the delivery of the lecture, a great number of quantitative observations on these lines have been made. Evidence of electro-magnetic waves 30 yards long has been obtained. I expect to get them still shorter.

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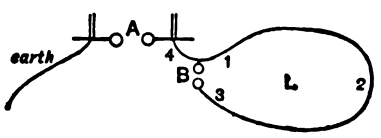
Attach one end of a long insulated wire to the machine, and connect the other pole of the machine to earth. Jars connected up also to the machine do no harm, but they are unnecessary. The wire now practically constitutes one coating of a condenser, of which the walls of the room are the outer coat. The wire is made to form a nearly closed circuit, and its further end brought within an inch or so of the near end, as at B (Fig. 8).

Under these circumstances one would at first sight say that a spark at B was absurd, for the two knobs are metallically connected through a stout conductor, which may be No. 1 wire, and not necessarily many yards long. Nevertheless, it will be found that sparks at B can be obtained quite as long, though not quite as strong, as those at A. Every A spark is accompanied by a B spark, unless, of course, the knobs are too far separated.

One may surmise that it is the static charge on the distant portion of the conductor which, having to rush toward A, prefers the short path, B, instead of the longer path *vid* the wire. But this is not the whole account of the matter, as can be shown by interposing high resistance in the conductor at various points; say at the places 1, 2, 3, or 4 (Fig. 8). Introducing a quarter of a megohm at the point 1 or at 3 weakens the B spark very much, and apparently about the same whether it be at 1 or at 3; the strength (*i.e.*, the noise and appearance) of the A spark remaining much the same. Introducing a high resistance at the point 4 weakens both the A and the B sparks. Introducing a high resistance at the point 2 leaves both sparks pretty much as strong as they were without it.

FIG. 8.



The spark at B is caused by electrical oscillation—a surging of the charge of the wire to and fro like water in a pipe. One might liken it to an elastic pipe pumped very full of water, and its end closed with spring valves. If, then, one end is suddenly opened and shut, a pulse is transmitted through the pipe, which may force open the valve at the far end and let some water escape.

It is these electrical oscillations, I doubt not, which account for the long spark obtained by the use of a "Winter's ring."

This last experiment, Fig. 8, however it may be explained, has an obvious application to the question of connecting roof gutters to lightning conductors. It is most desirable to connect them, but both ends should be connected. If only one is connected, the far end is very likely to spit off a flash.

Again, we see how, when a flash strikes a system, the electricity goes rushing and swinging about everywhere for no apparent reason, just as water might surge about in a bath or system of canals into which a mass of rock had just dropped, splashing and overflowing its banks. Just so with electricity. Bell-wires, gas-pipes, roof-gutters, conduct side-flashes in a way most puzzling to the older electricians; and thus gas may get ignited in the most unexpected places, and passengers in a train may feel a shock because a charge has struck the rails. In powder magazines it is apparent how dangerous this lawless sparking tendency may be; for even the hinge of a door may furnish opportunity for some trivial spark sufficient to ignite powder. By no means, it seems to me, should high rods be stuck up to invite a flash to such places. Build them, or line them, with connected iron, barb them all over the roof, connect them to the deep ground in many places, and I do not see what more can be done.

(To be continued.)

TEXT OF THE OFFICIAL INSTRUCTIONS FOR THE EXAMINATION OF APPARATUS ISSUED BY THE POSTAL TELEGRAPH DEPARTMENT.

All apparatus, before being issued from the depot, is tested mechanically and electrically.

MECHANICAL EXAMINATION.

The points to which the mechanical examination should be directed are as under:—

1. The apparatus must be well and strongly made in all its parts.
2. It must be accurately fitted.
3. It must be properly polished, lacquered, and finished.
4. All the adjustments must be true.
5. There must be no apparent friction in any of the moving parts.
6. The springs must be well made and properly tempered.
7. All screws must fit well and run smoothly, and such of them as are exposed to longitudinal percussion or vibration, or to any force tending to shift them, should be secured by binding nuts or other means.
8. The screws of all *new* apparatus should be of the B.A. standard screw gauge, with the exception of Stroh pattern, and slot-headed terminals, which must be of the P.O. standard terminal gauge.
9. All pivots and bearings should have sufficient end shake to prevent binding.
10. All train work should be wound up, so that the speed and regularity of running may be observed. The speed should comply with the specification as given below, and the running should be regular.
11. All moving parts should be supplied with oil at the points of friction.
12. All iron screws touching the cores of electro-magnets should be annealed and left black from that process.

Any instruments which do not comply with these requirements must be rejected.

ELECTRICAL EXAMINATION.

The following are the chief points to which the electrical examination should be directed:—

1. In a complete instrument the continuity in every lead and connection must be practically perfect; that is, there must be no appreciable resistance whatever, except that in the coils, which is specified.

The insulation of the parts electrically separated must also be practically perfect. This condition must especially be observed between the coils and the cores of all electro-magnets, and between the two wires of differentially wound instruments, which should not be approved if the insulation resistance is less than one megohm.

2. Connections and joints must be well and securely made, and where screws are used for making connections the lacquer must be removed from those surfaces on which contact depends. All contact points, studs, and plates, must be of platinum.

3. Resistances must agree within 1 per cent. of the amount specified, which is marked upon the instrument. In a few cases, which are indicated, a difference of only one-tenth per cent. is allowed.

4. The adjustments must be examined to see that the armature of the instrument has its proper range of movement between the limiting-stops, without making contact anywhere with the electro-magnet cores.

5. The apparatus must have its proper figure of merit. The figure of merit, in the case of instruments worked by a battery, is the minimum current in milliamperes with which they should work well. Thus one Daniell cell should actuate a standard relay of 400ω resistance through a total resistance (instrument, resistance coil, and battery) of 2,000ω. The current in this case would be approximately:—

$$C = \frac{1}{2000} = \cdot0005 = \cdot5 \text{ milliampere } (\gamma);$$

·5 is therefore the figure of merit of that standard relay. (In these calculations, for the sake of convenience, the electromotive force of the Daniell cell has been regarded as one volt, and the resistance of the cell, unless otherwise stated, as seven ohms. Where Leclanché cells are specified, the No. 1 form is referred to; and the electromotive force has been taken as 1·6 volt, and the resistance as 1·5ω.)

6. Nonpolarised instruments should work equally well with the current flowing in either direction through the coils. If tried with the current in only one direction, misleading results may arise from the presence of residual magnetism.

7. The proper range in the case of magneto-electric apparatus is that it must work either on short circuit or through the specified resistance without any alteration of adjustment.

8. A permanent magnet should be strong enough to support twice its own weight when suspended from a soft iron keeper placed across both its poles.

9. In all electro-magnets the armatures must be symmetrically placed with respect to the iron cores.

10. In single needle coils, galvanometers, and telephone indicators, the end of the needle from which the reading is taken should deflect in the same direction in which the current passes from terminal to terminal across the instrument, unless otherwise specified.

These points should be determined consecutively in each instrument, and every instrument that fails to comply with the requirements should be rejected.

The following are the specified resistances, ranges, and figures of merit, with other general information, for the different forms of apparatus.

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A B C Apparatus.

Communicator:—
Resistance 800ω
Range: Short circuit and 7,000ω external resistance.

Indicator:—
Resistance 250ω
Range: Short circuit and 7,000ω external resistance.

Bell:—
Resistance 250ω
Range: Short circuit and 7,000ω external resistance.

[N.B.—A reliable standard set must be used for the above examination.]

Single-Needle Apparatus.

Commutators.—These must be tested for continuity between the unmarked terminal and terminal A, when the tappers are at rest. They must also be joined up on short circuit through a galvanometer to test the battery connections, and to see that they reverse properly. They must not short-circuit the battery during reversal, nor when both tappers are depressed at the same time; and, in the old form, the contact springs must be so adjusted that when the ebonite collets are fitted for universal working neither key will join the battery through to the unmarked terminal during reversal. The play at the front end of the tappers should not exceed $\frac{3}{32}$ of an inch.

Induced Coils.—The needle should rest at zero when facing north or south. It should be free when the dial is turned into any position allowed by the stop-pin, or any position between 45° right and left of the normal position if no stop-pin is fitted; and when the back pivot screw is quite home.

Resistance 200ω

Figure of merit, with which the needle should deflect to the stop-pins, 3·06γ (10 Daniell cells through 3,000ω external resistance).

Neale's Sounder.
Resistance 200ω

Figure of merit, with which the needle should deflect to the stop-pins, 3·06γ (10 Daniell cells through 3,000ω external resistance). The adjusting-spiral at full tension should be strong enough to restore the needle to zero after it has been deflected by a current of 21γ (10 Daniell cells through 200ω external resistance).

Bright's Bell.

The steel plate should be on the left hand, and the brass plate on the right hand.

Resistance of Relay 200ω
,, ,, Sounders ..... 40ω each
,, ,, Induced coil (S.N.) 200ω

Figures of merit: Relay, 3·06γ (10 Daniell cells through 3,000ω external resistance). Sounders, 67γ (5 Daniel cells without external resistance). Induced coil, 3·06γ (10 Daniell cells through 3,000ω external resistance), with which the needle should deflect to the stop-pins. *See* general remarks under S.N. Induced Coils.

Double Sounder.

The steel plate should be on the left hand, and the brass plate on the right hand. The armatures of the sounders should not touch the cores when the local current is on. The outside ends of the sounder coils should be of strong wire—24 mils. in diameter—to prevent breakage.

Resistance of relay (200ω+200ω parallel) 100ω
,, ,, sounders ..... 20ω each.

Figures of merit: Relay, 3·15γ (10 Daniell cells through 3,000ω external resistance). Sounders: 71γ (2 large Daniell cells—each of 4ω resistance—without external resistance).

Galvanometers.

Each galvanometer should give equal deflections on opposite sides of zero. In vertical galvanometers the pointer should rest at zero when facing north or south.

Ordinary (S.C.).—In galvanometers of this form fitted with revolving dials, the needle should be free with the dial turned into any position allowed by the stop-pin, or any position between 45° right and left of the normal position if no stop-pin is fitted; and when the back pivot screw is quite home.

Resistance ..... 30ω *

Figure of merit, with which the needle should deflect to the stop-pins, 9·3γ (1 Daniell cell through 70ω external resistance).

Differential.—The coils should be differential with the needle in any position between 30° right and left of zero, with 50 Daniell cells without external resistance, care being taken that the current is passed through the coils in both directions. In those galvanometers into which switches are fitted the short-circuiting action should be proved.

Resistance of differential coils ..... 50ω each
,, ,, extra coil (if provided) 8ω

Figures of merit, with which the needle should deflect equally on each side not less than 40° nor more than 50°. Each differential coil, 17·5γ (1 Daniell cell—of 7ω resistance—without external resistance). Extra coil, 128γ (5 large Daniell cells through a total resistance of 39ω).

Horizontal.
Resistance 800ω

Figure of merit, with which the needle should deflect not less than 25°, ·048γ (1 Daniell cell through 20,000ω external resistance). The oscillations of the needle in coming to rest should be not less than 10.

Q. and I. Detector:—
Resistance of intensity coil 100ω
,, ,, quantity coil ..... ·2 ω
,, ,, ,, ,, (shunted) ..... ·04ω (about)

Figures of merit: Intensity coil should give deflections of not less than 40° nor more than 50° with 9·3γ (1 Daniell cell—of 7ω resistance—without external resistance). Quantity coil should give deflections of not less than 20° nor more than 30° with 139γ (1 Daniell cell—of 7ω resistance—without external resistance). The "quantity" deflections should fall to one-fifth of their original amount when the shunt is applied.

Test Box Detector (old form.)—The connection and insulation of the terminals and switch plates should be tested by battery and galvanometer.

Resistance 200ω

Figure of merit, with which the needle should deflect not less than 20° nor more than 30°, 3·06γ (10 Daniell cells through 3,000ω external resistance).

Test Box Detector (new form)—
Resistance of "Line coil" 100ω
,, ,, "Daniell and Leclanché" coil ..... ·2ω
,, ,, "Bichromate" coil ..... ·1ω

Figures of merit: Line coil—Should give deflections of not less than 40° nor more than 60° with 9·3γ (1 Daniell cell—of 7ω resistance—without external resistance.) Daniell and Leclanché coil: Should give deflections of not less than 20° nor more than 30° with 139γ (1 Daniell cell—of 7ω resistance—without external resistance). Bichromate coil: Should give deflections of one-fifth the amount of those given by the Daniell and Leclanché coil, with 141γ (1 Daniell cell—of 7ω resistance—without external resistance).

Tangent.—The slot in the stalk of the controlling magnet must be perfectly straight so that the magnet shall not turn when raised or lowered. The key should short-circuit the coil when depressed.

Resistance of long coil—both plugs out 1,070ω
,, ,, left-hand plug in 320ω
,, ,, both plugs in *32
,, short coils—outer terminals ..... ·13ω

Figures of merit: the examiner facing west, with the galvanometer placed so that the terminals in use are on the side nearest to him; the controlling magnet also being removed from the instrument whilst the tests are being made. (Should the examiner face east, all deflections will be reversed.) Long coil.—Both plugs being out, should give deflections of not less than 25° nor more than 35° with 1 Daniell cell without external resistance. The oscillations of the needle after these deflections should not be less than 10. Short coils.—Should give the following deflections with 1 Daniell cell through a total resistance of 10ω:—C to right hand and Z to centre terminal, about 10 tangent divisions to the *right*. C to right hand and Z to left hand terminal, about 30 tangent divisions to the *left*. C to centre and Z to the left hand terminal, about 40 tangent divisions to the *left*.

Keys.

The play of keys (other than S.C.) should be $\frac{1}{16}$th of an inch at the front end of the lever. The freedom of the lever should be such that the front end will fall by its own weight when the antagonistic spring is unhitched. New platinum contact points should project $\frac{1}{16}$th of an inch from the studs. Contact springs must be properly hardened and tempered—a matter of special importance in the case of increment keys. The connections and insulation of all keys should be proved by battery and galvanometer. Double current keys must not short-circuit the battery during reversal. Reversing keys must short-circuit the battery during reversal, but for the shortest possible time. In all keys with switches a test must be made to prove that the switch when moving from side to side would not join the battery through to the receiving apparatus.

* This resistance must be exactly one-tenth of that obtained when the left hand plug only is in.

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Relays.

The tongues in those relays having two should be in line, and should be free in their pivot holes, so that when lifted they will drop back into their proper position again. The screw adjustment must be made to turn righthanded for marking and lefthanded for spacing. The spiral joining the axle to the frame should be of 4 mils soft uncovered copper wire. Every double-wound relay should be differential (when adjusted for its figure of merit) with 50 Daniell cells without external resistance, care being taken that the current is passed through the coils in both directions. The following working tests should be made with the coils in series, and at key speed, unless otherwise specified, a sounder being used to prove the local connections.

Post Office Standard A—

Resistance ..... 200ω+200ω

Figure of merit: ·5γ (5 Daniell cells through 9,500ω external resistance).

Post Office Standard B—

Resistance ..... 100ω+100

Figures of merit: For working sounder at key speed, ·5γ (5 Daniel cells through 9,700ω external resistance). For repeating at the rate of 400 words per minute, 17·5γ (30 Daniell cells through 1,300ω external resistance, a condenser of 2 m.f. capacity being joined across 800ω of the external resistance). In neutral relays (P.O.S. with spiral springs), the springs should be removed from the contact-arm whilst the tests are made. The pivot must not be raised from the plate when the spirals with their fullest tension on are holding the contact-arm in the neutral position. Dimensions of spiral: 10 turns, exclusive of loops, of 15 mils brass wire for standard "A," and German silver for standard "B," outside diameter of spiral ⅛ of an inch.

Post Office Standard C.:—

Resistance 1,200ω

Figure of merit, ·098γ (1 Daniell cell through 9,000ω external resistance).

Nonpolarised Relay B.:—

Resistance ..... 200ω+200ω

Figure of merit, 6γ (20 Daniell cells though 2,800ω external resistance). The adjusting spiral when fully extended should be strong enough to prevent the tongues from being attracted when a current of 12·2γ (20 Daniell cells through 1,100ω external resistance), is flowing through the coils, the tongues being at the same distance from the poles as for the figure of merit test.

Nonpolarised Relay B. (large):—

Resistance ..... 100ω+100ω

Figures of merit.—For working sounder at key speed, 6γ (20 Daniell cells through 3,000ω external resistance). For closing an electro-magnetic switch whilst a transmitter is sending reversals at the rate of 400 words per minute, 17·5γ (20 Daniell cells through 800ω external resistance, a condenser of 2 M.F. capacity being joined across the external resistance).

Siemens':—

Resistance ..... 200ω+200ω

Figure of merit, 1·13γ (5 Daniell cells through 4,000ω external resistance).

Stroh's (new form):—

Resistance 1,200ω

Figure of merit ·098γ (1 Daniell cell through 9,000ω external resistance).

The adjusting spiral should be of 7 mils brass wire; one tenth of an inch in diameter; and not less than one inch long including the loops. The pin in the tongue to which the spiral is attached must be not more than ⅜ths of an inch from the pivot.

Telephone Relay (*see* under Telephone Apparatus).

Switches.

Must make good contact in their various positions. All pegs must fit properly. The standard space below the point of a peg is ⅛ of an inch. All levers and springs must be properly insulated from each other, and rivets must be such as not to give way with constant use.

Electro-Magnetic Switches (*see* under Repeaters).

Telephone Switches (*see* under Telephone Apparatus).

Sounders.

In Pony sounders A and B the lacquer should be removed from the ends of the limiting screws, and from those parts of the lever or frame against which they strike. The limiting-screws should be flat at the end not pointed.

Pony Sounder A:—

Resistance 40ω

Figure of merit, 67γ (5 Daniell cells without external resistance).

Pony Sounder B:—

Resistance. { Electro-magnet..... 20ω / Shunt (German silver wire).. 500ω } 19·2ω

Figure of merit, 92γ (5 Daniell cells without external resistance).

Relaying Sounder A (*see* under Repeaters).

Relaying Sounder B:—

Resistance. { Electro-magnet..... 40ω / Shunt (German silver wire).. 500ω } 37ω

Figure of merit, 69γ (5 Daniell cells without external resistance).

(To be continued.)

GAULARD AND GIBBS v. FERRANTI.

In the Chancery Division of the High Court of Justice, on Friday, before Mr. Justice Kekewich, the petition *in re* Gaulard and Gibbs patent came on for hearing. Messrs. Gaulard and Gibbs claim to be the inventors and patentees of a system of distributing electricity by means of secondary or induced currents, and the petitioner, Mr. Ferranti, who is also the patentee of electrical apparatus, seeks to have Messrs. Gaulard and Gibbs's patent revoked on three grounds, namely—(1) want of novelty, (2) lack of utility, and (3) that it was anticipated. Sir Henry James, Q.C., M.P., Mr. Theodore Aston, Q.C, and Mr. Cutter appeared for Messrs. Gaulard and Gibbs; and Sir Horace Davey, Q.C., Mr. Fletcher Moulton, Q.C, and Mr. Pike for Mr. Ferranti.

Sir HENRY JAMES, in opening the case, said the petition was presented under the 26th section of the Act of 1883 by a person named Ferranti. Ferranti was not a person mentioned among the different classes of people entitled to petition under the Act, but he had obtained the *fiat* of the Attorney-General, and was therefore entitled to proceed. He had now to state the facts. The patent which was sought to be revoked was dated the 13th September, 1882, and was granted to Lucien Gaulard and John Dixon Gibbs, who now had it in their possession. The subject matter of this patent was a process of distributing electricity for lighting purposes. As his lordship was doubtless aware, the lighting of public places and large buildings by this agency was of great utility, but at the same time was a matter of great difficulty. Previously to the year 1882, and certainly during the years 1878 and 1879, the manner of the delivery of this electric agency had proved comparatively a failure. With the arc system of lighting there proved to be a want of constancy in delivery, and if the current ceased to run from either of the pieces of charcoal employed in the lamp there was a cessation of the current, not only in that particular burner but throughout the whole circuit. In all the patents obtained he thought his lordship would find none of them produced a commercial result, and that not a single invention was brought into practical use. The first thing sought was to obtain the delivery of the light in such a condition that it would be constant and not intermittent; and then came a problem which had not yet been entirely solved, namely, the supply of the electricity with such economy that it might be used as a successful competitor against gas. In order to effect that they had to deliver the electric light at the place of its use—that was, at the burner—under such conditions of force that it should not be too strong or too weak. They would find that for a certain time electricity was delivered by a primary current carried direct to the burner, and the result was that the distance over which the electricity could be carried was very limited. They would not discuss the number of yards it could be carried; but no one would say that the current could be carried under such circumstances more than half a mile. His lordship would therefore find that in the past times of electricity an attempt was made—an attempt which had proved a commercial and an actual failure—by means of the direct agency of electricity with one current and one force alone from the generating machine to the burner's mouth. The great point on which he laid great stress was that this system never did succeed and never could have succeeded. Men of the greatest ingenuity employed the greatest scientific research upon this subject, and attempts were no doubt made, first in one direction and then in another, to obtain greater economy and better regulation of the electricity at the point of its delivery, and to secure a greater power of delivery over longer distances than could be obtained by one direct simple mode of carrying the electricity. As he had said, none of these attempts succeeded, but in 1882 Messrs. Gaulard and Gibbs produced and made known to the world an invention to which he (Sir Henry James) would have to call his lordship's attention, and which could be worked, and had been worked, successfully. Whilst he had pointed out that probably the extreme length to which, under the old system, a current could be carried for lighting purposes was half a mile, the current under the method invented by Messrs. Gaulard and Gibbs could be carried to the extent of fifty miles. Whether it could be carried for fifty miles for all purposes, and under all circumstances, he could not say, but they would find that under all the conditions necessary for distributing electricity for actual use it could be carried to a distance approximating on fifty miles—at all events, to thirty or forty miles, and in such a way, and at such a cost, as to be a commercial success. When he said that it could be distributed to the extent of fifty miles, that was not a fanciful estimate, or a distribution under fanciful circumstances. In the year 1884 there was an exhibition of lighting apparatus at Turin, and advertise-

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ments were sent forth to the whole world, inviting people to exhibit apparatus there. From all points of the compass men brought their inventions, and Messrs. Gaulard and Gibbs, among the rest, shewed their apparatus. They did at the exhibition circulate electricity to the extent of fifty miles for lighting purposes, and from all competitors they carried off the money prize and the gold medal. That was an acknowledgment that their invention was a success ; and he would now tell the court what it was these gentlemen had invented. There was first of all a dynamo machine, and passing from the left-hand side of the centre was a wire. That was the conductor, and was the main line of the system. It passed round and re-entered the dynamo, completed the circuit, and produced what was known as an alternating current. In old times the current of electricity was direct, and they would have tapped their main wire, and so have conducted the current from the dynamo to the burners. That would have furnished a certain amount of electric power, but it would have required so much force behind it that it would have been expended before it had gone many hundreds of yards. There were two kinds of wires which might have been used. If a wire of large diameter—say, a foot—were employed, they would in such an agent obtain very little resistance to the electricity ; but if they employed a very small conducting wire, as, for instance, one-eighth of an inch, they would get a very large resistance relative to the amount of electricity which went through. If, therefore, under the old system it was desired to send the electricity a long distance they could only do it by lessening the resistance. Therefore it would be necessary to employ a wire of very large diameter and involving such enormous expense as to be prohibitory. What was required was a wire of small diameter, and yet in that small wire they found such tremendous resistance that that also failed. The result was that people had to set themselves to work to find out how to overcome this prohibitory resistance at such a cost as would enable electric lighting to be economically carried out. The gentlemen who opposed this petition set themselves to work and produced this patent. First, they had to secure a small main wire, and that they had done. They had secured the use of a wire as small, he believed, as one-sixth of an inch, and then they got rid of what had always previously existed, namely, the direct communication between the dynamo and the burner's mouth. They employed what were known as secondary generators, and the wires that conducted the electricity after it had been brought into tension passed over this deliverer to the burner's mouth. In the old system the electricity passed direct from the dynamo to the burner's mouth, and therefore they had a high pressure throughout. Then came into play a system of what was recognised and known as secondary currents. As this great and powerful agent of electricity passed through a wire, if they put another wire near it there was such sympathy between the two wires that the electricity in the primary wire would display itself in a diluted form in the approximate wire, and sympathetically would act in that approximate wire. If, for instance, they got 2,000 volts in the primary wire, they would find it diminished in the secondary current in their system to 300 or 400 volts. His lordship would at once see the advantage of this. Directly they brought the electric current into contact with one of these secondary conductors they placed within the secondary conductor the exact amount of force required to carry the electricity on to the burner. They therefore got a small amount of force and a small amount of expenditure as the result of the dilution of the current in the secondary conductor, and they could regulate it to get exactly the force which was required. These two objects had been accomplished. Amongst other places where this useful and practical invention was employed was at the Grosvenor Gallery. The Grosvenor Gallery Company obtained the right under agreement to use the patentee's method for distributing electricity for the purpose of lighting the building. They had the right to use this invention ; they were bound to give an account of what they used, and to pay for it, and were not allowed to dispute the validity of the patent. They without a doubt said from time to time through their engineers that the system was not a perfect system, and the view of the patentees was that it had not been used in a perfect manner. But this occurred : the company employed to work this system a person of the name of Ferranti. Mr. Ferranti became perfectly acquainted with the patent obtained by Messrs. Gaulard and Gibbs, and with all that was done under it, and in December, 1885, three years after the date of Messrs. Gaulard and Gibbs' patent he obtained a patent of his own. He was not going to discuss Mr. Ferranti's patent, but its object was to accomplish the same results as that of Messrs. Gaulard and Gibbs. The Grosvenor Gallery Company were really the petitioners in this case. They took possession of this patent and used it. It was whilst he was under their fostering care, whilst he was their servant, that Ferranti acquired command of Messrs. Gaulard and Gibbs's patent. He learnt enough to enable him to frame a patent of his own, and got the Grosvenor Gallery Company to say, "We have Ferranti's patent ; we do not under Clause 2 of the agreement feel we have any obligation to burn your lights, and we set up Ferranti's patent against yours." Mr. Ferranti, who was a subsequent patentee, now petitioned to have the patent of Messrs. Gaulard and Gibbs set on one side. While I cannot say that this petition cannot lie, I do say that Mr. Ferranti, to succeed, must prove his case up to the very hilt. Without waiting for Messrs. Gaulard and Gibbs to attempt to enforce their patent Mr. Ferranti brought this petition, and said he would show that Messrs. Gaulard and Gibbs's patent was for all purposes and in every particular a bad patent. If he (Sir H. James) could show that this patent was good for any purpose he should submit that it was a good patent. He was not putting it to the Court that the patentees had invented any new principle. The dynamo was old and the main wire was old, but this was a patent got on account of a combination of several things which might be old, but which had produced results which had never been produced until the patent came into existence—results of substance, of great commercial utility and of a successful practical character.

The first witness called on behalf of Messrs. Gaulard and Gibbs was

Dr. HOPKINSON, F.R.S., who, examined by Mr. Aston, said that electricity, in its application to practical purposes, was usually obtained by the application of mechanical power working in conjunction with a dynamo machine. The direct-action dynamo was the one most commonly in use prior to the date of the patent. From the time of Faraday downwards the production of induced currents in a wire laid side by side with a main wire connected with a battery was well known. Prior to 1882 the use of induction coils for the purpose of utilising electricity was well known, and had been for many years. The passage of electricity was analogous to the passage of water through a pipe. The pressure of the water was represented by tension in the electricity, and the quantity of the water was represented by the size of the electric current. If it were desired to send electricity a considerable distance it would be necessary to have either very large conductors or a very high tension, and these difficulties prevented the application of a direct-acting current through a main wire or a long circuit. From 1879 to 1882 many attempts were made to apply upon a long main wire of small diameter installations of electric lighting at various distances. He did not know that any of these systems were attended with a great amount of success, and certainly neither of them depended upon an induced current excited on a local station by the presence in the main wire of an electric current in a state of high tension. He had examined the specifications of Messrs. Gaulard and Gibbs' patent. It was perfectly intelligible to competent electricians and fairly described a system of distributing electricity for lighting purposes. He had examined the various specifications put in by the petitioners, and not one of them described a system of distributing electricity which would supply the desideratum which existed between 1879 and 1882. Witness had made himself acquainted with the specification of Messrs. Gaulard and Gibbs's patent of September 13th, 1882. It was described as a "new system of distributing electricity for the production of light by means of incandescent or other lamps." This system consisted of the employment of an alternating current produced by electro dynamos, and determining by its passage through a number of electrical generators of special construction, the formation of induced currents, of which the quality and the value depended on the construction of the secondary coils in the electrical generators. The electricity was supplied by an alternating dynamo. The main conducting wire went round and passed in at the primary circuit of one of the secondary generators. It then passed through the primary circuit, and went on to the primary circuit of the second wire, and so on through the whole series, and then back again to the right-hand terminal of the dynamo machine. When, therefore, the dynamo machine worked, there would be induced currents in the armature of the machine of an alternating character. These currents circulated through the whole of the external surface, and through all the primaries of the secondary generator. Every secondary wire in every secondary generator would be a source of supply of electrical power, which might be used for the purpose of lighting lamps.

What would be the character of the current induced in the secondary coil constructed in the way you have described, and supplied from an alternating dynamo at high tension?—The current in the secondary coil would be of comparatively low tension as compared with the tension of the whole circuit.

Would the use of that diminished tension be beneficial for the application of the current locally, for a series of lamps, or otherwise?—It would be beneficial.

Witness explained that if a greater tension than 100 volts were used for incandescent lamps the lamps would be broken. In transmitting the energy to the dynamo machine, if the distance were great, the conductor would have to be very large in order to get the tension they desired for their lamps. By Messrs. Gaulard and Gibbs's invention they were relieved of that difficulty, because they could get whatever tension they pleased in the secondary circuits for the lamps, and were able, on the other hand, to have almost any tension they pleased for the primary circuit. The three co-operating elements of Messrs. Gaulard and Gibbs's patent which distinguished it from other systems were an alternating dynamo supplying a main wire with a current at high tension, and a secondary generator such as he had described. He did not find those three elements described in any one of prior specifications set forth in the particulars of objection. He first saw the system invented by the patentees at work at the Edgware-road Station of the Underground Railway, and at Mr. Gibbs's request he examined and reported upon the apparatus. The length of the main wire at work there was something about fifteen miles. There were about 2,000 volts of electricity passing over the primary coil, and when he measured the power between the terminals of one of the secondary generators he found there was a waste only of 13 per cent. He expected from his experience a very much larger waste. That was in the early part of 1884. He then satisfied himself that the system was at work and was working satisfactorily. Prior to that time he had never seen such results produced in that way. It was a matter of common notoriety in the electrical world now that this method was largely used in the United States. The original specification fairly represented the system which it professed to describe.

Cross-examined by Mr. FLETCHER MOULTON: Can you point to anything in the specification which describes the kind of secondary generator used by the patentees?—They do not do anything further than describe secondary generators, which would have answered their purpose. It was, continued the witness, well known prior to the date of the patent that the primary and secondary coils of the Ruhmkorff coil were interchangeable, and it was known, too, that it was possible to change tension to quantity and quantity to tension by the use of the induction coil. So far as the patentees' coil was concerned, it was an ordinary Ruhmkorff coil with six wires.

Was it common knowledge at the date of the patent that it was possible to distribute electricity by sending an alternating current through induction coils?—It had been suggested.

What is there beyond that in the first clause of this patent?—The spe

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cification states that the alternating current is to be generated by an alternating dynamo machine, and the alternating current must be of high tension ; moreover, the secondary generators have divided cores.

Does it make the slightest difference whether an alternating current is got from an alternating machine or not ?—It makes a great deal of difference in the cost. The alternating-current machine is older than the patent.

Now, the divided cores were quite common. If you placed any induction coil on a high tension dynamo, the tension is at your choice ?—Within limits.

Is there a single word or passage in the specification which tells the public they are to have a secondary current with a lower tension than the primary current ?—It is implied in the size of the wires through which you are to pass the secondary current.

Can you show in any place where the patentee points out how the tension in the secondary current is to be lower than in the primary current ?—No, I cannot.

The specifications of Jablochkoff's patent of 1877 shows a means of distributing electricity by means of alternating currents and secondary generators ?—It involves the use of lamps of a very high tension.

Was not Jablochkoff's process a perfectly applicable one at that day ?—Not as described in the specification.

But the lamp is no portion of the plaintiff's claim ?—No.

It has nothing whatever to do with the use to which you put the electricity when it is distributed ?—No. But Jablochkoff's is not an alternating current at high tension.

Why could it not have been used at high tension ?—It could, but he does not disclose it.

Do you mean to say that high tension in the primary would not assist in getting high tension in the lamps ?—You must have your tension suitable to your induction coils.

Do you mean to suggest that any ordinary electrical workman who took the Jablochkoff apparatus and used it in any ordinary induction coil would not have got a practical distribution of electricity ?—If he should use the Ruhmkorff coils he would do better, but he would very likely have done what Jablochkoff did—use an unsuitable secondary generator.

The case was then adjourned till Monday.

Monday, July 2.

On the resumption of the Court on Monday,

Dr. HOPKINSON, cross-examined by Mr. FLETCHER MOULTON, continued : In the specification of Jablochkoff's second patent there was a description of an electro-magnet. There would be no divided core in that if used for a continuous current.

But if you put a coil on it and use it as an induction coil the importance of a divided core would come in ?—Yes.

All that was thoroughly well known at the time ?—Known to a great many people, no doubt.

Would not any competent maker of electrical instruments, in following out the directions of Jablochkoff's second claim, use a wire core ?—I do not think they would ; some did, some did not.

Do you mean to say that a person in 1882 who was told to put a core to an induction coil would not necessarily have put a wire ?—Not necessarily.

Can you tell me a single coil in the market in any of the more carefully constructed instruments in 1882 in which the core was not divided ?—Undivided cores were used in some telephones, I think.

Can you show anything in this specification which limits plaintiff's first claim to the use of machines with divided cores ?—I can show you that he d escribes it as a machine with divided cores in two cases.

Apart from the question of the fineness or the coarseness of the wire, is not the method described in Du Moncel's "Exposé" the same as that plaintiff proposed to use ?—Yes; but without the high-tension primary.

Then apart from the size of the wire and the tension, Du Moncel's description would be an anticipation of the plaintiff's first claim ?—No, an anticipation of the third claim, as an instrument.

Du Moncel uses an alternating machine and a coil, which would have a wire core ?—Yes.

Then, except for the coarseness of the wire and the high tension, this would be an anticipation of the plaintiff's first claim ?—It is not for me to say whether it is an anticipation.

But Du Moncel describes a number of induction coils on the same circuit, and worked by an increase of tension ?—Yes.

Have you any doubt that this is an accurate description of what Jablochkoff actually did ?—I see no reason to doubt it.

And according to this Jablochkoff, by means of an alternating machine and a current passing through induction coils, obtained for distribution electricity for the purpose of lighting, the lights being placed on the secondary circuits of these induction coils ?—Yes, that is so.

It does not say what the dimensions of the induction coils were, and it does not restrict it in any way to any tension ?—He says the spark was scarcely more than two millimetres in length. That would be upwards of 2,000 volts.

Was that a suitable potential for using with his lamps ?—No doubt.

Suppose a person wanted to use the plaintiff's system for one of the lamps of the class Jablochkoff was using, he would have to have similar coils ?—Substantially ; but I am not aware the plaintiffs proposed to apply it to any particular kind of lamp.

Can you point out anything different between Jablochkoff's system and plaintiff's system ?—Jablochkoff had a different motive power, and proposed to work with a high tension.

Can you show anything in the plaintiff's specification which shows the light he was going to use required a high tension, or a low tension in the secondary ?—No, except that he had a light and a motive power which were available for low tension.

Where does the plaintiff say the tension of his secondary circuit ought to be low ?—He does not actually say so anywhere ; but it is implied by what I have told you.

With the exception that Sir Charles Bright states in his specification that the primary current is to have a high tension, is there any distinction between Bright's description and the plaintiff's first claim ?—Bright says nothing about the construction of his cores, and he does not say you are to use an alternating current, but rather inclines to a continuous current, and he uses a magneto-electric machine.

But a magneto-electric machine produced an alternating current as often as not ?—The inventor does not say which he proposes to use.

If you had a continuous current you would want an interruption ; if you had not a continuous current you would not want one ?—Yes ; and that makes a great deal of difference.

Now in the description of Johnson and De Meritens' method there is a distinct statement that the cores of the primary are to be made of bundles of fine wire ?—Yes, but they spoil the effect of it by putting in a solid piece of iron at the end (laughter).

Do you suggest this would not work well ?—No ; it would not work well.

Would it not distribute a light over fifty bobbins ?—No doubt over a considerable number of bobbins, but there would be a great waste of power in the apparatus. You may be perfectly certain it would not work successfully. Apart from the faulty construction of the secondary generator, and that the high tension is not disclosed, I do not know that I can point out any difference between De Meritens' system and the system described by the plaintiff in his first claim.

Witness, continuing, said he did not think Messrs. Edward and Normandy's system would work successfully, nor did he think the description which they furnished would lead one to work out Gaulard and Gibbs's system. He had looked also at Lake's specification, and he did not think Lake's apparatus would work at all. The inventor proposed to put secondary coils round the poles, which would result in waste of power.

Lake says any form of magnet can be used if the local coils are placed round the poles. Were there not many forms of magnet in which induction coils were placed round the poles, and which would have answered exceedingly well ?—There are none which occur to me. From the construction of the apparatus, witness thought it a reasonable inference that solid cores were used. There was nothing, in witness's opinion, in Deprez's specification which would lead one to construct Messrs. Gaulard and Gibbs' apparatus, and the same remark applied to the description of an instrument in the *Electrical Review*. He did not think there was anything in the last-mentioned apparatus which would obviate Foucault currents, and he doubted if the core was made of wire in such an instrument. The iron ends of the secondary generator would get very hot in consequence of the existence of the Foucault currents, and the core, if it were, as he imagined, solid, would also grow very hot. Coming to Harrison's system of 1878, the inventor described everything mentioned by plaintiff in his first claim except that he did not mention high tension and did not describe his secondary generator.

But there were plenty of efficient coils in the market ?—I do not think there were for this purpose.

Allowing for a high tension, you could have found suitable coils in the market ?—No doubt.

By simply following Harrison's description you could get a system of distribution with high tension in the secondary ?—With Ruhmkorff coils and appropriate wires he would be able to do it. But Harrison used iron where he should have used copper, which would increase the resistance and misdirect the lines of magnetic force.

Witness considered a tension which would be sufficient to kill a man a high tension.

Cross-examination continued by Mr. PIKE : The statement in Messrs. Gaulard and Gibbs's specification, that the quality and value of the current depended solely upon the construction of the induction coils, was not literally accurate, because it would depend also on the amount of current sent through the primary. That was clear enough. The word "resistance" was used in the specification not in its strict technical sense, but in a loose and vague sense.

Re-examined by Mr. ASTON : The statements contained in the provisional specification of Messrs. Gaulard and Gibbs were generally statements of electrical propositions.

Do these general statements affect the residue of the complete specification as it now stands amended ?—I think not.

Notwithstanding your attention having been called to several of these prior specifications, do you still adhere to your statement that prior to the 13th September, 1882, you do not find described the use in co-operation of the alternating dynamo sending alternating currents of high tension through long lines of wire upon which are placed at intervals secondary generators of the character described by the patentees ?—No, I do not find that in any one of them. If the secondary generators were constructed with solid iron cores they would not answer in Gaulard and Gibbs's instruments.

If they were constructed with solid iron cores, would there be any result such as is referred to in page 4 of the specification ?—No, there would be no reduction of the Foucault currents. There are little or no Foucault currents in the secondary generators described by Messrs. Gaulard and Gibbs.

In Messrs. Gaulard and Gibbs's generators, are there any conditions such as would generate any extraordinary heat in solid cores ?—No, there would be no such Foucault currents as would create any sensible heat. The avoidance of Foucault currents is necessary to the working of Messrs. Gaulard and Gibbs's patent, because if they existed they would make the inductive apparatus as hot in some cases as to be likely to destroy its insulation.

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In any previous specification is there any reference to the desirability of avoiding Foucault currents in the secondary generators on the long main wire?—No instance occurs to me at this moment.

Witness, continuing, said that in the ordinary Ruhmkorff coil the primary wire was something like one-eighth of an inch, and the secondary about one-hundredth, possibly less. The length of the secondary wire would be measured by miles, and the length of the primary by inches, or at the outside by feet.

If you send a current of low tension through the primary, what would be the result as regards the tension in the secondary?—You would get a tension in the secondary amounting in many cases to thousands of volts.

Is it true that in all cases where the secondary generators are mentioned Messrs. Gaulard and Gibbs appeared to contemplate a lower tension at that point than there would be in the main circuit?—Yes. No doubt that is an advantage.

Do you know any other system, prior to 1882, where the secondary generators were worked in that way on the main circuit?—No.

Witness, continuing, said that Jablochkoff in his specification dated May 22, 1877, spoke of his invention as one for "dividing" the electric current. In those days the opinion was that it was a matter of great difficulty to get more than one light with one machine, and the great object of inventors was to divide the electric light and produce lesser lights with a smaller expenditure of power.

What was the result if a lamp broke down?

His LORDSHIP: Well, the same result as would happen if a candle went out (laughter).

Witness: Your lordship is correct. You would be in the dark (laughter).

Mr. ASTON: But in the case of a series of lamps what would happen?—If one went out all would go out.

Is there anything to indicate that the induction coil which works that lamp is to have a special character?—No. On the contrary, it is indicated in the specification that the tension of the secondary circuit must be very high in order to overcome the resistance of the lamp.

Is there anything in Jablochkoff's specification which would lead anyone to employ Gaulard and Gibbs's system?—No; I do not think there is. Jablochkoff's evident intention was to divide the electricity and produce a high tension suitable to the lamp he employed.

What do you say of Du Moncel's system?—He intended to have a high tension, which was precisely the converse of Messrs. Gaulard and Gibbs's plan.

His LORDSHIP: What is the objection to Du Moncel's?—It would not work incandescent lights. Jablochkoff proposed to use a solid core; but even with his arrangements a solid core would have resulted in very great waste and trouble.

If this induction apparatus were used in Gaulard and Gibbs's system would it work?—No; Bright's specification of 1878 was more like Jablochkoff's than Messrs. Gaulard and Gibbs's. Johnson's specification was a provisional description of "an improved induction apparatus."

Which would be more suitable, an ordinary Ruhmkorff coil, or the one described here?—An ordinary Ruhmkorff coil would be much better.

Do you think the induction apparatus described would be suitable for use on a long main wire such as is described by Messrs. Gaulard and Gibbs?—I do not think so.

His LORDSHIP: Could it be used?—It could be used; but it would be inefficient. That is, it would cause great trouble, and there would be great waste.

Mr. ASTON: Did you ever hear of any attempt to use it?—No, never.

His LORDSHIP: Is it not an invention in practical use?—I never heard of it. I never heard of Edwards and Normandy's apparatus being used. You would get sparking wherever you broke the circuit, which would be destructive of the apparatus. For long distances its use would be impossible.

Would Edwards and Normandy's specification teach you to make Gaulard and Gibbs's apparatus?—No.

His LORDSHIP: Is it near the mark, or a long way off?—It is tolerably near the mark, no doubt, but the suggested use of the intermittent current is misleading.

Mr. ASTON: In electrical inventions prior descriptions do sometimes go very near, do they not?—Very near.

Witness added that there was nothing in the specifications of either Deprez or Harrison that would lead one to construct Messrs. Goulard and Gibbs's apparatus.

This concluded the evidence of the witness, and the Court adjourned.

Tuesday, July 3rd.

At the sitting of the Court on Tuesday Mr. Aston called

Mr. JAMES SWINBURNE, electrical and mechanical engineer, electrician to Messrs. Crompton and Co., who first carried out the arrangements for lighting the Law Courts. He had for many years taken an interest in electrical matters, and in 1878 he saw the Jablochkoff system at work in Paris. At that time the subdivision of electricity was supposed to be a very great difficulty in the way of electric lighting. The difficulty was supposed to be in making a series of lamps burn independently from one machine, and arranging so that when one lamp went out it should not extinguish all the others. There were in those days a large number of applications for patents up to Christmas, 1882, when Messrs. Gaulard and Gibbs's system was brought to his notice. He had some conversation with Mr. Swan on the subject, and he saw the light exhibited at the Aquarium in 1883. He then investigated the construction of the coils, and he found that alternating currents were sent at high tension into the main circuit. Witness saw Messrs. Gaulard and Gibbs's specification in 1883, or early in 1884, and he did not find any difference between what was described there, and the information given him by Mr. Swan, and what he saw himself at the Aquarium. He ascertained that Messrs. Gaulard and Gibbs's apparatus contained an arrangement for causing the currents in the main wire to excite the induction coils in the local generators. The co-operating elements that he found in Messrs. Gaulard and Gibbs's apparatus were an alternating machine of high tension, secondary generators connected with the high-tension dynamo, the secondary coils giving a comparatively low tension. The primary coils were of high tension. Prior to the date of the patent, September 13th, 1882, witness did not know of these three elements co-operating together to produce the result of electric lighting in local insulations. Prior to Sept. 13 he did not know of electric lighting being successfully worked by means of an induction apparatus excited by currents in a state of high tension supplied by an alternating dynamo. The difficulty of distribution over large areas from a central station was unsolved prior to 1882, and was exciting great attention. He had seen Messrs. Gaulard and Gibbs's system in operation in connection with the Grosvenor Gallery, and enormously developed by licenses in America, where its employment was increasing very rapidly. Witness personally saw the application of it in four or five towns there. He had examined the induction coils, and in no case was there a solid iron core. The system would not work commercially with solid iron cores, and it would be an absurd thing to use them. It would not do to apply the Ruhmkorff coil to Messrs. Gaulard and Gibbs's system; it would not be their system if it were so applied. If any electrician were to do what was directed in Messrs. Gaulard and Gibbs's specification, using the secondary generators as described, he would be able to distribute electricity from an alternating dynamo supplying local installations. Witness had seen Messrs. Gaulard and Gibbs's secondary generators at work at the underground station at Charing Cross. With a slight difference in details it was the same apparatus as was described in Messrs. Gaulard and Gibbs's specification. He knew no other system of that kind in use now. If a high-tension current, say 2,000 volts, were introduced with secondary generators, there would be extreme danger where people were able to touch the wires or the fittings. Witness had heard Dr. Hopkinson's evidence as to the prior specifications, and had made himself acquainted with those specifications. He did not find described in any of them the three elements which distinguished Messrs. Gaulard and Gibbs's instrument. Du Moncel gave no description which would enable anyone to adopt Gaulard and Gibbs's system with the three co-operating elements. He entirely agreed with Dr. Hopkinson's evidence as to the specifications.

Cross-examined by Mr. MOULTON: Is there anything in Messrs. Gaulard and Gibbs's first claim which limits the current in the secondary generator?—He specially mentions high tension in the primary, and the inference is that it was not high in the secondary. You could not produce a light with high tension in the secondary circuit, and that would lead one to suppose that the secondary circuit must be low tension.

But you could use high tension?—Well, you could, but it is dangerous.

Is there anything to point to any particular class of secondary current which Messrs. Gaulard and Gibbs intended to introduce?—Only the points I have mentioned.

I will take that answer. Is there anything to limit the source of the alternating current?—No, not in the claim.

Is there anything to limit the class of the secondary generators?—Not in words.

I believe the claim consists of words?—It does. Taking the claim by itself, there is nothing. The specification spoke of an alternating-current dynamo. It was a common source of alternating current in 1882. The "special construction" of the secondary coils of the generators which Messrs. Gaulard and Gibbs spoke of referred to the fact that these coils were divided into six wires and mechanically connected. Messrs. Gaulard and Gibbs's secondary generators were arranged in series.

Is not the success of the distribution by secondary generators due to their arrangement in parallel?—That is not the only reason; it is only one of many reasons.

May I not take it that in America the generators are arranged in parallel?—Yes. Except in the experimental installation, witness did not know of any instance in which the generators were arranged other than in parallel.

With the exception of the passage which says you may vary the number of generators, there are no explanations or directions as to how you are to vary these dimensions and arrangements according to circumstances?—The patentees simply take an instance and give instructions. Continuing, witness said that Jablochkoff, as described by Du Moncel, had a high tension in his secondary generator. Witness did not think Jablochkoff distributed electricity; he simply divided it.

J. Johnson in his specification described the use of alternating currents derived from an alternating machine which are under certain circumstances to have a considerable quantity, as well as tension, and may be caused to travel all over a town, say five or six miles or more. Apart from the construction of the secondary generator, is not that an example of what is described in Messrs. Gaulard and Gibbs's specification?—I think that, apart from the construction of the generator, Johnson's idea was quite different.

But is it not what is described in plaintiff's specification?—I do not think it is. You cannot have a current of vast quantity going through Messrs. Gaulard and Gibbs's generators.

Do you say that in Messrs. Gaulard and Gibbs's secondary generators you cannot pass a current of considerable quantity?—No, not in the same sense that you can pass a current of considerable tension.

I put it to you that the generator employed by Johnson is superior to that described by Messrs. Gaulard and Gibbs because it has its poles united. Does not that increase its efficiency?—Yes, if there are no Foucault currents. Witness could not say if lamination for the purpose of overcoming Foucault currents was known in 1878.

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Apart from the generation of the particular form of generator used, would not the description of Lake's system apply equally to the plaintiff's first claim?—I do not think it would; I see nothing about high-tension there. Witness did not think the description of Edward and Normandy's apparatus would supply a knowledge of Messrs. Gaulard and Gibbs's patent.

Re-examined by Mr. ASTON: The parallel arrangement of the lamps was an alternative plan to the series suggested by the patentees. If the wires were represented by a ladder and the lamps placed on the rungs that would be a parallel arrangement; if the rungs were removed and the lamps placed on the main supports that would be an arrangement in series. Messrs. Gaulard and Gibbs gave an arrangement by which the lamps could be worked in parallel. He thought electricians might have employed the parallel arrangement with the knowledge possessed at the date of the patent.

Throughout the whole of Messrs. Gaulard and Gibbs's specification did you find indicated the use of a dynamo other than one which would send a high tension current into the main circuit?—No, not in my opinion.

Taking the tension between the terminals of the secondary wire in the secondary generator and comparing that tension with the tension between the terminals of the dynamo machine, what would you find?—The tension between the terminals of the secondary wire would be very much lower. Witness, continuing, said that after having had his attention called to all the prior specifications, he was still of opinion that Messrs. Gaulard and Gibbs's patent was novel, and the commercial utility of it was enormous. The disadvantage of the arrangement of the lamps in series was that there would be difficulty in turning out the lamps unless they had the regulator mentioned in the patent. The directions contained in Johnson's specification would not lead anyone to adopt Messrs. Gaulard and Gibbs's apparatus. It would, on the contrary, lead to an absurd fallacy.

His LORDSHIP: What do you mean by an absurd fallacy?

Witness: He thought by putting his lamps on the secondary circuit he would not absorb any power from the dynamo. That touches the principle of perpetual motion.

His LORDSHIP: Do not let us go into that, pray (laughter).

Witness, continuing, said he thought Lake's specification would not lead anyone to construct Messrs. Gaulard and Gibbs's apparatus. He did not believe Lake's system provided for the distribution of electricity over a long wire for the purpose of feeding different installations, and he would say the same of Edwards and Normandy's plan.

His LORDSHIP said that it seemed to him the evidence was weak in establishing what Messrs. Gaulard and Gibbs really invented. So far it had gone to show what other people did or did not invent, and that they had not anticipated Messrs. Gaulard and Gibbs.

Prof. ADAMS, F.R.S., Professor of Natural Philosophy, King's College, London, stated he was on the jury which decided the merits of the exhibits at the Electrical Exhibition at the Crystal Palace, in 1882. At that exhibition there was nothing like the patent which formed the subject of that trial. The first instance he saw of electricity being distributed for lighting purposes from a central station by means of secondary generators was Messrs. Gaulard and Gibbs's system, when it was at work at the underground station of Edgware-road and Notting Hill-gate. It was produced by a high-tension dynamo machine, capable of producing a high-tension current, probably 2,000 volts. In the secondary generators the current could not have been more than 100 volts. He had never before seen such a system of distributing electrical power. He had read what were termed the prior specifications, and in none of them did he find anything which anticipated Messsrs. Gaulard and Gibbs's patent. The novelty in Messrs. Gaulard and Gibbs's invention was an alternating dynamo machine for the production of electricity. This current was carried by a system of distribution by means of fine wires over long distances with secondary generators, the primary wires of which received the current, and the secondary wires of which gave it out for use at local stations, where several lamps were to be lighted. The great object of electricians prior to 1882 was to sub-divide the electric light. The Ruhmkorff coil would not have been suitable for use in Messrs. Gaulard and Gibbs's patent. Witness had studied the construction of the secondary coils as shown in Messrs. Gaulard and Gibbs's specification. The effect of passing a current of high tenson over them was to produce a current of lower tension in the secondary circuit. The two forms of generators described in Messrs. Gaulard and Gibbs's specification could be used with a parallel arrangement of lamps. Witness agreed generally with what had been said by the previous witnesses as to the prior specifications.

Cross-examined by Mr. MOULTON: Is there in this patent one word which points to the possibility, or gives any direction for arranging these generators in parallel?—There were no directions.

And there is nothing in the figure which shows it?—No, it was not necessary.

But if you were to put generators, such as are described in Messrs. Gaulard and Gibbs's specification, on a high-tension current they would be both burnt up?—If you put one it would.

Witness said that in 1882 it was not novel to send a high-tension alternating current to a long distance for the purpose of being transformed into low tension.

If you wanted to do that, was it not the natural way to take the alternating current from an alternating-current machine?—Yes.

Then Gaulard and Gibbs simply used the most ordinary way of producing alternating currents?—I do not agree that it was the ordinary source of alternating currents at that time.

Re-examined by Mr. ASTON: You have stated that if one of these generators were placed in parallel it would be burnt up?—Yes; that would be owing to the small amount of resistance in the primary.

Was it not perfectly well known in 1882 that if too large an amount of electricity was passing through you could diminish it by increasing the resistance?—Yes.

Have you any doubt that any intelligent workman could have put the generators in parallel?—I have not.

Witness, continuing, said that in 1882 he had never heard of an alternating dynamo approaching anything like 2,000 volts; in fact, at the time of the exhibition at the Crystal Palace 800 volts was considered enormous, and the mention of 1,000 volts would make a person's hair stand on end. It was only since that year they had heard of the enormous pressure to which they were now accustomed.

Mr. JOHN H. GIBBS, one of the patentees, said he remembered being in Paris during the Electrical Exhibition of 1881. He then gave attention to electrical matters from a commercial point of view, and engaged the assistance of Mr. Gaulard as an electrical expert. Mr. Gaulard's mind had since broken down, and he was now in an asylum. His object was to convey electricity to a distance, and light glow lamps in various installations. He and Mr. Gaulard were working for nearly 18 months, and when they perfected their plans they obtained English, French and American letters patent for the invention. They exhibited it at Vienna, and it was afterwards employed at the Grosvenor Gallery. In 1883 a company was formed for supplying the apparatus, and five stations on the underground railway were lighted. The generator—an alternating current dynamo machine constructed by Siemens, was set up at Edgware-road. That installation cost them £4,500. It was a 15-mile circuit, and there were about 150 incandescent lamps and 4 or 5 arc lamps. He never knew and never heard of any such installation being set up before. In working the system they found that 85 to 95 per cent. of the power in the primary wire was reproduced in the secondary circuit, and there was not a single scientific man at that time who did not ridicule the system. The company to whom they sold their patent—the National Company—afterwards competed for a prize offered by the Italian Government for the best system of distributing electricity. After a demonstration at Turin—where he believed the circuit was fifty miles—the company received £400 and a gold medal. In 1884, they set up the installation at the Grosvenor Gallery.

His LORDSHIP: I do not see whither this evidence is tending.

Mr. ASTON: To show utility.

Mr. MOULTON: I am willing to admit that the distribution of electricity by secondary generators is a good thing.

Witness, continuing, said they had sent an installation to Tivoli, which was working satisfactorily. The generators were arranged.

His LORDSHIP: Is your company paying a dividend?

Witness: It paid one dividend.

Mr. ASTON: The existence of this petition does not tend to help you.

Witness, continuing, said that under the licence granted to the American Company the National Company was receiving "comfortable" royalties.

Cross-examined by Mr. MOULTON: In the early history of the patent witness wrote putting forward his views on the subject. At that time he believed his complete specification to be scientifically correct.

You know the scientific world did not agree with your view?—The scientific world did not believe in the possibility of doing what we professed to be able to do.

Do you mean to say scientific people did not believe that your patent involved perpetual motion and all sorts of absurdities?—Scientific men never said so to me. I believe the primary circuit at Tivoli is more than ten miles. It is worked on the "series" system. I believe there is another installation on that principle at work in the United States.

Did you ever say it was a *sine qua non* that there should be equal masses of metal in the primary and secondary circuits?—The masses of metal should be as nearly equal as possible to obtain a good return.

Is it true your secondary generator was based on this idea?—In one respect it was, because you cannot make an effective instrument without it.

Did either of your generators satisfy that requirement?—They came as near to it as the ordinary market size of the wire would admit.

Do you say that wire is not made of all sizes?—There are only certain trade sizes.

Will you say you chose these sizes because they were nearest to equal metallic masses?—It was one of the reasons.

Did you know there ought to be equal metallic masses in the two circuits?—Yes.

The Court then adjourned.

WEDNESDAY, JULY 4.

The first witness called on the Court resuming was

Prof. GEORGE FORBES, F.R.S., Consulting Electrical Engineer, who stated that he was well acquainted with Messrs. Gaulard and Gibbs's patent. The features which specially distinguished the apparatus were the selection of proper secondary generators, a high-tension main, and a proper alternating-current dynamo. Since 1883 he had seen many installations for electric lighting. Some of those covering short distances were on the direct-supply system; but for long distances he knew of none which were successful which did not employ the three elements combined in Messrs. Gaulard and Gibbs's patent. He had seen Messrs. Gaulard and Gibbs's system as described in the specification actually at work at the exhibition held at the Aquarium in 1883; the next time on a thoroughly practical scale, on the Underground Railway, in 1884; at the Grosvenor Gallery, and extensively in America. He was not certain as to the arrangement of the generators in the Grosvenor Gallery; but on the railway and at Pittsburg, in America, they were worked just as shown in the patentees' drawings. He had made himself familiar with the prior specifications, and in none of these did he find the three elements which he had described as distinguishing Messrs. Gaulard and Gibbs's apparatus. The secondary generators mentioned in Messrs. Gaulard and Gibbs's specification had divided cores. He knew now that such cores would make all the difference between success and failure. In some of the prior specifications there was a reference

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to a divided core generally when the induction apparatus was used to give a high tension, but always with a "continuous current interrupted." In several of the specifications he found references to the use of a solid core. In every one of these cases the alternating current was employed. Prior to 1882 a good many experiments were known for determining the qualitative effects produced by different arrangements, but there was no measurement made as to the loss of energy produced by using particular kinds of cores in induction apparatus. With a solid core they would get, perhaps, 30 or 40 per cent. of the energy. They knew now that the loss of energy in a solid core was caused by the Foucault currents creating heat and using up the energy. He found it extremely difficult now to divest himself of the knowledge he had acquired since 1882, but he thought the qualitative effect of the Foucault current was known prior to 1882, but there was no quantitative experiment known to him until Messrs. Gaulard and Gibbs's system was invented. Other things being equal, an electrician in those days would obviously have taken a solid core, for the simple reason that it would make a better mechanical arrangement. Prior to 1882 he had never seen any experiment for ascertaining the effect of an alternating current upon a solid core as compared with a divided core. Prior to 1882, however, it was known that in the use of induction coils the tension of the secondary coil at the moment the primary coil was broken was enormously intensified by the use of the divided core. Witness believed at the time Messrs. Gaulard and Gibbs made their patent known the term secondary generator was new to the scientific electrical world. In all previous induction apparatus the object had been simply to transform or convert the tension from a low value to a high value without any great regard to economical results, but the object in Messrs. Gaulard and Gibbs's patent was to get a regeneration of the energy, and with that special object in view they designed their instrument and apparatus.

Cross-examined by Mr. MOULTON: In 1882, the importance of using a wire core instead of a solid one was thoroughly appreciated by the electrical world for the purpose for which it was then used.

Was the importance of economy appreciated?—No, economy was not.

But it was known that wire core ought to be used?—Yes, with a high tension in the secondary.

Are there any directions in this second specification of Messrs. Gaulard and Gibbs that the core should be made of wire?—It is distinctly stated so, with the object of preventing Foucault currents.

Mr. MOULTON: Do not try to mislead the Court.

Mr. ASTON: That is a most unfair observation.

Do you tell his lordship that that remark about the Foucault currents refers to the same cores which are spoken of as "the exciting cores which enable the gradations of the tension," and so on?—No; the core in the secondary apparatus is sub-divided in sheets.

I am talking of the "exciting cores." Are there any directions that those shall be made of wire?—Yes, on page 3.

That is the "exciting core," do you say?—Yes; those instructions were intended for both.

Where is there any direction that it is essential or important in the second instruction that the core should be of wire?—In his description of how to make a core he has said distinctly it shall be of wire.

Witness, continuing, said the arrangement of discs would work; but it was not the best arrangement.

Was it not known in 1882 that the tension in the secondary was in proportion to the number of turns in the primary?—No; probably at that time the problem had never been put to anybody.

Do you mean to say that has been discovered since 1882?—It has been announced since 1882.

And was never announced before?—Never; I am thoroughly of opinion it was absolutely unknown before 1882.

Taking your own description of the three co-operating elements in this patent, where do the patentees tell you how to select the proper secondary generator?—I do not think they ever make a great point of the particular parts; but they show two types which would work.

Is that the only answer you can give?—I do not care to go further than that.

Where do they speak of a high-tension main?—When they speak of sending a current 50 kilometres it is clearly understood that must be a high-tension current. They do not expressly refer to a high-tension main. The Pittsburg installation was put in this year after the commencement of the action.

Re-examined by Mr. ASTON: If an electrician endeavoured to carry out fairly the directions given in the specification he would be able to make secondary generators which would answer the purpose. There was nothing in the specifications to take him away from having generators with divided cores, the disadvantage of Foucault currents being pointed out. Any person wishing to use a solid core would do so, because it could be made in any shape, and included a greater quantity of iron than a sub-divided core, and because of the facility with which it could be bolted together. As regarded the quantitative results, he knew of no publication which said prior to 1882 that the tension in the secondary wires would be proportionate to the number of coils. The quantitative results would be known.

This concluded the case for the plaintiffs.

Sir HORACE DAVEY, for the defence, said that if the alleged invention had been true to the provisional specifications, and had made it possible to supply an unlimited number of lamps without any loss of energy in the primary current, it would undoubtedly have been of great value, but unfortunately, though that claim was clearly made for it, the achievement was not equal to the promise. There was a distinct difference between the original specification and the subsequent one, and he asked was the inventor at liberty to strike out what was said in the provisional specification to be the distinct feature of the claim, and to insert something different? The word "unlimited" of the provisional specifications meant that you might have as many induction coils as you pleased without impairing the value of the primary current, which was, therefore, constant; and if this had been true the result aimed at would have been achieved. The patentee claimed to have invented something which obviated all necessity for putting a limit upon the number of induction coils or secondary generators, which would be used with the primary coils, notwithstanding the fact that the current had been induced for the purpose of serving lamps at various points. But this being, unfortunately, untrue the whole system crumbled, and the word "indefinite" had been substituted for "unlimited" in the specifications, which was, of course, very different, and the claim for the special construction of generators had been also struck out. He should use the power to take the complete specification in its amended form as if it had been the original specification, and should also have regard to the disclaimed pattern for the purpose of keeping the patentee to the pattern as it had come down. The claim for the construction of secondary generators was abandoned, and the patentee admitted that they were already old. Then the claim for the process of distribution did not describe the invention as it was described in the original specification, but the claim was obviously vastly larger—"the employment of an alternating current of high tension for the generation on a number of secondary generators of induced currents individually utilised for the production of light or motive power." The claim had reference to generators of every construction, and thus went far beyond the supposed invention of the original specification. Having to deal with this claim as amended, he ventured to submit that by the confession of Dr. Hopkinson himself, of Swinburne, and Adams, there was not a shadow of novelty in the invention. If he had claimed a special kind of generator, or dynamo machine, or a special arrangement of the lamps, or special provision for their lighting it would have been different; but the claim was so wide that it brought within it every system in which an alternating current of high tension was used for the generation on induction coils of every description for the purposes of light and motion, and every such system would be an infringement of the patent. Could he maintain that position in the face of the evidence which had been given? In the third place, the wide difference between the claim as formulated at that bar and in the patent should be noticed. The system was hopelessly old in 1882 when this patent was granted.

Mr. JUSTICE KEKEWICH: My difficulty has been to see how the evidence and the patent agree.

Sir HORACE DAVEY: That is our difficulty also. They had produced half-a-dozen descriptions of alternating-current systems, and if he could see in public works descriptions of a system of alternating currents with or without high tension, with nothing about the tension, but with secondary generators, he was entitled to say that, on the ground of the invention being anticipated, the patent was not good. Dr. Hopkinson described the wire cores of the coils as the novelty, but he did not say that in the body of the specification. But if this was an essential, how was it that Dr. Hopkinson and Prof. Forbes did not point it out? How was it that the proper distinction between what was novel and old and between what was essential and not essential was not drawn? They were told that the great thing was the use of the wire coils, but they had the evidence of Dr. Hopkinson that the Ruhmkorff coil was before the date of this patent always made of wire, and that it was so arranged that you could use either the thicker wire as the primary and the thinner as the secondary, or *vice versâ*. There was no novelty in the divided coil; it was the most common form of induction coil, and no one in his senses would have used a solid core where the divided one was used according to the specifications. There was, too, an absence of all instruction that the divided core must be used; neither were directions given as to the number of the coils or convolutions for the coil or the secondary wire. They knew that the quality of the tension of their secondary wire would depend upon the cross section and the fineness of it, and secondly on the number of convolutions round the induction coil. The quantitative value, they were told, was not known before. But the patentee did not tell that, and it would be most material for regulating the tension. In regard to Fig. 3 on the specifications it was said that it was most important to overcome the difficulty of the Foucault currents by securing that the iron case in which the coil was contained should not be in contact with the coil itself. But it was the very use of that iron case which created the danger of the Foucault currents; they had nothing whatever to do with the coil itself. And the letterpress was alone in showing the splitting; the figure ignored it. Do away with the iron case, and the danger of the Foucault currents would vanish. The particular form of coil was not at all insisted upon as essential to the success of the process, and in the drawing of the second method of producing these currents, the core was shown as solid, with a handle such as used to be in vogue years ago for drawing it in and out. If this divided core was something which a workman would not use unless he had it pointed out to him, directions concerning it would, one would think, have been given. Sir Horace Davey proceeded to quote authorities bearing upon the necessity of a full description being given of all new patents, and asked his lordship whether if the use of a divided coil was essential to the success of this invention, the patentee had told them that it was so. Mr. Gibbs, in cross-examination, had told them it was a *sine qua non* that the mass of metal in the primary and secondary circuits should be equal, and that he knew this at the time the patent was obtained. Then he ought to have said so; but he told them nothing of the kind in the first specification. He had not told them either how many convolutions there should be round the coils. If these points were essential, what was there to inform the world that that was so? This was an obligation from which an inventor could not escape—to explain the features of his invention as they were beneficial to the public to the best of his knowledge at the time. The learned counsel proceeded to support this position by quotations. The claim, he

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continued, was one for an alternating current, from whatever source and from any kind of energy, to produce light from lamps of every description It might be asked how was it, if this plan was so well known in 1878, that no trace of its general use was found until 1882. Well, it was not true that it was not used, for Jablochkoff's system was in full vigour in Paris. But the real reason of its remaining in abeyance was that the incandescent light was not known except as a scientific curiosity. The system arose out of simple elements which were in everybody's hands, but there was no lamp fitted for the light, and therefore the system was not used. The almost universal method of using this system was by parallel and not by series. Dr. Hopkinson was uncertain whether they contemplated that or not, and the directions given were not sufficient to enable that method to be applied to the invention. In order to fit an induction coil for use in parallel, alterations in the whole were required which were not pointed out in the pattern, and therefore if the pattern was intended to explain the use in parallel as well as in series he had not given the directions which would be required to enable it to be used in that way. As to whether the specifications as originally prepared described the same invention as the amended specifications, the duty of the patentee was to describe the end of his invention in the provisional specification, and the final must not go beyond or be distinctly different from or larger than was the original. He wished to lay special stress upon the word "ascertain" in the rule that the inventor must "ascertain" how his invention is to be carried out, and what is essential and what is not. This had not been done in this instance. Sir Horace proceeded to refer to Du Moncel's description of Jablochkoff's system as he saw it worked, and to show that in its main features it was like the system now under discussion. Dr. Hopkinson's criticism upon this was that high tension was not used, and that his secondary generator cores might have been solid. But there was no ground for this statement, as it was not recorded whether high or low tension was employed. The tension was adapted to requirements, as admitted by Mr. Swinburne and Mr. Adams. There was in reality no definition of high tension, except that it meant that you regulated the tension so that it should be sufficient for your purposes. Messrs. Gaulard and Gibbs were, in fact, merely teaching a man the best way of using an old machine, and he quoted precedents to show that in such a case a patent should not be granted. Dr. Hopkinson admitted that the process described by Du Moncel was precisely the same thing as Messrs. Gaubard and Gibbs's system, except that that did not mention the tension. He said it was used to supply a high-tension lamp. Why because in that particular instance it was used to supply a high-tension lamp he should say the process was confined to high tension surpassed his (Sir Horace Davey's) comprehension. It was said that in this system the primary current was of a low tension compared with the tension in the secondary current. But when it was the common knowledge and property of mankind that you could increase the tension that objection speedily vanished. In regard to the system of Edwards and Normandy, Dr. Hopkinson said they did not use an alternating machine ; but he admitted that alternating dynamos were well known before the date of this invention in 1878 A dynamo machine was nominally an alternating machine, and you made it into a continuous one by the use of the commutator. There was not one iota of difference between this discovery and that except that the earlier one was perhaps more clearly and accurately described. Here you simply put on a commutator to make the alternating current of the dynamo continuous, and then by another machine you made the current alternating again. What Dr. Hopkinson had said on this point was an illustration of the straits to which the best men were sometimes put to support a thesis. The protection sought was against the use of any alternating current produced in any way, so that if any one were idiotic enough to adopt Dr. Hopkinson's suggestion, and put on his reverser, he would still get an alternating current which would be within the respondent's patent, and an infringement of it. The system of Deprez was that of an ordinary current of high tension to be used for the purpose of inducing currents for use at distant stations. The only criticism made upon this by Dr. Hopkinson was a practical admission of the case as regarded that authority. Bright's theory was that it was necessary to adapt the size of both his primary and secondary wires to his requirements. The general system of lighting by means of induced currents was perfectly well known, and therefore the new points of Gaulard and Gibbs's system must be confined to the particular description of apparatus employed. In regard to Johnson's system, Dr. Hopkinson did not think his secondary generator would work very well. That Johnson's was not a perfect form did not take away from it the quality of being an anticipation of a patent which claimed the whole process. In the case of De Meritens' system the iron case was a difficulty, but not so great as it was in that of Gaulard and Gibbs, and the coils might be arranged for either tension or quantity. Curiously this system anticipated Messrs. Gaulard and Gibbs even in their errors, for it was announced that there would be no loss of energy in the primary wire. If it was said that De Meritens' generator was not perfect, it might be replied that neither was Gaulard and Gibbs's, and that if the system failed on that account in the one case, it did in the other. If you broke off the ends of De Meritens' coils you would have the same form of generator as Gaulard and Gibbs's. Dr. Hopkinson believed Lake used the solid core, but there was nothing whatever in Lake to show whether the core should be solid or divided, and if figures were to be relied upon those attached to Messrs. Gaulard and Gibbs's specification would be inconvenient to them. When it was known that Ruhmkorff's coils were used for induction purposes, it would be perfectly unwarrantable to say that he confined himself to the use of the undivided core.

On the conclusion of Sir Horace Davey's address the Court adjourned.

Yesterday (Thursday) Sir William Thomson was examined on the part of the defendants. The report will be continued in our next issue.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June 23rd*, 1888.

The agitation against overhead wires in this city seems at last to have reached a definite point, where action succeeds discussion, and where the strong arm of the police is used to enforce the provisions of the law. In my last letter I made reference to the steps that are being taken to remove the dead wires from the streets. The more the matter is investigated the more remarkable becomes the number of such dead wires strung around the city, on well nigh every street, at well nigh ever possible or impossible angle. One of the early estimates as to the extent of such wires placed the quantity at not less than 10,000 miles, but a second detailed examination is promising to bring the total up to twice as much. Of course all these wires cannot be taken down at once, but where owners can be found for them the work has already begun; and in the case of wires that belong to nobody, the Board of Public Works has been called upon to render its assistance. In one case, General Newton, who is the Commissioner of Public Works, has been requested to remove a big cable running pretty well half the length of business Broadway. It was put up by the Baltimore and Ohio Company, but was found unsatisfactory, it is said, and was rejected. Then the company passed into the hands of the Western Union Company, which declined to saddle itself either with the dispute or with the cable. Thus it happens that the cable might go on hanging until some time in the next century, but for the decision of the Subway Board to have it removed, with its other less conspicuous companions. Of course, when all the wires are removed, as well as the abandoned poles, our streets will present a less ragged appearance than they do now. The Subway Board has also given notice of its intention to condemn every electric light station that has not been examined and properly passed by July 1st, and to see by July 15th that all conductors shall have been placed in conduits where such provision has been made. In order to perform this work with discretion, the Subway Board has also just selected, as its electrical expert, Mr. Schuyler S. Wheeler, of whom there is the highest opinion entertained in technical circles for electrical and engineering ability. Mr. Wheeler is already at work, and there is every indication that before the summer is over a most decided advance will have been made in regard to putting the wires under ground in New York.

A great deal of public attention has been directed during the last week to the performance of the electric launch "Magnet," the first boat of its kind, I believe, to make its *début* in New York waters. This boat was built early this year on the designs of Messrs. Anthony and Frederick Reckenzaum. She is 28ft. long, 6ft. beam, 3ft. deep amidships, and draws 2½ft. of water by the stern. She is equipped with a Reckenzaum motor, weighing 420lb., driving a two-bladed screw 18in. in diameter. She carries 56 cells of the battery made by the Electrical Accumulator Company, weighing about 2,400lb. All told, the machinery weighs about 3,000lb. A speed of 12 miles an hour can be attained, but it is at the expense of the total mileage. The accumulators are arranged along the bottom of the boat, snugly under cover. Above them runs a bench nearly the whole length of the boat, giving seating accommodation for nearly 20 passengers back to back. The accumulators are arranged to work in a straight series of 56, or in two parallel groups of 28 cells each. They are capped at the top with rubber to prevent slopping in a rough sea, and stand in a bed of sawdust. For some time past this boat has been in use as a pleasure craft on the Passaic River, getting its charge at the Electrical Accumulator Factory on the river bank, at Newark. At the present time another launch, much larger, is being built at one of the yards up the Hudson River, also to be run by storage, the Electrical Accumulator Company supplying the batteries. I hear that the peculiarity of this boat will be the disposition of the batteries, which are to line the sides of the ship, leaving room in the middle for a cosy cabin. This boat

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is said to be nearly ready, so that before long New Yorkers will become familiar with the spectacle of boats driven by their own ballast.

Matters phonographic occupy a great deal of public interest just now. It will be remembered that Mr. Edison's phonograph was exhibited at the Electric Club here a few weeks ago. I hear it whispered, however, that the machine, before it is put on the market for commercial purposes, will undergo a number of modifications and improvements. In the meantime, it is reported from Washington that the Tainter graphophone has been brought to such a degree of perfection that it is more than equal to the phonograph, besides being a less complicated piece of mechanism. How far this claim can be substantiated I do not know, but those who have had conversations with the instrument speak of it very enthusiastically. A company with $1,000,000 capital has just been formed in this city, under the laws of New Jersey, to sell the machine, and I suppose that pretty soon several of them will be in use. So far as can be learned, there is not much difference between the phonograph and the graphophone, as both employ the method of cutting the record into or upon wax, Mr. Edison using a tube wholly of wax, and Mr. Tainter a paper tube with a prepared waxen surface The latter gentleman, I believe, claims broadly this method of re-producing speech from a record thus cut, as distinguished from the method of punching or indenting, as practised with the phonograph when it was first brought out.

On Tuesday last, before the American Institute of Electrical Engineers, meeting by special invitation at Columbia College, Mr. F. J. Sprague read a very interesting and able paper on "The Solution of the Municipal Rapid Transit Problem." Mr. Sprague's solution was, of course, an electrical one, and he took occasion to point out the many advantageous ways in which electric motors might be employed to expedite passenger travel in such a city as New York. As to horses, he pointed out the many objections, and added the notable fact that with them the operating expenses are about 82½ per cent. of the gross receipts. With the cable system he showed also that the operating expenses were high, for the reason that only about 20 per cent. of the power of the engines was actually availed of in moving the cars. Coming to electricity, he showed that the percentage of power recovered for actual use was higher than that in other such systems; that it was not open to the objections brought against steam, with its many inconveniences; and that a car with electrical equipment occupied about 35 per cent. less space in the streets than the horse car, which means a great deal in crowded thoroughfares. As to the potential of the current to be used, he did not favour anything above 400 volts, which he considered perfectly safe for all practical purposes, and not in any way likely to endanger a human being, though perhaps a horse or mule might not find it agree with its constitution. In substantiating the many arguments which he presented, Mr. Sprague made specific reference to his big road at Richmond, Virginia, which is now in such successful operation. This road was illustrated by means of about sixty or seventy stereopticon illustrations, prepared specially for the occasion, and giving a most vivid idea of the many difficulties which have been encountered and triumphantly overcome. This road is now running about thirty cars, and carries about 60,000 passengers a week, the number being rapidly on the increase. It is believed that before the year is out the number of cars will be at least doubled, if, indeed, the whole street car service of the city is not made electric. Mr. Sprague made an application of the results obtained at Richmond to the conditions now to be dealt with in New York, and pointed out how the emergency might be met in various ways, such as a four-track underground road from the Battery Park up town, with two branches in residential and suburban districts. This line would be supplied with power and light from four central stations, which would be able to make enough money from the sale of power by stationary motors to pay the whole running expenses of the railway itself. The Paper was intensely interesting, and when taken up for discussion in the fall, will, without doubt, bring out a great variety of additional opinions and data.

We are awaiting the nomination of the Republican candidate for the Presidency by the Convention now sitting at Chicago. The telegraph service of the whole country is in a state of the greatest activity, and the wires are kept hot with messages from morning till night. Some notion of the amount of matter to be handled may be formed from the statement that there are now over 500 special correspondents at Chicago, each of whom is sending out his news by telegraph. The telegraph companies and press associations have, as usual, made very extensive preparations, but the competition this time is by no means as great as it has been before.

ELECTRIC LIGHT AT THE COPENHAGEN EXHIBITION.

(FROM OUR OWN CORRESPONDENT.)

The Grand International and Scandinavian Exhibition at Copenhagen was opened on the appointed day, May 18th, by the King of Denmark. The bulk of the exhibitors—at least those from the three Scandinavian kingdoms, Denmark, Norway and Sweden—had their exhibits in readiness, and the buildings had already been completed a considerable time beforehand. Some of the other countries were more or less behind their time, but with exception of the German section the whole is now finished. This Exhibition is a very large affair, the grounds covering about 60 acres, and the buildings are both large and numerous. The main hall is a remarkably fine structure, but unfortunately the electric light has not been extended to this building, which is closed for the public before dark. There is, however, no lack of electric light, and several firms have very interesting installations. One of the more important is that of the Swedish firm, Palmerantz and Co., Stockholm. Outside the main entrance they have an arc lamp of 2,000 candle-power, and eleven more are to be found in the grounds, most of them lighting the promenade along the main building. Another interesting installation is that of the Allgemeine Elektricitäts Gesellschaft, Berlin, whose arc lamps are very effectively fixed in lampettes in old German style. This firm supplies the electric light for the Horticultural Pavilions, the grounds to the east of the machinery hall, and the bridge between these and the main grounds. To the right of the promenade is a pavilion, very prettily lighted by incandescent lamps, from S. Schuckert, Nürnberg, exhibited by his representative for Denmark, Mr. L. Lund. The chandeliers are from the firm of Spinn and Sohn (Limited), Berlin, by their agent for Denmark, Mr. F. Berg. Not far from there is a number of arc lamps from the well-known Danish firm of Prof. C. P. Jürgensen, which has lately been transformed into a limited company; the same firm has also supplied the lighting of the Aquarium by incandescent lamps. Another pavilion is lighted by incandescent lamps, both single and arranged in chandeliers, from Palmerantz and Co., Stockholm. Prof. Jürgensen's establishment has also supplied the incandescent lamps to the Duval restaurant and to the quaint edifice in the shape of a bottle erected by the large Tuborz Brewery. S. E. Hanberg's Engineering and Electrical Company, or as it is now termed, Koefoed and Hanberg (Limited), is represented by the incandescent lamps in the restaurant close to the machinery hall; the lamps are quite artistically arranged in a chandelier and lampettes of glass from the firm of J. Fritzsche, Copenhagen. The exhibitions of the Asuig and Novz are lighted from installations by the Submarine Mining Corps, part of the Machinery Hall by arc lamps from Siemens and Halske, Berlin (representatives for Denmark, Otzen and Phorstenson, Copenhagen), and the grounds at the various agricultural buildings by arc lamps from L. Lund, Copenhagen. The firms enumerated here are also exhibiting dynamos. We shall in a future article have occasion to return to this subject and the various exhibits, among which are one or two novelties of considerable interest.

CORRESPONDENCE.

MAXWELL'S THEORY OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is perhaps hardly worth mentioning, but the diagram in Mr. von Tunzelmann's paper on page 233, labelled "Maxwell's Representation of a Magnetic Field," is not copied from any paper of Maxwell's, but from one of mine.

It is, of course, a merely accidental slip; and Maxwell's theory has undoubtedly been the foundation of all I have attempted, but the removal of Maxwell's "idle wheels," or connecting particles supposed to constitute electricity, and the introduction of the two kinds of electricity as physical

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entities, seems to me to make all the difference between an artificial analogy and a possible semblance of the truth.—Yours, &c., OLIVER J. LODGE.

University College, Liverpool, June 30.

SHACKLE OIL INSULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to your remark in last week's issue that the oil shackle insulator which I stated that I had designed had been anticipated by Messrs. Johnson and Phillips, the inventors and patentees of oil insulators, I think you must be misinformed, because I left my sketch of the oil shackle insulator with Messrs. Johnson and Phillips themselves for a quotation in February last, and I am quite positive that no question of that form having been anticipated arose at that time, and it was considered that the small space between the rim and the oil cup was likely to present some difficulty in manufacture. This, however, was not the case, the insulators having been delivered perfect in form and very well made, with an important improvement introduced by Mr. Pell, by which the strain of the wire is always thrown on the centre of the bolt, thus preventing the fractures which sometimes occur in shackle insulators from the warping of the material in the baking.

The sketch which I sent you was made from the original, and did not contain Mr. Pell's addition.—Yours, &c.,

F. HIGGINS.

The Exchange Telegraph Company (Limited),
17 and 18, Cornhill, E.C., July 3, 1888.

[In the Note in our last issue to which our correspondent refers we said that the shackles were "already" made by Messrs. Johnson and Phillips, and our correspondent has perhaps not unnaturally taken this expression to imply that the firm in question had anticipated his design. We should have said that the shackles are "now" made by Messrs. Johnson and Phillips. We are sorry for the ambiguity, which this explanation will doubtless remove.—ED. *E.*]

THE CONDITIONS OF REGULATION IN DYNAMOS FOR CONSTANT POTENTIAL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was much interested by Mr. Esson's article on the "Conditions of Regulation in Dynamos for Constant Potential," and the discrepancy between the actual excitement of the series-winding to produce self-regulation and that indicated from the magnetisation curve of the machine is a point which has caught the attention of everyone practically engaged in dynamo building. There is no doubt that even the amended formula given by Dr. Thompson will not serve for the winding of machines of every kind, and is on that account insufficient; but I think that the discrepancy noted by Mr. Esson is very much exaggerated in the instances he has chosen on account of the meagre proportions of his field-magnets.

The necessity for extra excitement on the series coils springs from the presence of self-induction in the main circuit occasioned by the reversals of current in the coils of the armature. This vicious phenomenon may be greatly checked by pushing the magnetisation of the core to a very high degree. The resistance or reluctance of that portion of the magnetic circuit which is under the influence of the excitement proceeding from the current reversals in the armature is then so great as to ensure a practically sparkless collection on the commutator together with a corresponding diminution in the amount of "waste excitement" of the field.

From the same cause the necessity of giving a "lead" to the brushes will disappear with the increased field section, and although *per se* the fact of giving the brushes "lead" does not entail an extra excitement of the field, it is symptomatic of the disease to which such a requirement is attributable.

As a matter of fact, it appears from the figures given by Mr. Esson that the induction in his armature core is only 8630 per square centimetre, or 9·35 lines per square inch, in Kapp's notation. This is very low indeed, and follows from the insufficient section of the magnets. The ratio of the sections of the armature and field cores is as 1 : 1·41, and to obtain a really good induction in the former it should be at least as 1 : 2.

For a considerable time I failed myself to realise the tremendous magnetic leakage which is inherent in ordinary continuous-current dynamos, and, in consequence, I always designed the fields too small. Latterly, however, by correcting this error, I managed to practically eliminate all the ill effects of self-induction from the machine, and I have very little doubt that if Mr. Esson tries the same remedy he will be more mercifully disposed towards Dr. Thompson's formula.—Yours, &c., GUY C. FRICKER.

12, Delahay-street, Westminster.

UNIPOLAR INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On referring to the statement under heading 3 of my third article (page 203) I find that Mr. N. G. Thompson's difficulty arises from an omission which had escaped my notice, and I must thank him for calling attention to it. The statement should read "as the *positive and negative* lines of force cross the two portions of the circuit in the same direction, there is neither increase nor decrease in the total number passing through the circuit." The error consists in the omission of the words in italics. The same thing would be expressed by saying that each line of force crosses the circuit twice in opposite directions. It would perhaps have been better, to prevent misunderstanding, to have spoken throughout only of the positive direction of the lines of force, and instead of stating in the third paragraph of the same column that "for every positive line of force, coming from the north pole of the magnet, which crosses the circuit in a given direction, a negative line of force coming from the south pole of the magnet will cross it in the same direction," to have simply said that every line of force will cross the circuit twice in opposite directions, namely, as it enters it and leaves it respectively.

As Mr. Thompson misquotes the expression, "passing through the circuit," replacing it by the phrase, "cutting the circuit," I think he must have failed to see that what is meant is an increase or decrease in the number of lines of force passing through the area enclosed within the circuit, which is usually expressed more briefly by the phrase, "passing through the circuit." The statement that this increase or decrease is zero is absolutely equivalent to the statement that every line of force cuts the circuit twice in opposite directions, as is pointed out in the second paragraph of the second column of the article referred to.

Mr. Thompson's statement that there will be no current when the terminals of the fixed circuit are symmetrically situated with regard to the poles is correct in the case of a uniformly magnetised bar. The statement that this is equivalent to the terminals being at equal distances from the poles is ambiguous. I presume that what Mr. Thompson means is that the distances of one terminal from the two poles are respectively equal to the distances of the other terminal from the two poles, which would be perfectly true.

The general statement applicable to any magnet producing a field symmetrical about its axis would be that there will be no current when the terminals of the fixed circuit are situated at any two points on the surface of revolution traced out by any one line of force.—Yours, &c,

G. W. DE TUNZELMANN.

LEGAL INTELLIGENCE.

Swaby v. Watt and Others.

In the Chancery Division of the High Court of Justice, on Friday last, the action of Lewis Swaby against Hugh Watt and others, directors of the Maxim-Weston Electric Company (Limited), came on again before Mr. Justice Stirling. It was a motion on behalf of the plaintiff to restrain the defendants from forfeiting or cancelling 400 shares which the plaintiff held in the Maxim-Weston Electric Company, to prevent

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the defendant Howell from acting as director of the company, and the defendants from excluding the plaintiff from Board meetings, and to allow him to act as a director. The company was registered in 1881, the capital being £172,000. The plaintiff had allotted to him 2,000 shares, in addition to 400 fully paid-up shares, and in 1883 he was elected a director. In 1887 the defendant, Mr. Watt, was elected chairman and managing director of the company, at a salary of £1,200 a year, the three directors being the plaintiff, Mr. Brown, and Mr. Watt. By the Articles of Association it was enacted that two directors should form a quorum. In March, 1886, the plaintiff and Mr. Brown attended a directors' meeting, and the latter verbally intimated that he intended resigning, but gave no written intimation of his intention, as required by the Articles of Association, and it was said there was no acceptance of his resignation by the Board. An entry, however, was made in the minute book to the effect that Mr. Brown's resignation had been accepted by the Board. Mr. Watt subsequently informed the plaintiff that he intended to appoint Mr. Howell, M.P., a director in the place of Mr. Brown, provided the plaintiff accepted the proposal. The plaintiff wrote in reply that his approval of that appointment depended on the Board's decision. Another entry subsequently appeared in the minute book that the plaintiff accepted Mr. Howell's appointment, and that he had been appointed a director at a meeting. But it turned out afterwards that the only person present at the so-called meeting was the chairman, and that by his direction Mr. Howell, after having returned thanks for his appointment, took his seat as a director. The plaintiff remonstrated at the course which had been pursued, and he subsequently received a letter from the defendant's solicitor to the effect that as he had not paid up the money due on his 2,000 shares, the 400 shares he held would be cancelled, and as he had ceased to be a shareholder he could not act as a director. The fact, however, was that these 2,000 shares had, about twelve months previously to the receipt of that letter, been transferred to Mr. Watt and duly registered in his name in the books of the company, and as regarded the 400 shares nothing was due upon them. The defence was substantially that Mr. Howell had been properly appointed.

Mr. Pearson, Q.C., appeared for the plaintiff; Mr. Hastings, Q.C, and Mr. A. Young for the defendants, Watt and Howell; Mr. Buckley, Q.C., and Mr. Robert Wallace for the company.

His LORDSHIP, in giving judgment, said the case disclosed some peculiar transactions. And the ground upon which the defendants had cancelled the 400 shares was the most curious one he had ever heard of. As to the appointment of Mr. Howell in place of Mr. Brown, he came to the conclusion that Mr. Brown's resignation had not been accepted by the Board, and that Mr. Howell had not been duly appointed. As regarded Mr. Watt, he had acted in a high-handed manner towards the plaintiff. There was no ground whatever for cancelling the 400 shares which the plaintiff held, and he was accordingly entitled to act as a director. The plaintiff was therefore entitled to the relief he claimed.—Judgment for the plaintiff accordingly.

BOOKS, &c., RECEIVED.

"Safe Dynamo-Electric Currents." Quotation from a lecture of Leo Daft, delivered at Plainfield, N.J., December 8th, 1887. (New York.)

"Electricity *versus* Gas." By John Stent. (London: Swan Sonnenschein and Co.)

"Price List of Electric Light Cables and Wires." The India Rubber, Gutta Percha, and Telegraph Works Company (Limited). (July, 1888.)

COMPANIES' MEETINGS & REPORTS.

United Telephone Company (Limited).

The eighth annual ordinary general meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on the 3rd inst., Mr. James Brand presiding.

The SECRETARY (Mr. Thomas Blaikie) read the notice convening the meeting. The report and accounts were taken as read.

The CHAIRMAN said: Gentlemen, you have all received a copy of the report, and I have no doubt studied the accounts. I will not trouble you with going over these accounts just now, as I know that there is a gentleman, a friend of mine, in the room who is going to make some inquiries about the accounts by-and-bye, and then I will endeavour, by myself or by some of my friends here, to answer him as well as I possibly can. Very likely you will have noticed that at the commencement of the present session our Board, being desirous of giving effect to the recommendations of the Select Committee of 1885, lodged a Bill in Parliament asking for this Company the powers which the Committee said we ought to have, and giving a central authority the powers of inspection and control suggested by that Committee. Well, the Postmaster-General was not disposed to aid us in passing this Bill. He suggested that the Local Government Board, perhaps next year, might be the proper persons to deal with it. We did not desire to have any conflict with the Government or the authorities, and, therefore, we withdrew the Bill for the present. We may have something more to say about this matter next year. Then, I should say a word or two on a very important subject indeed, and that is as to our relations with our subsidiary companies (cheers). This is a point on which I think there should be no misunderstanding, and bringing it before you prominently to-day was suggested to me by some remarks I read yesterday in the *Financial News*, which is a paper that is very cleverly written, and which evidently takes very great interest in all telephone companies generally, and in the United Telephone Company in particular. I was much surprised to read in the report of the meeting of the South of England Telephone Company, held on the 29th of June, some remarks reported to have been made by the Chairman of that company as to the relations of his company with the United Company. In reply to Mr. Billet, the Chairman said this: Mr. Billet asked, "Has there not been some suggestion for these outlying lines to be connected with London?" And the Chairman is reported to have said, "We are not an independent company so far as that is concerned—one-half will have to be run in the United Company's district. We have urged this matter on them repeatedly, but we get no further. With regard to Brighton, it is a joint line between the United Company and ourselves. Under the old arrangement we pay one-half, and derive no immediate advantage from it. It was an experimental line." Well, now, I feel sure that Mr. Bateson, the Chairman of the South of England Company, would not willingly say anything but that which he believed to be true, and I can only suppose that he has forgotten the numerous interviews that we have had with him, and the proposals that we—the United Company—have made from time to time. Let me tell you the fact as it stands. The United Company have, through the General Post Office, run a wire to Tilbury, among other places, at their own expense. On the 20th of April, 1887, we wrote to the South of England Company, offering to work this line at our own expense and give the South of England Company half of any profit that was made, and to bear the whole loss, if any, ourselves; and I pledged myself to Mr. Bateson that if at the end of one year this manner of working this trunk line proved unsatisfactory to him or his company, the whole matter should be revised and settled in a way that should be satisfactory to his company. Now, again, as to the Brighton wire, I may tell you about that. The General Post Office ran this wire also for the United Telephone Company. For two years, 1884 and 1885, we paid £446. 10s. per annum ourselves for rent to the Post Office. After that I arranged with the Chairman of the South of England Company that his company should pay one half of the rent of the Brighton wire for 1886 and for all time after; but that the United Company would at their own cost fit up the necessary apparatus in the switch room at Brighton. Since then the South of England Company have worked the Brighton trunk wire without let or hindrance from the United Company. The United Company have paid the rent of the wire for 1887 and 1888 to the General Post Office; but we have not yet received any payment on account of these two years from the South of England Company. On the 29th June the South of England Company wrote agreeing in a great measure to certain proposals I had made in the letter I have mentioned of the 20th April, 1887, and yet at the meeting that was held on Friday last—that is the same day as that on which the letter was written—the Chairman of the South of England Company is reported to have said, in reply to Mr. Billet's question (who said: "Surely it could be no intention of the United to stifle its own children?"), "We have proposed terms and cannot get them"—that is, the United Company—"to second them at all. They refuse to enter on the subject at all. Since I have been in the chair I have constantly urged this matter on the United Company, but have got no further to-day." Now, such statements as these, of course, are calculated to do great injury to the United Telephone Company in the eyes of you gentlemen, the shareholders, and of the public in general; and I think it my duty, therefore, to contradict them, and to dwell at some length on this subject. A good deal of the property of the United Company, as you know, consists in its shares in the subsidiary companies, and we should be fools indeed if we tried to stifle our own children. It is not true that the United Company puts obstacles in the way of trunk wires. It is our own interest to push trunk wires with all our might. We are doing it now, and it will be one of our chief operations in the future. The National Company is as anxious in this direction as we are to join its different centres on to our system. On the 3rd January this year the United and the National Companies made arrangements mutually satisfactory for the erection and working of a trunk wire to Birmingham. I think I may say that the difficulties of the way-leaves are practically overcome. We have been met in a liberal spirit by the landowners, with whose property we interfere, and we hope that within a month we may be able to commence the construction of the line. This line will provide nearly half the distance required to connect Manchester and Liverpool with London, and also enable Nottingham, Leicester, Derby, Sheffield, and other midland towns to speak to London, as also the northern towns of Newcastle and Sunderland. The same desire for inter-communication exists between the Western Counties Company and ourselves, and friendly negotiations are in progress for connecting London and Bristol, and the Western Counties have got as far as Bath. They have considered it best, however, before tackling with us the heavy outlay for the trunk wire to London, to connect their head-quarters at Bristol with Newport, Cardiff, Swansea, &c., and the coal and iron fields of South Wales. You are aware that our agreements with our subsidiary companies prevent us from running truck lines from London to any town beyond twelve miles and working without the consent of the subsidiary companies. They all know, however, that we are willing to join hands with them. I think I have said enough on this matter to show you how groundless are the curious statements that are constantly being made—(A Shareholder: No, certainly not. The Chairman: I will speak to you by-and-bye, sir. Laughter)—that are constantly being made as to the dog-in-the-manger policy of the United Company. It is hardly

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possible for the shareholders to realise the difficulties that we meet with and have to overcome, and I wish the shareholders would lend us their aid to a greater extent than they do. It is surprising how few of the shareholders are subscribers to our lines. I do not think that 10 per cent. of our shareholders subscribe to our exchanges. However, we do the best we can, and during this year we have increased our mileage of wire from 7,500 to about 8,700 miles. There are at present free call rooms for the use of subscribers existing at Oxford-court, Chancery-lane, the Law Courts, the House of Commons, Regent-street, and Edgware-road, and arrangements have been made, in deference to the wishes expressed by some of the shareholders, and as a matter of experiment, for establishing paying call rooms at Kilburn, Balham, Limehouse, Earl's Court, Denmark-hill, Holloway, Brixton, Greenwich, Notting Hill, Clapham, Croydon, Richmond, Stratford, Putney, Wandsworth, Norwood, and Brentford. I must tell you that these paying call rooms have not been so much pushed by the United Telephone Company as, perhaps, by some of the other companies further north and west. Our opinion is that these call rooms in London, as a matter of revenue, will not be very successful. In the north they have proved a good source of revenue, but then that is because of the trunk lines existing between town and town, and the public who are not subscribers take advantage of the call rooms to communicate from town to town, and are willing to pay 3d. or 6d. or 1s., or whatever it is, I do not know exactly how much. As far as I know, the call rooms established in the towns have not been made much use of for what we call local communication. However, we think it is a good thing to try the experiment, and if it does not pay us directly by revenue we think it will pay us by educating people more and more to the inestimable blessings of the telephone. Well, then, we have put up during the year new iron derricks, at great expense, of course, to replace those derricks that were destroyed in what the *Financial News* calls "the good old snowstorm" (laughter). We have got one at Oxford-court, another at Queen Victoria-street, Mincing-lane, East India-avenue, Cornhill, the Hop Exchange, and Smithfield, and there is another in preparation for Heddon-street. We have opened a new exchange at Smithfield with a largely-increased capacity, and the lines have been transferred from the old exchange to the new. With the view of centralising the work of switching, three minor exchanges have been closed—those are Leadenhall-street, Stratford, and Shadwell. The exchanges having been transferred to the larger exchange, a new multiple switch-board has been erected in the new exchange at Smithfield, and preparations are well advanced for erecting multiple switch-boards at East India-avenue, Westminster, and Chancery-lane. We have opened and got in very good order now a new trunk line to Croydon on our own poles, free from the induction of railway poles and other electrical wires, and it is working very well. It has only been opened about a month, and we hope it will be a source of good profit to us. Then I come to a question that has no doubt occupied your minds a good deal, and that is the question of amalgamation. Various reports have got abroad respecting the proposed amalgamation of this company with its affiliated companies, and it is desirable, I think, now that we are all together, that I should explain to you shortly in what position that matter actually stands. All sides are agreed that an amalgamation would certainly be desirable in the interest of all the companies, provided it can be settled in a manner fair, not only in view of the present state of each company, but also taking into account to some extent their future prospects. This latter consideration will involve questions of considerable difficulty, and it will be necessary to ascertain how far the accounts of the several companies have been made up on the same basis as regards allowances for depreciation of wires, plant, &c., and also as regards the allocation of expenditure between revenue and capital. To enable us to have a basis for discussion on these points, the accounts of the various companies are now in the hands of Mr. Griffiths, an eminent accountant; and when his report comes in—and it will certainly take some weeks to prepare—we shall be able to meet the directors of the other companies and see how far their views accord with ours as to the proportions to be allowed to the several companies. Of course, before making any arrangements for amalgamation it would be necessary to obtain the consent of the Postmaster-General to the various licenses being transferred to the new company. Subject to this being obtained, I am personally very much impressed with the advantages of carrying out this scheme, and my colleagues on the Board heartily concur in my views. If all sides are animated with a desire to settle the questions that may arise in a fair and liberal spirit, I can see no reason why the thing should not go through (cheers). It would be idle, however, to shut our eyes to the fact that questions may arise on which different opinions may legitimately be held, and, of course, they may be more or less difficult to solve. The question as to the value to be attached to undeveloped business is an apt illustration of what I mean. Such questions I hope we shall always meet in an equitable spirit; but, of course, we have your interests to protect just as much as the directors of the other companies have the interests of their shareholders to look after. I know very well that this matter should be settled promptly, for until it is settled it retards the development of the Company's business in new lines and connections in the direction of which I have already spoken. You will have seen from the accounts laid before you that during last year we expended nearly £29,000 on this account, but this has been solely within the metropolitan area. The development of the system of trunks will, of course, involve a large expenditure of capital, and one considerably larger than we can provide, as we have hitherto done, out of the sums debited to revenue for depreciation and other things. If and when it is necessary to raise money for this purpose we will, of course, call you together and ask your advice on the subject. Well, then, as to law, during the year, Mr. Winterbotham has sent me this report, which I will read to your. He says: "Since the decision of the Court of Appeal in favour of the Edison patent in the action against Messrs. Bassano and Slater, of Derby, there has been no serious attack upon the Company's patents, and the Directors were in hopes that the many ingenious attempts to get outside the patents were at an end. However, at the beginning of the present year Mr. Campbell Swinton, a Scotch gentleman, brought out an instrument and formed a small company to manufacture and sell it, and as the company was beginning to do business on a somewhat extensive scale it became necessary to take action. The directors are glad to say that an interim injunction was promptly obtained, which has for the present put an end to further sales, but the defendants appear inclined to fight the whole question over again. As the question of the validity of the company's patents has already been decided by the Court of Appeal, and the directors have the best possible advice (that of the present Attorney-General and other well-known counsel) that the instruments are infringements, they are in no way anxious about the result. At the same time it is much to be regretted that the law allows limited companies without any uncalled capital to put a patentee to all this expense after the question has already been litigated and decided." Well, now, I think I have said enough for the present. But before I move the first resolution, that the report and accounts be taken as read, I shall be glad if any gentlemen have any questions that they ask them now. After a pause he added: I was waiting to see if any questions were going to be asked about the accounts, but in order to have this brought about I have to move—

"*That the report and accounts be taken as read, be received and adopted, and that a dividend for the half year ended the 30th April last of 10s. per fully-paid share and of 5s. on the new shares, less income-tax, be paid, making a total dividend for the year of 15 per cent. on the paid-up capita of the company.*"

The DEPUTY-CHAIRMAN (Mr. J. S. Forbes) seconded the motion.

Mr. SICHEL referred to the expenses which had been involved by the great snowstorm, and said it had been double the amount which the chairman stated at the last meeting. The public was, he said, dissatisfied with the service of the telephone, sufficient facilities not being given for its use, and that was shown by the small increase in the receipts. He advocated an increase in the number of call offices, coupled with a system of issuing tickets to the public for five guineas per annum, entitling the holders to go to any office in the metropolitan area, and to use it as and when they liked. He had seen that system at work in Paris. He was satisfied that the business of the Company was capable of immense development, and measures should be taken with that end, especially in view of the termination of their patents.

The CHAIRMAN then replied to certain questions on the accounts which had been put by Mr. Begg.

Mr. BEGG afterwards contended at some length that the management of the Company was both extravagant and inefficient, and in regard to the latter view maintained that there ought to be an all-the-year-round, including Sunday, service given by the Company. The Chairman had said he was willing to join hands with the sub-companies about the trunk scheme; but willing to join hands was not the attitude of the Board of a telephone company. The Board should insist, and if others would not go ahead in the matter, compel them to. They could not get a communication of any sort except in Tilbury and Brighton. He would impress on the Board the absolute necessity of something being done in the matter at once. The great bulwark of the Company was its patents, which were three years within their expiration, and unless they made good use of the remaining time they would not get from the Government, which, no doubt, must ultimately buy the property, anything like what they ought to get. He did not wish to propose anything hostile, but to test the feeling of the meeting he would move that the accounts be not passed, and that a committee be appointed to investigate the affairs of the Company, and report to the shareholders.

Sir JULIAN GOLDSMID, Bart., M.P., strongly complained of the Directors' fees, which he regarded as excessive. He seconded the amendment.

Sir E. H. GALSWORTHY dissented from the view which had been taken by the last speaker.

Other gentlemen having addressed the meeting.

The CHAIRMAN, in reply, said he had not given a guarantee that the expenses connected with the snowstorm should not exceed £15,000.

Mr. FORBES, in further reply, regretted that Sir Julian Goldsmid had left the meeting, as the hon. baronet had been the parent of what one might treat as the personal question. He was sorry that a gentleman in the position of Sir Julian should have hazarded imputations, and he was still more surprised to find that a lawyer and a gentlemen and a man of the world should get up what, after all, was a trumpery question of the remuneration of the Directors. He hoped that the shareholders would listen (oh, oh). He was also a bit of a lawyer himself, and he thought he knew as much about this special class of business as Sir Julian. He (the speaker) would venture to say that in the Articles of Association of almost every foreign company of importance the most common thing was a contract—a legal and a moral contract between the man who lent his money and the man who, in addition, lent his brains and his knowledge to his partners. That was the nature of almost every bargain of every *société anonyme* in France, Germany, and other countries; and it was not limited to those countries, but was very common in this country, too. He wanted to know what principle could be more judicious, and he had been very glad to find that the gentleman who spoke first (Mr. Sichel) enunciated the principle when he said that he thought the best way of governing the Company was not by the Directors, with whom the shareholders had made a bargain, but by engaging the services of some competent man whom they should remunerate with a fixed sum and a commission. That was exactly the contract which the shareholders had made with the Directors. Under that arrangement the Board received £1,500 a-year, and he would undertake to say that in one or two instances in

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the history of the Company a single hour's work would have justified the Chairman and himself in taking a good many £1,500's; and the shareholders would find that out in the future. He wanted to ask any reasonable man, first, whether the principle on which Directors were paid was unreasonable? Why were they taking such large fees? First of all, because they had "gone into the swim" with the shareholders and held a very large number of the shares; and, therefore, in that respect the Directors had done their share with the shareholders; and then the Directors also found the brains and the knowledge, and had the burden of responsibility of working the shareholders' money, to the latter's advantage. Having done so, they received £1,500 up to the point when the shareholders received a 10 per cent. dividend. But what was the good of talking about one year? The average was the thing to talk of in this business. For the five years during the labour, anxiety, discouragement, and difficulty of making the Company—because the Directors had made it—they received about £210 a year on the average. Who among the shareholders, having the capacity and the knowledge to do the work—as no doubt many of them had—was going to do the work for £210 a year? By means of the Directors' money and that of the shareholders, and with the use of the brains and knowledge of the gentlemen forming the Board, the dividend had been got up to beyond 10 per cent., and the Directors were to receive 20 per cent. of all the money they made for the shareholders over 10 per cent. Was it unreasonable for the shareholders to receive 80 per cent. for every 20 per cent. paid to the Directors of the amount beyond the sum required to pay a dividend of 10 per cent.? He would defend before all the world the bargain that had been made. The Directors accepted the position, the responsibility, and the labour of the business in that bargain, which he maintained was a reasonable bargain, and one which had redounded enormously to the interests of the shareholders of the Company, whose investment had now paid them for some years over 10 per cent., the Directors having also put by a substantial reserve fund. The shareholders having received more than 10 per cent., and since, therefore, the legal and moral claim of the Directors to be paid a commission on the profits had come into force, what had the Directors received over the three years? £750 each. Was that an undue remuneration under the circumstances he had mentioned? If the shareholders thought so, let them find other men who would do what the Directors had done for them in the past, and who were as capable of doing what they would have to do for the Company in the future. It was all very well to talk about amalgamating, but there were not five men in the room who had the least idea of the danger before them. They had three years of the patents. After that the whole world might be their competitors, including the Post Office. Were the shareholders going to discourage the Directors by blinding their eyes to what the Board had so far done for them? Whatever their criticisms might be on the manner in which the Company's business had been conducted they had made a substantial property of it—with the £5 share worth £15, a 15 per cent. dividend, and a reserve fund of about £120,000. That was not such a very bad outcrop of a Company which had been only eight years in existence. He had made those statements, so that Sir Julian Goldsmid and their critics might think about them. It was a pity that critics did not think or know before they complained. Mr. Begg was evidently a man of great ability; but that gentleman had enlarged very much upon the manner in which the Company had neglected its business by not developing, among other things, call offices. He was sure that if Mr. Begg had had before him the knowledge and the figures possessed by himself, that gentleman would not have been so very surprised in connection with this question of call offices. The exchange business was the cream of the United Company's business, and the call office business was a mere bagatelle. He saw by the report of the Lancashire and Cheshire Company for last year that their gross income was £81,000, and their trunk wire and call department yielded them £6,500. The gross income of the National Company was £90,000, and their fees for messages were £1,800. The United Company had 8,700 miles of wire, 4,835 exchange subscribers, and 21 exchanges, through which the whole of this enormous number of calls had to be forced. They were to endanger a service not yet nearly as efficient as it ought to be, and might be made, by letting Tom, Dick, and Harry go to call offices and use the wires that were already flooded by the messages of the ordinary subscribers. That was the position of the matter, and who was going to run the risk? If Mr. Begg had any greater responsibility at his back than he had at that moment, of talking about it, he would not run the risk; and the Directors were not going to. The position of the National Company was quite different. That Company had 10,900 miles of wire and 7,926 exchange subscribers, but they had 214 exchanges spread in all the great towns and in all the districts over the area which they covered. The United Company had, speaking in round figures, more than half the number of the subscribers which the National Company had, but they had to force all their work through twenty-one exchanges, and exchanges the complications and difficulties of which were not equalled in any city of the world or any place. If he had a private wire with a telephone at one end and his own servant at the other he could generally get attended to. If he was at the Westminster exchange and wanted to call to a gentleman in the City he had to go through one, two, three, or four exchanges before his message caught the gentleman he wanted to talk to. They knew pretty well what was being done in America and in Edinburgh and other cities; but he said they must compare like things with like, and there was no comparison with any place or city in the world and London. Let them look at the mere question of way-leaves; everything they did was on sufferance. Therefore, their exchanges were multiplied because they could not get the shortest cuts, and for that reason their service is made inefficient. He felt sure that Mr. Begg was not going to press for a committee of inquiry into their business. At all events, he was not going to submit to such an inquiry. Either the Directors knew their business, and were worthy of the shareholders' confidence, or they were not, and in the latter case the shareholders should turn the present Board out and put in Mr. Begg. He knew of no form of censure so unjust or so insidious as the appointment of a committee. They had seriously considered the "fad" of Sir Julian Goldsmid about the enormous payments to the Directors; but he (the speaker) was not going to work for £200 a year, for he could carry his brains to a much better market. The Directors knew the defect of this system and its difficulties; the shareholders knew its defects but not its difficulties. That was the difference, and anyone who was put in the place of the Board would soon find them out. Nothing but long service could give the Directors the knowledge of which the present Board were possessed. He trusted that the gentlemen who had put questions were satisfied with the replies, and he hoped that the shareholders would reflect that in view of the position of the Company and the difficulties as to the proposed fusion with the other companies, and the question of competition at the end of three years, as well as the delicate questions which would then arise, it was no favour to the Directors to have paid them the fees which the shareholders, under a binding contract, had agreed to pay them.

Mr. SICHEL remarked that what he had had in view had been referred to by Mr. Forbes in the last part of his speech, his contention being that they ought to get all that they possibly could out of the concern before the end of the three years which the Company yet had.

The CHAIRMAN put the amendment in the usual way, and announced that two had voted in favour of it, and that it was lost. He then put the original motion and declared it carried unanimously.

The retiring directors and auditors having been re-elected.

Sir E. H. GALSWORTHY then proposed, and Mr. BEGG seconded, a vote of thanks to the Chairman and Directors, and the motion was unanimously agreed to.

The CHAIRMAN acknowledged the vote, and the proceedings then terminated.

South of England Telephone Company (Limited).

The annual general meeting of this Company was held on Friday, the 29th June, at Winchester House, Old Broad-street, under the presidency of Mr. D. Owen Bateson.

The SECRETARY (Mr. Fred. L. Robinson) having read the notice convening the meeting,

The CHAIRMAN said: We are pleased again to meet you, gentlemen, and to give an account of our proceedings during the past year. The report and figures which we have sent you show our progress. We cannot pretend that our district is one that is capable of any sensational development; still, I think we may lay claim to endeavouring to make the best of what has fallen to the lot of our Company. You will note that our exchange lines have increased from 1,130 in 1887 to 1,521 in 1888, and private lines from 348 in 1887 to 386 in 1888. In this latter item the new lines have been many more than are indicated by these figures, but they have been counterbalanced by an unusual number of withdrawals. I apprehend this is occasioned by some of our subscribers having been induced by apparent cheapness to try some of the new-fangled instruments which are so industriously advertised nowadays. I do not think there will be a continuance of these withdrawals, as there is no doubt but that our instruments are the best; indeed, we have already had some subscribers who, after trying the new ones, have discarded them and returned to us, assuring us that the old are the most reliable, and are decidedly superior.

As regards our gross rentals, they stand at £19,325, against £15,190 in 1887, showing an increase of £4,135, and after deducting the amount carried forward to this year, £6,970. 16s., for unexpired terms, and the royalties paid the parent company and the Post Office, £2,501. 16s. 10d., we show a gross profit of £9,852.

As the business increases the management and working expenses must naturally increase. This year we have expended on these accounts £5,099, against £4,198, showing an increase of £901, which, considering the additional extent of business done, is not an undue sum. In the accounts last year there was a debit of £1,365 odd carried to revenue on account of the damage done by the snowstorm of December, 1886; happily this year we have met with no such disaster, and we trust for similar immunity in the future. We have taken every pains to guard against it, and some of our extra expenditure is due to charges for strengthening our system where we have found it necessary.

As regards our capital, it will be seen that all the 20,000 Six per Cent. Preference shares are now issued. The 3,567 remaining according to our last report have been all disposed of at par, viz., £2 each, completing the entire issue with this sum paid. It will be needful ere long to call another 10s. Your Directors, however, will delay it as long as possible, knowing that the 6 per cent. interest will be an additional charge on the resources of the Company. It will be noted that we have spent £16,457 on capital account this year, against £16,077 last. You must be aware that in a new company such as ours, almost the entire of our expenditure is in construction work, and comparatively little on maintenance. The charge for running trunk lines comes very heavy on us, and hence a great part of this large sum. This year we have completed the Brighton, Shoreham and Worthing lines, as also Brighton and Lewes. We are now engaged between Lewes and Eastbourne, as well as between Canterbury and Dover. These two lines we hope to complete within a month from this time. Our next trunk lines will be between Canterbury and Ramsgate, Deal and Ashford. For these lines we are busy canvassing for way-leaves. These are generally accorded us without much difficulty by both landowners and road authorities, and I beg to tender our thanks for their consideration in this regard. Now and then undue difficulties have been placed in our way, which we get over as best we can, and we have

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occasionally been obliged to vary our routes, often to our material cost. One line between Margate and Westgate we have been obliged to abandon altogether, consequent on the obstructive policy of the representatives of a charitable institution, much to our annoyance and the great inconvenience of our subscribers. I am happy to think that this is quite an exceptional case, and an example not likely to be followed elsewhere.

Our various exchanges are doing fairly well; Brighton especially runs far ahead of all the others, thanks in some measure to the efforts of our energetic and capable manager there. Our subscribers, exchange and private, have increased from 284 in 1887 to 397 in 1888, and we have no fear that they will stop at this figure. The trunk lines between Brighton and Worthing, and also to Lewes and Eastbourne, will doubtless much assist the development of this exchange. Our more business centres are not so active. However, Reading, Northampton, Norwich, and Ipswich progress fairly. We have lately made a diligent canvass of all these towns and their environs, which we think will increase the number of our subscribers eventually. Cambridge continues to do well, and at last Oxford seems to be awakening to the advantages of our system. We have taken great pains to bring ourselves prominently before the authorities and tradespeople in this town. We are now engaged in developing new exchanges in Tunbridge Wells and Tonbridge; Guildford will also follow in due course. It would appear as though this would be a paying business if we are not hampered by way-have difficulties. The exchange in Canterbury promises well. We are making this a centre from which various lines are to radiate, namely, to Dover and Folkestone in the first place, and this portion of the scheme is nearly complete. Subsequently lines to Ramsgate and Margate will be run, also Deal, Sandwich, Ashford and probably Faversham. If we carry out this plan each place on the radius will be able to speak to our subscribers at the other towns on the radius. We think the scheme will tend much to develop our system in this district, and be a great convenience to our supporters. Westgate will necessarily be excluded from partaking of the advantages of the scheme, for the reasons I have before stated. I may say, however, that we are quite prepared to reconsider our determination of abandonment if the circumstances are so far altered as will enable us to run our lines.

Our instruments continue to give every satisfaction to our subscribers, and we have very few complaints of bad service. These few are almost invariably occasioned by accidental contacts of the wires, and are set right with as little delay as possible. In many of our districts we have established fee call offices worked by automatic call boxes, by means of which anyone, subscriber or not, on payment of 3d. for local, or 6d. for trunk communication, can call up subscribers on the exchange and have three minutes' conversation. Up to the present we have not derived much revenue from this source, but we shall continue it, as we can see what an immense convenience it is to our subscribers and others, and it tends to bring our system before the public and to popularise it. We expect when it becomes better known what the advantages of this scheme are, that we shall derive some profit from our outlay, which has been considerable.

Now, as regards a dividend, it will be seen from the net revenue account that we have had £4,964. 1s. 2d. to dispose of. Out of this we have already paid £1,849. 0s. 6d. in two half-yearly dividends on the Preference shares, leaving us with £3,115. 0s. 8d. Our auditors have strongly advised us to commence a reserve, so we have decided to place £500 to such a fund. I must say that I hardly see the force of the auditors' argument as to this, it appearing to my mind somewhat of a farce endeavouring to secure a capital of £340,000 by anything we can possibly lay aside out of our limited income. It has, however, this good feature, that in case of any disaster, such as a snowstorm, we shall have something to fall back upon without jeopardising our dividend. I am not disposed to accumulate this fund beyond the need in this direction, but this is for your consideration in the future. With the balance, £2,615. 1s. 8d., we propose to pay a dividend of ½ per cent., amounting to £1,500 in the aggregate, carrying forward £1,115. 0s. 8d., which is much the same as last year, viz., £1,058. 9s. I do not know that I have anything more to say, and I will move

"*That the report and accounts for the year ended April 30, 1888, now presented, be read and adopted.*"

Mr. ALEXANDER MACGREGOR seconded the motion.

Mr. BILLETT observed that it used always to be said that their lines would come into London.

The CHAIRMAN: You must remember, so far as that matter is concerned, that we are not an independent company. Half of these lines have to be run in the United Company's district. We have repeatedly urged the matter on their notice, but we get no further.

A SHAREHOLDER inquired the position of the Brighton line.

The CHAIRMAN: It is a joint line between the United Company and ourselves. We pay for half the expense of it; but we really derive no immediate benefit from it except that it develops our Brighton exchange. Anyone on our Brighton exchange can use that line, but they pay nothing for it. In further reply, the Chairman admitted that it would not pay to make a trunk line to other places on the same terms; but it was an experiment.

Mr. STEWART: Is there not some arrangement in prospect for the consolidation of all the telephones on the system?

The CHAIRMAN: Something has been mooted with respect to that, and there has been a meeting of the different subsidiary companies and the United Company. A sub-committee has been formed to investigate on what terms it can be done. It has gone no further than that.

Mr. BILLETT asked whether it was not part of the agreement that the Company would have power to construct other lines to London.

The CHAIRMAN: No, the point of the agreement was this—that we can run our lines to the 12-mile radius; but we cannot do any work in the United Company's district, and until they consent to it we are perfectly powerless. In further reply to Mr. Billett, he repeated that they had brought the matter several times before the notice of the United Company.

A SHAREHOLDER: Is there not a line being made northwards? I see it on the map.

The CHAIRMAN: It is merely on the map at present, I believe.

Mr. BILLETT: There can be no intention of the United Company to strangle its own children. This is a child of the United Company, and surely they should give us every facility.

The CHAIRMAN: Surely they ought, but certainly they do not.

A SHAREHOLDER: Have they proposed any terms?

The CHAIRMAN: We have proposed terms, but we cannot get them to second it, or to suggest any alternative terms.

A SHAREHOLDER stated that it was thoroughly understood by the late Chairman of the Company that they would be able to come into London when they had a sufficient number of subscribers.

The CHAIRMAN: I really do not know what arrangement they made with the late Chairman, Mr. Kendal, but I do know that since I have been in the chair I have constantly urged this matter upon the United Company's attention, and I am no further in regard to it to-day than I was three years ago.

Mr. BILLETT: Perhaps that explains the reason why with five million people they have only four thousand subscribers. I think they should be requested to give us every facility.

The CHAIRMAN: Well, I hope you will attend the meeting of the United Company, and bring this matter up there. My representations have had no effect at all.

A SHAREHOLDER inquired whether any steps had been taken to get a quotation for the shares on the Stock Exchange?

The CHAIRMAN: We have moved in that matter, and it has been laid before a leading stockbroker, who has also represented it to the Stock Exchange. The Stock Exchange would require a great many alterations in our Articles of Association before we could get a quotation, though the changes would be merely formal. We should have to hold a special meeting of the Company before we could make these alterations. We contemplate doing it, and we shall not be very long before we do it, if we find it necessary. It rests with you, however. If you want a quotation we will do our best to get it.

Mr. STEWART: The Chairman suggests that any shareholders here who are shareholders of the United Company should attend the meeting of that Company. They are very large shareholders in this Company, and it is in their own interest that they should do all they can to further the extension of this Company's business.

The CHAIRMAN: I say "Hear, hear," to that decidedly.—He then put the motion in the usual way, and having declared it carried unanimously, said: The next resolution is one that you will probably agree to—

"*That a dividend at the rate of ½ per cent., free of income-tax, on the ordinary shares, be declared payable on the 3rd July.*"

Mr. MACGREGOR seconded the resolution, which was carried unanimously.

On the motion of Mr. MARSHALL, seconded by Mr. BILLETT, a resolution was passed to the effect that £200 should be paid to the Directors for their services during the 12 months ended April 30, 1838.

The CHAIRMAN then proposed the re-election of Mr. Thomas Fielden Campbell. Those who best know Mr. Campbell most appreciate his value, and until he was laid aside by illness a short time ago, he was one of our most regular attendants. I think you will be standing very much in your own light if you do not re-elect him.

Mr. MACGREGOR seconded the motion, expressing his regret that illness prevented Mr. Campbell from being at the meeting that day.

The CHAIRMAN put the resolution, and it was carried unanimously.

On the motion of Mr. BEVIS, seconded by Mr. CHATER, Mr. J. Weise (of the firm of Turquand, Youngs and Co.) was re-elected auditor for the present year with a remuneration of 40 guineas.

A vote of thanks to the Chairman and Directors was then passed.

The Chairman having acknowledged the compliment, the proceedings terminated.

United River Plate Telephone Company.

Report of the Directors to be presented to the shareholders at the second ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, E.C., on Thursday, the 12th inst., at three o'clock:—

The balance-sheet and profit and loss account of the Company's operations during the sixteen months ended 31st March last, after paying all working expenses abroad, debenture interest and London charges, and after writing off the whole of the preliminary expenses in London and Buenos Ayres connected with the formation of the Company, amounting to £4,139. 6s. 8d., shows a profit of £34,942. 1s. 6d., from which has to be deducted the sum of £10,775. 19s. for loss on exchange, leaving a net profit of £24,166. 2s. 6d., out of which an interim dividend of 2½ per cent., or £6,250, was paid in October last, the actual available balance being thereby reduced to £17,916. 2s. 6d.

Out of this balance the Directors recommend that a further dividend of 4½ per cent., being 4s. 6d. per share, free of income tax, be now paid, which absorbs £11,250; that £5,000 be placed to a depreciation and renewal fund; and that the balance of £1,666. 2s. 6d. be carried forward to the credit of profit and loss account for the current year.

The shareholders will observe that the capital expenditure during the sixteen months amounted to £56,415. 3s. 7d., which includes the cost of the business in Rosario, and the establishment of the exchange at La Plata, of which the Directors informed the shareholders in their circular of 3rd October last, and also the purchase of an exchange at Corrientes,

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while the expenditure at Buenos Ayres is represented by the important and costly erection of the multiple switch-board, and the improvements of the general system there. In order to further develop the Company's business, the Directors have recently made a provisional agreement for the purchase of a rival exchange business at Rosario, the possession of which, in conjunction with the business previously obtained, will, they believe, constitute a valuable addition to the Company's property, as those who know the increasing importance of Rosario will readily appreciate.

The rapid extension of the Company has made it necessary for the Directors to be in a position to further consolidate and render thoroughly efficient the various points of the Company's system, and so ensure larger working results. With that view the Directors now propose, acting under the powers conferred on them by the Articles of Association, to increase the capital of the Company by £25,000, being the equivalent of 5,000 fully-paid shares of £5 each, which shares they will offer at par to the shareholders now on the register *pro rata*. These shares will rank for dividend as from the 1st April last, and, with the warrants for the dividend now recommended, a circular and form of application will be forwarded to each shareholder.

Notwithstanding considerable difficulties during the period under review, many of which were inseparable from the inauguration of an amalgamated business, the Directors have every reason to be satisfied with the progress made, and believe that the business of the Company will now steadily develop and increase.

Under the Articles of Association Mr. J. Irving Courtenay, Deputy Chairman of the Company, and Mr. R. E. Bateman retire by rotation at this meeting. Mr. Courtenay, being eligible, offers himself for re-election; Mr. Bateman, owing to pressure of other engagements, does not seek re-election, and the Directors propose the appointment to the vacancy thus occasioned of Mr. John Coghlan, who since January last has given the Board the benefit of his advice and of his experience in the River Plate, and whose appointment the Directors therefore recommend the shareholders to confirm as from that date.

The auditors, Messrs. Cooper Bros. and Co., also retire, but offer themselves for re-election.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 29th, 1888, were £3,941.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of June was 4,114, estimated to produce £3,000, against 3,613 messages, producing £2,929 in the corresponding month of last year. The traffic receipts for the month of March, estimated at £3,800, realised £3,835.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this company for the month of June amounted to £1,690, against £1,561 in the corresponding period of last year.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of June, 1888, amounted to £48,096, and to £45,426 in the corresponding period of 1887.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of June, 1888, amounted to £41,764, and to £35,138 in the corresponding period of 1887. Increase, £6,626.

NEWFOUNDLAND LAND COMPANY.—The report of the committee of the shareholders of this Company (the shares of which are principally held by the shareholders of the Anglo-American Telegraph Co.) has recently been issued. The committee are of opinion that the 64,000 acres of land allotted to the company should be partly sold or leased in small lots for farming purposes, and partly for fish-curing warehouse sites. They advise the appointment of a competent engineer to survey the company's land, with a view to ascertaining its mineral wealth. Finally, they propose the raising of the necessary funds by the issue of debentures not exceeding £10,000, to be issued at 25 per cent. discount, and carrying interest at the rate of 7½ per cent. per annum.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—The directors of this company have decided to pay an interim dividend of 12s. per share on the 17th inst.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 29th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £3,278.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this company for the month ended June 30th, 1888, amounted to £5,225.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended June 30, were £2,553, as compared with £3,052 in the corresponding period of last year. The March receipts, estimated at £7,036, realised £7,051.

NEW COMPANIES REGISTERED.

BUCKINGHAM ELECTRIC LIGHT AND POWER SUPPLY COMPANY (LIMITED).—This company was registered on the 22nd June, with a capital of £5,000, in £1 shares, to carry on, in the town and county of Buckingham, the business of an electric light and power supply company in all branches. The subscribers are:—

	Shares.
A. C. Rogers, Prebend House, Buckingham, miller, &c.	1
J. Wilson Thorpe, Buckingham, merchant	1
G. Watson French, Buckingham, ironmonger	1
Albert Fyle, Buckingham, draper	1
Henry Thorpe, Buckingham, coal merchant	1
L. Varney, Buckingham, photographer	1
W. Habgood, Hazlebrook, Buccleuch-road, West Dulwich, electrical engineer	1

The number of directors is not to be less than three nor more than five; qualification 25 shares.

ELECTRICAL PURIFICATION COMPANY (LIMITED).—On the 23rd June this company was registered, with a capital of £15,000, in £1 shares, to acquire and work the letters patent No. 1,333, dated January 27th, 1887; No. 15,760, November 17th, 1887; No. 15,939, November 19th, 1887; No. 472, January 11th, 1888; No. 1,105, January 24th, 1888, granted to William Webster, relating to the electrical treatment of sewage and other impure liquids. The subscribers are:—

	Shares.
*Wm. Webster, 50, Lee-park, electrician	2,000
*Thos. Slater, 19, Great George-street, engineer	100
J. Crow, 54, Wickham-road, Brockley, secretary	1
J. Hunter Jones, C.E., Cairo, Egypt	1
*V. Cassavetti, 6, Clarendon-place, Hyde Park	1,000
W. Porter, Baring-lodge, High-road, Lee, engineer	1
*Edwin Webster, 9, Lee-terrace	1,500

The number of directors is not to be less than 3, nor more than 4; the subscribers denoted by an asterisk are the first.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, July 4, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending July 4, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	36 37	3 14 3	Jan., Apr., July, Oct.	...	...
2,614,820	Stock	10/0	Do. Preferred	59½ 60½	4 11 0	,, ,,	...	...
2,614,820	Stock	nil.	Do. Deferred	11½ 12	...	February	...	...
130,000	£10	3/0	Brazilian Submarine xd	12⅝ 12⅝	4 15 0	Mar., June, Oct., Dec.	12⅝	12⅜
16,000	10	8/0	Cuba Submarine	13¼ 13¾	5 16 6	February and August	...	...
6,000	10	10/0	Do. Preference	19 19½	5 2 7	,, ,,	...	..
12,931	5	4%'87	Direct Spanish (£4 paid)	3½ 4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference	8½ 9½	5 5 3	April and October	...	...
60,710	20	2/0	Direct United States	8¼ 8½	4 14 3	Jan., Apr., July, Oct.	8 5/16	...
380,000	10	2/6	Eastern	11⅜ 12	4 11 8	,, ,,	11¼	11 1/16
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜ 15¼	3 19 0	,, ,,	15¼	14⅞
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	110½	...
250,000	10	2/6	Eastern Extension	12⅝ 12⅞	5 1 0	Jan., Apr., July, Oct.	12 13/16	12⅜
22,050	10	8/3	German Union Telegraph and Trust	9 9½	7 7 4	January and March	...	...
179,177	10	2/0	Globe Telegraph and Trust	5¼ 5⅜	5 8 9	Jan., Apr., July, Oct.	5½	...
178,992	10	3/0	Do. 6 per Cent. Preference	13⅜ 14	4 5 8	,, ,,	14	13⅞
150,000	10	7½% '87	Great Northern xd	13½ 14	5 7 2	Jan., July, and April	14 3/16	13¾
17,000	25	37/6	Indo-European	36 38	6 11 9	April and October	...	...
38,348	10	3%	London Platino Brazilian	5⅞ 6¼	...	May and November	...	...
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	...	...
338,225	Stock	15½%	Submarine	140 150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America	6¾ 7¼	7 8 2	January and July	7⅛	6 1/16
150,000	100	8%	Do. Debentures	110 115	6 19 2	June and December	...	...
88,321	10	nil.	West India and Panama	⅞ 1⅛	...	...	1	...
34,563	10	10/0	Do. 1st Preference	10⅝ 11	8 12 8	April and October	10 13/16	...
45,181	15	9/0	Western Brazilian	9½ 10	6 7 6	March & September	10	9 13/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	£5 7/ '87	Consolidated Telephone and Maintenance	⅝ ¾	5 0 0	Yearly	⅝	...
220,000	£1	2½%'87	Oriental (11s. paid)	¼ ⅜	3 13 6	...	...	...
80,000	5	10/0	United	13½ 14	5 7 2	June and December	14 1/16	13 1/16
50,000	5	2/6	United River Plate	5¾ 6¼	...	April and October	6 1/16	5¾
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb.'86	Anglo-American Brush (£4 paid)	2⅛ 3	...	...	...	...
23,692	5	nil.	Do. (fully paid)	3¼ 3⅜	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2⅜	...	...	2⅜	2¼
312,000	½	0/1½d '86	Maxim-Weston	1/16 1/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39½ 40½	5 18 4	March and July	40½	40
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 3	February & August	17¼	16¾

* On account of arrears of dividends.

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

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The principal objects of the Corporation are :—

1. Performing the duties of Trustee, Executor and Administrator.
2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the duties of the family solicitor.

The Corporation acts as Trustees for the Debenture Holders in Public Companies.

For terms, &c., application should be made to the General Manager at the Company's Office.

GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

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ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

On Monday last Mr. Justice Kekewich delivered judgment in the case of Gaulard-Gibbs *v.* Ferranti, ordering that the patent should be declared null and void. The full text of the judgment will be found on another page. Mr. Justice Kay's judgment in the case of the Edison Swan Company *v.* Holland and others has not yet been delivered.

Although it is to us a matter for unqualified regret that vast sums of money should have been transferred from the electric lighting interests—where capital was never more needed than at present—into the pockets of lawyers, who are probably far too shrewd to invest in "A.T." or "B.T." systems, yet we cannot help expressing our admiration for the way in which the said lawyers have defended the interests of their electrical clients. The points with which they have had to deal have often demanded both a very considerable acquaintance with the principles and a firm grasp of the practical details of electric lighting, and in only a very few instances have the counsel on either side failed to rise to the occasion. We trust that we may without impropriety apply the same remark to the judicial bench. The manner in which Mr. Justice Kay has grasped the bearing of the technical evidence has been the subject of remark amongst everyone present in court. This is the more noteworthy in the case of the judges, because, unlike the counsel, they have not the advantage of being coached by the leading witnesses.

We are, however, constrained to make an exception in the case of the opening speech of counsel in the trial of Gaulard-Gibbs *v.* Ferranti. From a purely technical point of view the speech of Sir Henry James is perhaps the most remarkable forensic effort to which the whole history of electrical patent litigation has given rise. We must not venture to comment thereon, lest we should be led into contempt of Court—possibly of a pronounced character.

We understand that negotiations are going on between the Atlantic Cable Companies for an arrangement with regard to rates. The English Companies having always been willing to adopt a shilling tariff for a time, in the hope that it would develop traffic sufficient to pay a moderate dividend, it has remained for the Western Union Company to agree with Messrs. Mackay and Bennett, of the Commercial Cable Company, to adopt this rate. We believe it has not yet transpired whether there are any conditions attached to the proposal or not. It will be seen, therefore, that the matter rests at present very much in the hands of the American Companies, who seem to desire a minimum tariff per message of 5s. This, however, is contrary to the rules of the International Telegraph Convention, and we believe it will be impossible to carry out any such retrograde step. Most of the Atlantic Companies hold concessions, involving adherence to the Convention, from France, and the Anglo-American Company from Germany also, and these companies would certainly not permit such an infraction of the rules they have themselves established at the telegraphic conferences.

The First Commissioner of Works told Sir Henry Roscoe in the House of Commons the other night that to extend the present system of electric lighting throughout the whole of the Houses of Parliament would not cost less than £40,000 per annum. In the absence of detailed information we are unable to check the accuracy of this calculation; but taking the cost of a 16 candle-power lamp, including interest and depreciation charges, at ½d. per hour, the total sum named by Mr. Plunket would suffice for 19,200,000 lamp-hours, or say, roughly, 10,000 lamps burning 2,000 hours per annum. Now we may, of course, be mistaken, but we are inclined to think that 10,000 lamps would be in excess of the actual requirements of the building, and we feel almost certain that the *average* duration of lighting per lamp would be less than 2,000 hours per annum. If Mr. Plunket asks for tenders in the open market, we have little doubt that he will find responsible firms willing to carry out the work at a more moderate figure.

The Society of Arts may well be congratulated upon the remarkable results which have already attended the foundation of the Dr. Mann lectures on Atmospheric Electricity. There can, we take it, be no question that the recent lectures of Dr. Lodge on this subject are a most important contribution to our knowledge of the general principles underlying the phenomena of the thunderstorm. And although the lecturer confined himself chiefly to questions of principle, yet the practical recommendations with which the address concluded ought to be carefully read and pondered over by everyone who is in any way responsible for the protection of buildings from lightning. This is all the more necessary from the fact that the lecturer is driven to the conclusion that such protection is "by no means so easy a matter as the older electricians thought it."

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A good "earth," high conductivity, and one or more sharply pointed sky terminals were supposed to be the only essential details. This state of ignorance continued until in January, 1886, Prof. HUGHES disclosed the influence of the self-induction coefficient, and insisted on the superiority of flat tape or stranded wire. We need not recapitulate here what are the points upon which Dr. LODGE lays stress, since they will be found on page 306 of our present issue.

As an appendix to these lectures, we are enabled to publish some extremely interesting correspondence which has taken place between Dr. LODGE and Prof. HUGHES on the question of iron *versus* copper for lightning conductors. We do not wish to offer any criticism upon the merits of the controversy in its present stage, but we may perhaps be permitted to point out that the *fact* that a Leyden jar discharge will, under certain conditions, traverse a thin iron wire in preference to a thick copper rod is not in dispute. The real question seems to be whether the experiments of Dr. LODGE or those of Prof. HUGHES approximate most nearly to the more dangerous phenomena of the lightning flash. It is clear that either kind of discharge—that is both the continuous flow and the "impulsive rush," with its accompanying electrical oscillations—may, and do, occur during thunderstorms; and we take it that Dr. LODGE has shown that the latter is by far the more dangerous, and should chiefly be considered when planning the conductors.

WE are also indebted to Prof. HUGHES for calling our attention to a remarkable Paper by Prof. GUILLEMIN which appeared in the *Comptes Rendus* as long ago as 1866, and of which we now print a translation. In the correspondence above alluded to will be found some account of the experiments which Prof. HUGHES carried out in connection with Prof. GUILLEMIN on lightning protectors for use on telegraph lines on behalf of the French Government. It was after Prof. HUGHES had left for St. Petersburg that the experiments described in Prof. GUILLEMIN's Paper were carried out. It is evident that the Professor was considerably astonished at the results obtained, which he regarded as altogether irreconcilable with the law of Ohm.

WE are inclined to agree with the opinion expressed at the meeting of the Association for the Promotion of Technical Education last Saturday, that to delay legislation on this important subject will tend to paralyse local effort, and to indefinitely postpone all action whatsoever in the great towns. It is to be hoped, therefore, that, although it is not among the measures which the Government is pledged to carry this Session, the promised Bill authorising Board and Voluntary schools to establish technical instruction may be reintroduced in the autumn. At the same time, it will be well for members of the Association to take note of Lord ARMSTRONG's criticisms in this month's *Nineteenth Century*, and make up their minds what it is they want. In the title of his article, "The Vague Cry for Technical Education," Lord ARMSTRONG concisely expresses a widespread objection to the Association's somewhat indefinite aims, which as at present propounded are, in his opinion, open to a more serious objection still, namely, that they are directed to the acquisition of knowledge rather than to the training of the faculties. No one, perhaps, is more competent to form a sound judgment on this industrial question, and the article referred to is an opportune and admirable contribution towards its solution.

TO-DAY we are able to complete the text of the Instructions which have lately been issued by the Postal Telegraph Department relating to Mechanical and Electrical Examination of Apparatus before being sent out of the Depôt. The document, as a whole, ought to be of great interest and value to the telegraphic world, seeing that it deals with almost all known forms of appliances used in the operative branch of the profession, and is the result of the most lengthened and most varied experience that any telegraph service, public or private, can possibly have had. It should, perhaps, be mentioned that there are two kinds of tests. The mechanical examination is done by the Department of the Controller of Stores, the electrical examination by the Engineering Department. The latter Department, however, necessarily repeats to some extent the mechanical examination.

THE *Statist* has joined in the general assault on the United Telephone Company, though in a more candid and temperate spirit than has been common with its financial contemporaries of late. Under the heading of "Two Different Telephone Systems" the *Statist* draws a comparison between the National Telephone Company's system in Glasgow and the United Company's system in London, a comparison, we need hardly say, all in favour of the former. The last-named company, however, takes its punishment very philosophically; and, entrenched in its 15 per cent. dividends and the smiles of its shareholders, can afford to defy all criticism. Were it not so, however, there are at least half a dozen points of view from which comparisons such as this are either unfair or beside the mark. In the first place London is not Glasgow, and this circumstance alone accounts for a great deal of difference in their respective demands for telephonic service. That this demand depends in no way on population, as the enemies of the United Telephone Company would have us believe, is demonstrated by their own figures. These figures, if we cared to employ them in that fashion, would prove that while such insignificant places as Ayr, Kilmarnock, Grangemouth, and Hamilton are admirably served, Glasgow, the ideal of telephonic perfection, is, by comparison, far inferior to London. But all such reflections are irrelevant and idle in face of the obvious fact that the provincial companies are struggling to earn dividends, whereas the metropolitan company earns a very handsome dividend without struggling at all. This, at any rate, is the probable explanation; and from a financial point of view it constitutes a justification as well.

OF course, there is the point of view of the public; but we entirely fail to see where it comes into the arguments of the financial press, which is mainly occupied in teaching the United Company how to earn more money, or how to enable its subsidiary companies to earn more. The interests of the public have been advocated on their merits in these pages from the

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very beginning; but we have always had to admit that by granting patent rights and allowing them to be worked independently of State control the public surrendered its title to complain when those concessions, so long as they last, are employed for profit, and for profit only. Of course it may be urged that the Company would get more profit, as well as credit, by serving the public better; but this apparently is just the point which the Company is not prepared to admit.

In the highly interesting Paper by Profs. Ayrton and Perry on alternate-current electrolysis, which will be found on a later page, it will be seen that under certain conditions the evolution of gas from either or both electrodes may be determined at will. In *The Electrician* of December 16th, 1887 (p. 123), a suggestion was made to the effect that in the case of electrolysis by an alternating current under given conditions of temperature, pressure, current density, &c., there is probably a critical rate of alternation for every electrolyte, the determination of which might be of considerable value in the study of molecular physics. We are, therefore, especially interested to note that Profs. Ayrton and Perry find that the rate of evolution of gas depends in part upon the rate of alternation. We have also before us a further Paper by MM. Chappuis and Maneuvrier, in which the same fact is mentioned. We hope to publish a translation of this Paper next week.

We are happy to see that our recent remonstrance against the use of low candle-power incandescent lamps for street lighting has induced the Barnet Local Board to revise their contract with Mr. Joel, and to substitute 32 candle-power lamps for 16 candle-power. This is undoubtedly a step in the right direction, although we should have been glad to learn that either arcs or at least 100 candle-power incandescents were to be used, as Mr. Joel himself advised. After this the Board called upon Mr. Joel to reduce the contract price, which he very naturally declined to do, remarking that he had already fixed it too low. We think that Mr. Joel is now taking a perfectly correct view.

Leamington.—At the last meeting of the Leamington Town Council it was resolved to accept the proposal of the Midland Electric Light and Power Company to light the exterior of the Town Hall with four arc lamps.

Newington.—At a recent meeting of the Newington Vestry the clerk read letters from several electric lighting companies announcing that they intended to apply to the Board of Trade for provisional orders empowering them to supply the parish with electric light. The communications were sent to the Works Committee for consideration and report.

Royal Agricultural Society's Award for the Priestman Petroleum Engine.—We are pleased to note that Messrs. Priestman Brothers have received the award of a silver medal from the Royal Agricultural Society, for the petroleum engine exhibited by this firm at Nottingham. Probably there is no award of this character which carries with it greater weight than that of the Royal Agricultural Society.

The Institute of Medical Electricity.—We are informed that the directors of the Institute of Medical Electricity (Limited) have taken commodious premises at 24A, Regent-street, with side entrance in Jermyn-street, and are having them fitted with the latest and best appliances for electrical treatment by all known methods. It is expected that the establishment will be opened in a few weeks.

Toulouse.—The electric lighting of the Théâtre du Capitole at Toulouse, which was undertaken by the local gas company, has just started working. It comprises 1,000 incandescent lamps of 10, 16, and 20 candle-power, arranged throughout the theatre on alternate circuits, so that complete extinction of the light is impossible so long as one circuit is intact. Each circuit is run off a 500-light Bréguet dynamo, driven by a two-cylinder 50 horse-power Otto gas engine.

An Electric Organ. — A new electric organ has been erected at the back of the stage of the Burg Theatre, in Vienna, and is connected by a cable with the orchestra, where the key-board is situated. The cable is long enough to admit of altering the position of the key-board within a radius of 30ft. The organ has been built by Messrs. Rieger Brothers, of Jagendorf, and the signals are transmitted from the key-board to the relay lever by five Callaud cells.

Siemens' Potential Dynamometer.—An occasional slight source of error in the well-known Siemens potential dynamometer is pointed out by Herr Isenthal in the *Centralblatt*, No. 16. The damping vane attached to the bell-magnet becomes at times, for reasons best known to itself, electrified, and there is then an attraction between the vane and the damping plates, as owing to the mechanical construction of the instrument the vane is insulated. When the fact is realised, it is, of course, easy enough to get over the defect either by uninsulating the vane or by making it of mica instead of aluminium.

The Lighting of Lambeth.—At the last meeting of the Lambeth Vestry a letter was received from the Assistant-Secretary of the Board of Trade stating that all reference to the parish of Lambeth had been omitted from the proposed South Metropolitan Electric Lighting Order. A notice was received from Messrs. Deacon, Gibson and Medcalf that the London Electric Supply Corporation intended to apply for a provisional order for the supply of electricity for an area which would include the whole of the parish of Lambeth. A similar notice was received from the South Metropolitan Electric Supply Company.

Telephonic Charges at Hull.—At a meeting of the Council of the Hull Chamber of Commerce and Shipping, held last week, a letter was read from the Postmaster-General on the subject of telephonic charges at Hull. He had made calculations, and was convinced "that there is no room at present for a reduction. At the same time I may say that when the patents have expired it may be possible for the department to obtain telephones at a much lower price, and it would then be only right to reconsider the charges for telephone exchange wires, and to give the public the benefit of the reduction." Alderman Seaton considered the reply very unsatisfactory.

The Annual Excursion of the Anglo-American Brush Employes.—The eighth annual excursion and dinner of the *employés* of the Anglo-American Brush Corporation came off with great *éclat* on Saturday, July 7. The party, numbering 146, left Liverpool-street per Great Eastern Railway at eight o'clock in the morning, arriving at Clacton-on-Sea at 10:42. All made the best of their time in boating and bathing, and at 1 o'clock the party adjourned to the Osborne Hotel for lunch. The chair was taken by E. Garcke, Esq. There were also present—Messrs. Mordey, R. P. Sellon, J. Evans, Jackson, Fells, and Paterson. The party arrived in London at 10 p.m., highly delighted with their trip.

Ealing.—At a recent meeting of this Board the clerk read a letter from the West Middlesex Electric Lighting Company,

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informing the Board of the company's intention to apply for a provisional order empowering them to supply the electric light within the area of the Board's jurisdiction. The chairman said it was for the Board to decide what action they would take in reference to the notice. They had a similar one three or four years ago, he believed, and determined to oppose it. The surveyor said he thought this was an entirely new company. The chairman suggested that the letter should be referred to one of the committees to report upon. It was referred to the clerk to report upon the letter at the next meeting.

The Telephone in the Spanish Colonies.—By a decree May 12 last, the Queen Regent of Spain has set forth the conditions upon which telephone enterprise must be undertaken in Cuba, Porto-Rico, and the Philippine Archipelago. The State is to receive at least 6 per cent. of the gross receipts. The concessions are to last twenty years, at the end of which period everything passes to the State. The telephones, as regards taxes, way-leaves, and hours of service, are to be on the same footing as State departments. The *concessionnaires* will have to guarantee the service, and erect offices open to the public. The maximum charge for places situated within municipal boundaries is 102 piastres (1 piastre = about 5d.). This charge is increased to 204 piastres for flats, and 333 piastres for hotels, clubs, &c. An additional 1½ piastre may be charged for every 100 metres outside the municipal boundaries.

The London Chamber of Commerce and the Proposed Electrical Section.—The following circular has been issued by the London Chamber of Commerce:—Sir: I beg to inform you that a preliminary meeting of the members of the Chamber interested in the electrical trades will be held here (Botolph House, Eastcheap) on the 13th July, at three p.m., to consider the appended agenda, when your attendance is specially requested.—Yours faithfully, Kenric B. Murray, secretary:—Agenda.—1. To consider the formation of the proposed electrical section. 2. To decide upon the number of sub-sections, such as those for telegraph and cable companies, electrical lighting companies, telephone companies, electric locomotion, and manufacturing industries appertaining thereto. 3. To nominate a chairman, and fix a date, for the public meeting to be convened for the formation of a section. 4. To suggest a working committee reqresentative of each sub-section.

The Newfoundland Land Company.—A general meeting was held yesterday of the shareholders of the Newfoundland Land Company, which was an offshoot of the original Newfoundland Cable Company. When amalgamation took place about fifteen years ago between that company, the French Atlantic and Anglo-American Companies, there were no powers in the Memorandum of Association of the latter by which land could be taken over. The Newfoundland Land Company was therefore formed, remaining under the management of Mr. Cyrus Field, Sir James Anderson, and Mr. Weaver, and Mr. Mackay in Newfoundland. The shareholders have now formed a new Board in the hope, as stated in the report, of raising capital for the purpose of exploration and, if possible, developing a profitable enterprise in connection with the large quantity of land owned by the company in the Island of Newfoundland.

Electric Lighting at the Houses of Parliament.—In the House of Commons on Monday last Sir H. Roscoe asked the First Commissioner of Works whether, in view of the serious deterioration of the stone fretwork of the interior of the Houses of Parliament, owing to the corrosive action of the products of combustion of gas, he would undertake to extend the system of electric lighting throughout the building, so as to avoid the evil consequences which attended the present system.—Mr. Plunket said that to extend the present system of electric lighting throughout the whole of both Houses of Parliament would involve a very considerable expenditure, not less than £40,000, for plant. It would, however, probably effect a considerable saving in the annual cost of lighting the Palace. Before making any proposals upon the subject, it would be necessary to consider whether some more economical way of obtaining the necessary current of electricity than that which we now use may be made available.

Progress of Repairs to the Interrupted Australian and Atlantic Telegraph Cables.—We are informed that one end of the Eastern Extension Telegraph Company's original Java-Port Darwin cable has been picked up, and the ship is on the spot endeavouring to secure the other; but a telegram yesterday morning reported the weather bad, causing delay to the operations.——In reference to the interruption of the Direct United States Company's cables we are informed that one repair has been effected in mid-Atlantic in upwards of 2,000 fathoms. In regard to the other interruption 600 miles from Ireland, one end of the cable has been picked up, and the "Scotia" is probably grappling for the other.——The Anglo-American Company's ss. "Minia" has repaired a deep-water fault in the Brest cable, and is now engaged on a repair near St. Pierre.——Both ships in the Atlantic, as well as the "Recorder," engaged on the Australian cable, are probably at the present time encountering bad weather, but we understand the directors look with confidence to the early completion of the repairs of all the cables.

Messrs. Fowler and Co.'s Exhibits at the Royal Agricultural Society's Show.—At the Nottingham Show of the Royal Agricultural Society Messrs. Fowler and Co., of Leeds, exhibited a 12 horse-power compound semi-portable engine, specially constructed for electric lighting. This engine is fitted with Hartnell's automatic expansion gear on both cylinders. As usually constructed, engines of this type have automatic gear only on the high-pressure cylinder; but it is essential that the automatic gear should act on both cylinders if the power given off by each cylinder is to be equal under varying loads. This engine is not only economical but extremely well governed. It is incapable of exceeding by more than 1 or 2 per cent. its mean speed when the load is suddenly removed, and will not fall below the mean speed by a greater amount when the whole load is suddenly thrown on. In practice a small fraction of 1 per cent. variation of speed at once begins to alter the degree of expansion, a result quite unattainable in ordinary governing, but which we need hardly say is highly advantageous in electric light engines.

Renold's High-Speed Steel Driving Chains.—We have recently had occasion to refer to the fact that the use of steel chain driving gear for electric tramcars has come into very general favour. We may now add that the chains most in use are those made by Hans Renold, of Green Lane, Manchester. Referring to a chain of this description on the Bessbrook and Newry Tramway, Dr. Edward Hopkinson writes as follows:—"One of the chains made by Hans Renold was put on July 13th. The locomotive has run about 6,000 miles, drawing trains of 9 to 27 tons gross weight; and yet the chain has not been off, nor has it been tightened—in fact, it shows little sign of wear. This is no doubt due to the new method of oiling, as well as to the strength of the chain." In these chains the studs, links, and blocks are each made of a different class of steel, specially selected for the purpose. The bearing surfaces are particularly hard and smooth, and almost dust proof, and special provision is made for oiling. The links

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are made in different widths, according to the speed at which the chain is to be run, which may be as high as 1,000 feet per minute.

The Electric Lighting of the Arena at the Italian Exhibition.—The arena of the Roman Coliseum which was opened last week at the Italian Exhibition is lighted for the evening performances by 20 Thomson-Houston arc lamps of 2,000 candle-power each, similar to those used throughout the Exhibition. Instead of using reflectors to shade the lamps from the auditorium and to throw the light upon the arena, the half of each lamp which is turned towards the auditorium is painted on the outside with black enamel paint, and on the inside with white enamel paint. The result of this simple device, due, we understand, to a happy thought of the engineer in charge of the installation, Mr. Ireland, is thoroughly satisfactory. The arena is lighted up quite as much as is desirable for the comfort of the spectators, and the light is perfectly steady, showing in that respect a marked improvement over the lighting for the Wild West performance at the American Exhibition last year, when search lights on the roof were employed, and as the latter were not automatically regulated they not only required the presence of a man on the roof throughout the performance to attend to them, but caused some discomfort to both spectators and performers by occasional flickering.

The St. Catherine Lighthouse.—The lighthouse at St. Catherine's Point, on the southern coast of the Isle of Wight, contains the most powerful electric arc light at present in existence. The carbons burnt in this lamp have a diameter of 60mm. (nearly 2½in.), and the light is estimated at 60,000 candles, which when concentrated by the lenses gives a beam of 6,000,000 candles. The carbons are not circular in section, but fluted. This device promotes the access of air to the centre of the arc; it keeps the carbons cooler, and tends to maintain the centrality of the arc. The lamp is a modified form of the Serrin-Bergot type. There are two dynamos by De Meritens, of Paris, each containing sixty permanent steel field-magnets. The armature is 2ft. 6in. in diameter, and consists of five Gramme rings side by side. The motive power has been supplied by Messrs. Robey and Co., of Lincoln, and consists of three compound engines and boilers, each of 12 nom. horse-power, but capable on a push of working up to 48 horse-power. The engines embody all the latest improvements of this well-known firm, and run at 122 revolutions with remarkable ease and smoothness. The fuel used is gas coke, and the boiler pressure is 150lb. Only two engines are employed for the dynamo, the third being required for the steam siren or fog horn.

Fatal Accident from an Ascending Lightning Stroke.—*Il Telegraphista* gives a highly remarkable account of a fatal accident during a thunderstorm. It appears that in the Isle of Farignana, at a height of 1,000 feet above the sea level, there is a telegraph station, a telephone office, and a semaphore signal post, provided with a lightning conductor. These three lines all make earth in a well. Between 2 and 3 o'clock in the afternoon of October 26, 1887, sparks were seen to be passing from the telephone lines to the walls of the iron building in which the instruments were placed. It appears to have been raining at the time, but no mention is made of any other signs of a thunderstorm. The telephone attendant sent for a linesman named Duran; on his arrival he noticed that the lightning conductor belonging to the semaphore post had been fused at a point where it touched the iron frame of the building. Duran carried in his hand a hammer, with a wooden handle, which was connected to the head by two metal strips. He then touched *the earth portion* of the fused conductor with his hammer, and immediately fell dead. It appears that the unfortunate man, at the moment he touched the wire with the head of his hammer, was in metallic connection with it through the two metal strips, and with the floor of the building through his damp boots. It is suggested that a considerable difference of potential existed between the building on the solid rock and that of the earth, with which they were only in communication by means of the earth wire which had already been fused. When the linesman touched the earth end of this wire a discharge passed through his body from the building to earth. It would, however, be satisfactory to have further details of this remarkable event.

Conversazione of the President of the Society of Telegraph-Engineers and Electricians.—On Tuesday, 10th inst., Mr. E. Graves (President of the Society of Telegraph-Engineers and Electricians) and Mrs. Graves held a reception at the Royal Institute of Painters in Water Colours in Piccadilly, which was attended by a large and brilliant assemblage. The band of the Coldstream Guards performed an excellent programme of chamber music under the leadership of Mr. C. Thomas. Amongst those present were the following:—

Visitors.—Sir Edward and Lady Birkbeck, Captain E. M. Shaw, C.B.; M. Fontaine, Prof. Groves, F.R.S.; Rev. J. Macnaught, Prof. Frankland, F.R.S.; Geo. Berkeley, Prof. Vernon Harcourt, Captain W. J. L. Wharton, R.N.; T. A. Highton, L. W. Courtenay, H. Perigal, Sir P. Magnus, Don Arthuro de Marcontu, Prof. W. Hudson, Dr. Plimpton, Sir A. Blackwood, K.C.B.; Captain Adams, C. Hawksley, G. J. Symons, F.R.S.; J. Wimshurst, Dr. Tison, Wolfe Barry, Dr. Radcliffe.

Members.—Sir W. Gurdon, Sir H. Mance, C.I.E.; Prof. S. P. Thompson, F.R.S.; Prof. G. Forbes, F.R.S.; Prof. J. Perry, F.R.S; Prof. D. E. Hughes, F.R.S.; Alexander Siemens, W. Crookes, F.R.S.; W. H. Preece, F.R.S.; Captain H. Sankey, R.E.; Colonel Hamilton, R.E.; Dr. J. H. Gladstone, F.R.S.; Bernard Drake, Augustus Stroh, E. March-Webb, Major C. F. C. Beresford, R.E.; F. H. Varley, Louis Loeffler, J. N. Shoolbred, J. Hookey, F. T. B. Daniell, C. F. Kierzkowski-Steuart, W. M. Mordey, H. Benest, G. C. Fricker, Dr. Baur, Musgrave Heaphy, Walter T. Glover, Capt. Lugar, Sir D. Salomons, Bart.; Sir Douglas Galton, K.C.B.; Prof. G. C. Foster, F.R.S.; Prof. W. G. Adams, F.R.S.; Prof. W. E. Ayrton, F.R.S.; W. Lant Carpenter, Dr. J. A. Fleming, M.A.; J. W. Swan, C. H. B. Patey, C.B.; Capt. M'Evoy, Major-General Festing, F.R.S.; Dr. J. Hopkinson, F.R.S.; Major-General C. E. Webber, C.B.; R. P. Sellon, C. E. Spagnoletti, W. H. Snell, W. B. Esson, F. Higgins, Dr. Walmsley, Dr. Sleet, Capt. G. W. Addison, R.E.; F. Despointes, J. Farquharson, Ch. Gerhardi, Dr. Obach, R. Waring (Pittsburg, U.S.A.), R. E. Crompton, R. K. Gray, and Shelford Bidwell, F.R.S.

Ilfracombe.—At a recent meeting of the Ilfracombe Local Board the surveyor reported that the Gülcher Company were willing to light the new promenade with twelve 300 candle-power incandescent lamps from sunset till eleven o'clock every night for £360 per year, this to include cost of plant, erection and labour.—Messrs. Laing, Wharton and Down would erect 18 arc lamps, each of 1,200 candle-power (being four for the new promenade, and 14 on the Parade), and light the same from sunset until 11:30 every evening for £450 per year.—Messrs. Nicholson and Jennings would provide the light at the rate of from 1s. to 1s. 2d. per 280-candle power per hour.—Mr. Woodley, who, prior to the last meeting made a verbal offer to the Chairman, now wrote offering to light the new promenade five hours per night for £150 per year; at the expiration of twelve months he would remove the plant on payment of £60, or the Board might take it over for £300.—Mr. Lake pointed out that the price now given was 50 per cent. higher than was named at the last meeting by Mr.

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Woodley.—Mr. Russell said there was no doubt that if Mr. Woodley would provide the electric light on the terms he stated at the last meeting the Board would be justified in accepting the offer. In reply to Mr. Lake, the surveyor said that he estimated that if lighted by gas the Shelter would require about ten lights at from £10 to £12 each. Mr. Lake said he felt confident that the Shelter could be lit by gas at less than £50 per annum. Mr. Day was of the same opinion, and it was resolved after some conversation that the clerk should ask the gas company the cost of lighting by gas before proceeding further. Mr. Russell proposed that the Board should write to Mr. Woodbury to ask upon what terms they would light the whole town. The surveyor said he had written twice already, but he had not obtained a satisfactory reply. The chairman said he should be sorry to see the gas taken into the Shelter. Mr. Camp thought a price should be obtained both from the gas company and an electric light company, and see which was the better. It was also decided, on the motion of Mr. Russell, to ascertain upon what terms Mr. Woodley would light the whole of the town with electricity.

Electric Light Progress in Austria.—The Vienna correspondent of *Industries* writes as follows:—"Considerable progress is being made in various Austrian towns with electric lighting. The total number of glow lamps now installed in Vienna may be estimated at 18,000, and in addition there are about 1,000 arc lamps in use. A small central station is projected for Neuhaus, in the south of Bohemia, where there will be a total of 600 glow lamps installed, the motive power being supplied by turbines. Consumers will have to buy their own lamps, and pay for the current—not by meter, but at a fixed sum of 15 florins (about 24s.) per annum—for every 16 candle power glow lamp fixed. In Pisek, also a town in Bohemia, a central station is in course of erection for 22 arc and one hundred glow lamps for street lighting; power will be supplied by a 45 horse-power water wheel. The station at Karolienthel, near Prague, which I described some months ago, is in successful operation. There are now three hundred glow lamps in use, and the current is partly supplied direct from the dynamos and partly from Khotinski accumulators. One of the most complete installations in Bohemia is that on the Sophieninsel, in Prague, an island on which is a casino used for public entertainments. This installation has been erected by Herr Krizik, and consists of three Otto gas engines, each of 50 horse-power, and a small gas engine for starting the big engines. There are four disc dynamos, each capable of supplying four hundred lamps. In the assembly rooms of the casino there are fixed five arc lamps, and nine hundred glow lamps; but as there is current to spare, some street lighting by arc lamps will be done from these dynamos. The whole of the plant for this installation, including the handsome electroliers, has been manufactured and supplied by Herr Krizik, who is also the contractor for the lighting. The light is not paid for, not by the amount of current consumed, but by the amount of gas used in the engines, the charge varying from 20 kreuzer to 32 kreuzer per cubic metre, according to the number of lamps in use at a time. The gas for the engines costs 9½ kreuzer per cubic metre, or about 4s. 9d. per 1,000 cubic feet, so that the contractor for the electric light receives a surplus of about 7s. on every 1,000ft. of gas required, and this covers his profit, the payment of wages, lamp renewals, carbons, and other charges standing against the installation."

Barnet Local Board and their Electric Lighting Contract.—A special meeting of this Board was held on Friday last. The Chairman reported that Mr. Joel had attended before the committee on electric lighting and had put it to them that it would be unwise to light the town with incandescent lamps of 16 candle-power, as provided in the contract, specialists being of opinion that lights of this power were unsatisfactory for street lighting. The Board having decided on 16-candle lamps it became necessary to call a meeting to take the matter into consideration. Mr. Joel suggested lamps of 32 candle-power, and a plan had been prepared showing seventy-one lamps as sufficient for lighting the town (the cost of which would be about equivalent to gas) instead of 104 16-candle lamps. Another matter for the consideration of the Board was that Mr. Joel's bond had not been executed.—Mr. Schmidt said the reason the bond was not executed was that Mr. Joel did not want to enter into a binding contract to fix a light which he and other scientists believed would be unsatisfactory and discredit electric lighting.—The Chairman: I do not think that is the way to put it. Mr. Joel contracts to provide electric light of any power which the Board may decide, the price being arranged on a certain basis for the 16-candle lamp. We decided to have these lamps; but there is nothing in the contract, I think, to prevent us having larger lamps if that is desirable.—The Clerk, in reply to the chairman, said the contract and drafts were in London for execution, and he could not therefore produce them then for reference.—Mr. Parsloe: I understand Mr. Joel declines to execute the contract if the Board adhere to 16-candle lamps.—Mr. Schmidt: He does not want to be bound to do something which will discredit electric lighting and be unsatisfactory to the Board. Mr. Tryon: It is a most extraordinary thing that this gentleman, who was introduced to us as the first electrician of the day, should have taken all this time to discover that 16-candle lamps are of no use, and that he should make that an excuse for not signing the contract.—Mr. Marriott: He has been advised not to use 16-candle lamps if he can possibly use larger; the small light has been a failure at other places, and he does not want to have a failure here.—After some further discussion, Mr. Widdicombe said, to bring matters to a point, he would move "That the Board is willing to adopt 32 candle-power incandescent lamps in place of the 16-candle lamps mentioned in the contract submitted, at a price to be agreed upon between this Board and Mr. Joel."—Mr. Schmidt seconded the motion.—Mr. James: If we agree to this alteration, how do we know whether in a short time something else will not be proposed? *The Electrician*, which advises Mr. Joel not to attempt street lighting with 16-candle lamps, says nothing under 50 candle-power should be used.—Mr. Widdicombe: We are going to light our streets more cheaply, but we also propose to give additional light. Light for light, we shall save by using the electric light; the additional cost will arise in providing the town with more light than it has hitherto had.—On the motion being put it was carried by a majority of 6 to 3.—A discussion then arose as to the price of the electric light. The terms agreed upon for lamps of 16 candle-power were £2. 14s. each lamp, as against £2. 18s. 6d. paid to the gas company, and, in addition to the difference in price, Mr. Joel claims in favour of the electric light that it will be kept going for an hour later each night. The contract makes the charge for 16-candle lamps the basis, and Mr. Joel was called into the room and asked if he could not reduce the price now that the Board had agreed to the larger lamps.—Mr. Joel replied that he could not; indeed, he had fixed the price too low in the first instance. Mr. Joel also said he recommended arc lights, but the Board decided to have incandescent.—The Board then adjourned, having first impressed on Mr. Joel the desirability of having the bond and the contract executed without further delay.

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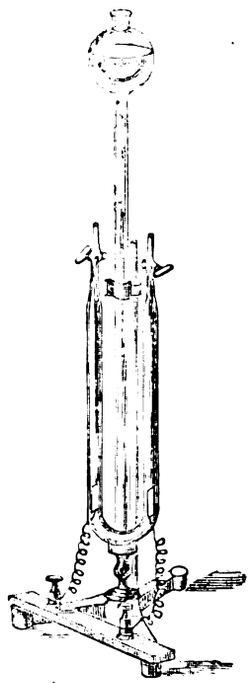
ALTERNATE-CURRENT ELECTROLYSIS.

BY PROFS. AYRTON AND PERRY.

1. The article in *The Electrician* for June 29th on Alternate-Current Electrolysis leads us to mention that, although we have not yet had time to carry out the investigation on this subject that was commenced nine months ago at the Central Institution, one of our assistants, Mr. Raine, in conjunction with Messrs. Lamb, Smith and Priest, three of the third-year students of electrical engineering, have from time to time made detached experiments on this subject. Their results are partly in accord and partly apparently contradict those communicated by MM. Maneuvrier and J. Chappuis to the French Academy, and therefore will probably be of interest to readers of *The Electrician*.

2. MM. Maneuvrier and Chappuis commence by saying that with an ordinary voltameter no evolution is, as a general rule, observed with alternate currents, but the experiments made at the Central Institution have been conducted with an ordinary Hoffmann's voltameter, as shown in the figure, containing a 33 per cent. solution of sulphuric acid, and decomposition has never failed to be produced when an alternate current has been passed through it. The platinum plates are each about $3\frac{1}{2}$



Hoffmann's Voltameter.

centimetres by about 1 centimetre, and the platinum wires inside the voltameter are respectively about 1·6 and 1·9 centimetres long, and about 0·06 centimetre in diameter. On passing an alternate current of about 3 amperes with 10,080 alternations per minute through the voltameter for the first time last November, it was observed that about 10 cubic centimetres of gas came off from each electrode in about three minutes. The gas, as far as could be seen, came off entirely from the wires, and, contrary to what occurs with a direct current, not at all from the plates; the wires became black during the experiment, and the liquid in the voltameter became very hot, showing that there was much decomposition accompanied by rapid recombination of the gases, which produced therefore no visible gas. It was further noticed that a Varley's resistance made of flexible carbon cloth* which was in circuit with the voltameter for adjusting the current strength, became far hotter than if a direct current of 3 amperes was passing through it, the result being produced possibly by a rapid decomposition of the moisture on the cloth, followed by a rapid recombination of the constituent gases.

*Described and illustrated on page 397 of "Practical Electricity."

3. MM. Maneuvrier and Chappuis say that no visible gas is produced at either electrode by an alternate current of from 4 to 5 amperes if the platinum rods exceed 0·1 centimetre in diameter, and are more than 4 to 5 centimetres in length. In other words, their experiments tend to show that a current density of at least $\frac{4}{\pi \times 0{\cdot}1 \times 4}$, that is at least 3 amperes per square centimetre, is necessary to produce visible decomposition. But in our experiments, if we reckon *only one* surface of each platinum plate, the surface exposed was at least $3\frac{1}{2}$ square centimetres, so that in our case visible decomposition was effected with a current density of less than 1 ampere per square centimetre, or less than $\frac{1}{2}$ an ampere per square centimetre if we include both surfaces of each plate. Either, then, it must be assumed that no current leaves the platinum plates, and that all, or practically all, the current goes from wire to wire, or else it follows that an alternating current of much less density than that stated by MM. Maneuvrier and Chappuis can produce visible decomposition of dilute sulphuric acid.

4. In the next experiment the speed of the alternate-current dynamo was increased, and the current rose to $4\frac{1}{2}$ amperes, but the rate of decomposition became much less, tending to show that rate of alternation as well as current density must be taken into account. Again the speed was lowered until a current of 3 amperes passed through the voltameter, but the rate of decomposition was found to be much less than in the first experiment, and curiously enough now the gas was evolved at one electrode about twice as fast as at the other, and on testing the gases it was found that the gas of large volume appeared, on burning, to be pure, or nearly pure, hydrogen, while that evolved at the other electrode was an explosive mixture.

5. No experiments were then made for some months, when, on trying the voltameter again, it was found that when an alternate current was passed through, gas came off freely at one electrode, but none came off at the other. The terminals of the voltameter were then connected with the reverse terminals of the dynamo, but the gas continued to come off only from the electrode from which it came off before. Thinking, perhaps, that the wires of the voltameter had become differently polarised by a direct current having passed through the voltameter on some occasion since the last observations with alternate currents were made, the following experiments were carried out, the letters P and Q referring to the electrodes of the voltameter and A and B to the wires coming from the alternate-current dynamo, B being connected with the uninsulated framework of the dynamo:—A direct current from six accumulators was sent from P to Q for some time (when hydrogen and oxygen came off freely from the respective electrodes in the usual way). The direct current was then stopped, and P joined to A and Q to B, and the evolution of gas observed. P and Q were now disconnected from A and B, a direct current sent from P to Q, then P joined to B and Q to A. Next the direct current was sent from Q to P, and then P joined to A and Q to B. Lastly, the direct current was sent from Q to P, and then P joined to B and Q to A, but in all cases when the alternate current was passing the gas came off solely at one and the same electrode. For the purpose of confirming this curious result, the four combinations just described were repeated over and over again, but always with the same result. It appeared, therefore, that no matter which way a direct current was sent through the voltameter (when hydrogen and oxygen came off freely in the normal way), and no matter which wire from the alternate-current dynamo, after the stoppage of the direct current, was connected to which electrode of the voltameter, the gas came off solely at one electrode. Here, for some reason or other, the voltameter electrodes had acquired a permanent difference, not possessed on the previous occasion, in their power of decomposing gas when an alternate current passed through the voltameter.

6. An interval of some weeks now elapsed, when an opportunity again occurred of making some further observations and the following results were obtained, the direction of the arrow indicating the direction on which the steady current was sent through the voltameter before it was connected to the

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wires of the alternate-current dynamo. In the first six of the following experiments six accumulators were used to produce the direct current and eleven accumulators in the remainder. The number of alternations per minute in all the experiments was about 10,000, and, as before, the direct current was always stopped, and the voltameter tubes emptied of gas before the alternate current was allowed to pass :—

No. of experiment.	Direction of steady polarising current	Connections for alternate current.	Alternate currents in amperes.	Relative quantities of gas produced at electrodes P and Q.	Nature of gas.
1	P←Q	P to A, Q to B	...	Twice as much at P as at Q	Not examined.
2	P←Q	P to B, Q to A	7	Equal quantities	,, ,,
3	P←Q	P to A, Q to B	7	Equal quantities	,, ,,
4	P←Q	P to A, Q to B	3	Equal quantities	,, ,,
5	P→Q	P to A, Q to B	7	Equal quantities	,, ,,
6	P→Q	P to B, Q to A	7	Equal quantities	,, ,,

Experiments 2 to 6 repeated with same results, but Experiment 1 not apparently reproducible.

Eleven accumulators subsequently employed to produce the steady polarising current.

7	P←Q	P to A, Q to B	Commenced with 5, but the current rapidly increas'd to 7, as if the resistance of voltameter diminished	Equal quantities	Both explosive
8	P←Q	P to A, Q to B	2½	Twice as much at Q as at P	Both explosive
9	P←Q	P to B, Q to A	2½	Eight times as much at Q as at P	Both explosive
10	P→Q	P to A, Q to B	2½	Gas came off at first more rapidly at Q than at P, then gradually it came off at equal rates at Q and P, finally it came off more rapidly at P, so that at the end there were about equal quantities produced at both electrodes.	Both explosive
11	P→Q	P to A, Q to B	2½	All at P	Explosive
12	P→Q	P to B, Q to A	2½	All at P	Explosive
13	P←Q	P to A, Q to B	2½	Nearly all at P	Explosive
14	P←Q	P to B, Q to A	2½	Ten times as much at P as at Q	Gas at P explosive, and little gas at Q, apparently oxygen.

An examination of the preceding fourteen observations led us to the following conclusions :—At the commencement the electrode P was better able than the electrode Q to produce visible decomposition when an alternate current passed. This superiority of P over Q was gradually diminished by sending a direct polarising current from Q to P through the liquid of the voltameter until at experiment 8 the electrode Q had the advantage. This advantage was increased still further at experiment 9. The direct polarising current was now reversed and sent from P to Q, and it will be observed that Q gradually lost its advantage until at experiment 11 it was P that now had the superiority again. Again reversing the polarising current at experiment 13 so that it passed through the liquid from Q to P, we observe that P was gradually losing its superiority.

7. On a later occasion similar experiments to the preceding experiments were carried out with a stronger direct polarising current of 6 amperes, the alternate current being still 2½ amperes, and the effects referred to above were very much more marked. It was now found possible to cause the 2½-ampere alternate current to produce rapid decomposition at either of the electrodes at will, and no visible decomposition at the other electrode, by previously sending for some time the 6-ampere direct current through the liquid from that electrode at which subsequent decomposition by the alternate current was desired. Hence it seems certain that a deposition of hydrogen on a platinum electrode hinders, or even stops altogether, visible decomposition being produced by alternate currents at that electrode, while a deposition of oxygen on the other platinum electrode does not stop, or it may be even favours, visible decomposition. It would further appear from the experiments referred to in § 5 that, although the direct polarising current may be strong enough to produce rapid decomposition, the gases so produced do not affect in a marked way the subsequent relative decompositions produced at the two electrodes by an alternate current, when the alternate current exceeds some particular strength relatively to the strength of the previous direct polarising current.

This communication is not put forward as being in any sense a complete exposition of the phenomena of alternate-current electrolysis, but merely as a fragmentary contribution to a subject which is attracting some attention at the present moment.

UNIPOLAR INDUCTION.—VI.

BY G. W. DE TUNZELMANN, B.SC.

(Continued from page 263.)

The other experiments mentioned were performed with the apparatus shown in Fig. 19. Two ebonite discs, *a g b h* and

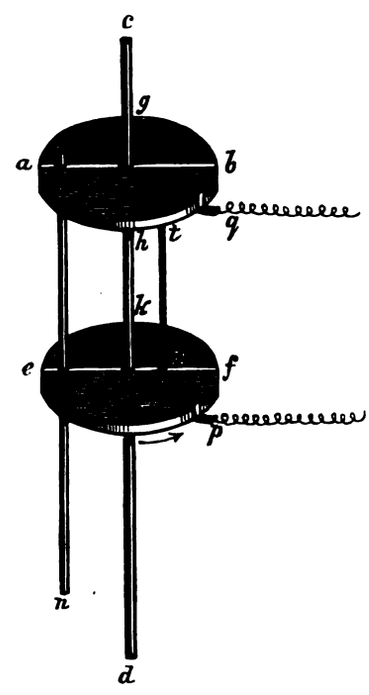

FIG. 19.

a g b h and *e k f m*, ebonite discs having their peripheries encased in brass bands; *c d*, a metallic axis to which they are fixed; *a b* and *e f*, brass bands connected at *a* and *e* with peripheral bands, but insulated from them at *b* and *f*, and from the axis; *t p*, a movable brass rod connected with *a b* and *e f*, and capable of sliding along them; *s n*, a magnet not in connection with any of the metal work; *p* and *q*, contact springs in connection with galvanometer circuit.

e k f m, of equal dimensions, having their peripheries encased with bands of brass, were pierced at their centres and attached to a metallic axis *c d*, about which they could be made to rotate. Two brass bands, *a b* and *e f*, were fixed to the discs and connected at *a* and *e* with the peripheral bands, but were insulated from them at *b* and *f*, and also from the axis. A magnet, *s n*, was passed through the two discs without being connected with any of the metallic portions of the apparatus. One of these discs was placed at the height of the south pole of the magnet and the other in the centre. A brass bar, *t r*, was made to

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connect the bands $a\,b$ and $e\,f$, and its distance from the axis could be varied at pleasure by sliding it along the bands. Connection with the galvanometer circuit was made by means of two contact springs p and q pressing against the peripheral brass bands.

When the apparatus was made to rotate about the axis in the direction shown by the arrow, a current was produced which flowed through the galvanometer from q to p. Edlund then concluded from his theory that for a given speed of rotation the direction of the current would be independent of the position of the bar $t\,r$, and this he found to be the case. According to the theory which I have adopted in these Papers the same result would evidently follow, for the induction takes place in the fixed portion of the galvanometer circuit, and therefore the position of the bar $t\,r$ cannot possibly have any influence on the E.M.F., and the slight change in the resistance due to the inclusion of a larger or smaller portion of the bands—namely, the portions between b and t and between f and r—will be too small to be appreciable. Neither of these experiments can, therefore, be considered as giving any confirmation of Edlund's assumptions.

Edlund then proceeds to consider the objection that might possibly be urged against his theory, that according to it a cylindrical tube rotating about its axis would exert an electro-dynamic action similar to that of a coil through which a current is passing. This would not be the case, as he points out, if the electric current consists in the transference of equal quantities of positive and negative fluids in opposite directions, as in that case the two fluids being carried with the same velocity in the same direction would neutralise each other's effects.

To explain the absence of any sensible electro-dynamic effect on the hypothesis that the electric current consists in the translatory motion of a single fluid in one direction, Edlund restates his theory of the electric current previously set forth in his "Théorie des Phénomènes Electriques" (Kongl, Svenska-Vetenkaps-Akademiens Handlingar, Vol. XII.). He points out that the phenomena of optics have led to the assumption that the æther is attracted by ponderable matter. "A material body," he says, "condenses the æther between its molecules until the attraction exerted upon an æther molecule situated within the body becomes equal to the repulsion exerted by the already condensed æther upon the same æther molecule. When this point is reached, the material body is no longer in a position to put in motion the external molecule of æther. Besides that quantity of æther which may be regarded as connected with the body's own molecules, there exists free æther between those molecules, and the quantity of free æther contained by the entire body must be equal to the quantity of æther contained in a volume of vacuous space equal to that of the body. This is what takes place as long as the body is at rest. If, on the contrary, the body is put in motion with the æther which it contains, not only the repulsion of that æther, but also the attraction of the molecules belonging to the body upon an exterior æther molecule at rest is modified, and that in virtue of the established principle that *every thing that takes place or is effected in nature requires a certain time.*"

"It does not, however, necessarily follow," he says, "that the modification which the attraction between the material molecules and the exterior æther molecule undergoes in consequence of the motion must be equal to the modification of the repulsion between the æther molecules contained in the body and the same exterior molecule." On the contrary, he maintains that the action between different kinds of molecules must be different also in this respect.

He then considers the following case:—Let an element, d, of a circuit (Fig. 20), containing a quantity, m, of free æther, and m_0 of condensed æther, be supposed to move with the velocity h in the direction shown by the arrow. Let m_1 be an exterior æther molecule at rest, and let the angle between the straight line $d\,m_1$ and the direction of the velocity be θ, and let $d\,m_1 = r$. Then he has shown, "Théorie des Phénomènes Electriques," that the repulsion between m and m_1 is

$$-\frac{m\,m_1}{r^2}\left(1 - a\,h\cos\theta - \tfrac{3}{4}\,k\,h^2\cos^2\theta + \tfrac{1}{2}\,k\,h^2\right),$$

and the repulsion between the condensed æther m_0 and m_1 will be

$$-\frac{m_0\,m_1}{r^2}\left(1 - a\,h\cos\theta - \tfrac{3}{4}\,k\,h^2\cos^2\theta + \tfrac{1}{2}\,k\,h^2\right).$$

Using a_1 and k_0 to denote new constants, the attraction exerted upon m_1 by the material molecules can be expressed by

$$+\frac{m_0\,m_1}{r^2}\left(1 - a_0\,h\cos\theta = \tfrac{3}{4}\,k_0\,h^2\cos^2\theta + \tfrac{1}{2}\,k_0\,h^2\right).$$

The sum of these three expressions will give the whole action of the element d on the æther molecule m_1.

The ratios of a to a_0 and k to k_0 may be determined from the consideration of the production of electricity by friction, when the æther molecules must be supposed to pass from the rubber to the body rubbed, or *vice versa*. This passage must arise, he considers, from the repulsion exerted on them by the body in motion being in some way modified by the motion itself.

Now if

$$\frac{a_0}{a} = \frac{k_0}{k} = \frac{m + m_0}{m_0},$$

the sum of the three expressions giving the action of the moving body on an æther molecule becomes equal to $\frac{-\,m\,m_1}{r^2}$, or the repulsion would have the same value as before the body was put in motion. Therefore, a_0/a and k_0/k could not have exactly the same value.

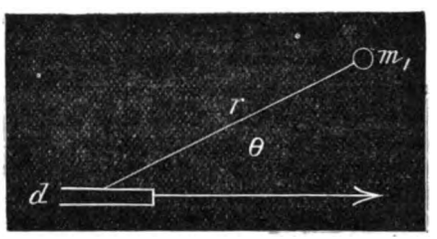

FIG. 20.

This applies to cases when bodies are in contact, or r infinitely small. If the two bodies are at a finite distance from each other, it is impossible to produce a sensible development of electricity by the movement of one of them, and therefore a_0/a and k_0/k must become sensibly equal to $\overline{m + m_0}/m_0$ when r has a finite value.

If, therefore, a body is put in motion together with the æther, both free and condensed, which it contains, its action upon a motionless exterior æther molecule at a given distance will be nearly as great as if the body were at rest at the same distance. When the exterior æther molecule is itself in motion, and therefore forms an element of an electric circuit, similar reasoning leads to the same results.

A cylindrical tube made to rotate about its axis will therefore exert little, if any, electro-dynamic action; in fact, the action of the currents due to the æther being carried in the direction of the rotation will be neutralised by the opposite electro-dynamic action produced by the motion of the proper molecules of the body in the same direction. Edlund states that M. Lemström has succeeded in showing that a rotating cylinder is capable of producing a real, though excessively feeble, electro-dynamic action.

M. Lemström made a pasteboard cylinder filled with air rotate rapidly round a cylinder of soft iron, and he found that the magnetic condition of the iron was modified by the rotation.

(To be continued.)

Meeting of the American Association for the Advancement of Science.—The American Association for the Advancement of Science holds this year its thirty-seventh meeting at Cleveland, Ohio, from Wednesday morning, Aug. 15, to Tuesday evening, Aug. 21. For all matters relating to membership, papers, and business of the association, the permanent secretary should be addressed at Salem, Mass.

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PROTECTION OF BUILDINGS FROM LIGHTNING.

BY PROF. OLIVER LODGE, D.SC., F.R.S.

(Concluded from page 276.)

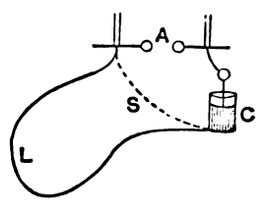
Experiments on Overflow of Jar.

Another way of making these electrical surgings more conspicuous is by their effect in causing a jar to overflow, *i.e.*, to spark round its edge. The overflow of a common jar is, in fact, very like a lightning flash, for it is a discharge direct between two coatings. That is just what a lightning flash is. There is ordinarily no conductor present except the two coatings—the clouds and the earth. I found a curious remark in Franklin* about the overflow or fracture of Leyden jars. He found that when one broke from overcharging a great number went together, *and also that the spark in the ordinary circuit did not fail.* He was led by this observation to doubt if the breakage of the jar was really due to a discharge of the electricity through it, and he surmises that it may be due to a sudden expansion of air bubbles in the interior, suddenly relieved of the strain.

No doubt he is wrong there, but the observation of the facts is good and noteworthy. We will repeat the experiment. It is not necessary to burst the jars ; overflow round the edge is just as good, and cheaper. The overflow experiment can be put into a variety of forms ; perhaps it will be sufficient if I show the simplest.

Fig. 9 shows the arrangement. It consists in nothing but establishing the connection between the machine and one or both of the coatings of a jar, through a long wire instead of through a short one as usual. If one connects the jar, C, by the dotted line, it does not

Fig. 9.



overflow until the spark length, A, is very great ; but with a long lead, L, to make the connection, a very short spark at A will cause the jar to overflow or discharge round its edge.

Here are a few numbers. The jar is one of the gallon jars, with the glass fully three inches above the tinfoil, so that when it overflows the spark has to strike along fully six inches of glass. When L is the thick No. 1 copper circuit round the room the jar overflows every time an A spark occurs, even though the length of this A spark is only ·64 of an inch. Short circuit out the long lead, as shown by the dotted line, and the jar refuses to overflow until the A spark length has been increased to 1·7 ; and when it does overflow now the violence is very considerable. Remove short circuit again, and the jar overflows in ever so many places at once with great violence, a perfect cascade of flashes leaping round the edge. Bring the A knobs nearer together, and the overflow does not wholly cease till their distance apart is again ·62.

On another occasion one got for the A spark length sufficient to cause overflow of jar :—

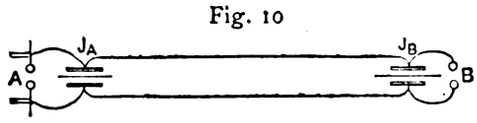
·56 with the long lead.
1·7 with an ordinary short wire.

With a small pint jar, and a less height of glass above its coatings, I took the following readings :—Length of A spark sufficient to cause overflow—

·67 with iron wire round room.
·52 with copper ,, ,,
1·40 with short circuit.

Fig. 10 shows very well, in a diagrammatic fashion, the effect of long leads in causing a jar to overflow, or of course to burst if the glass edges are too tall for the thickness and homogeneity of the glass to stand.

Fig. 10



A are the machine terminals, B those of a discharger, and J_A and J_B are two jars connected up by fairly long leads. Now of course sparks may be obtained either at A or at B, one as easily as the other, and one of the jars is liable to overflow, but not both. It is the jar J_B which overflows when a spark occurs at A. It is the jar J_A which is made to overflow by a spark at B. It might be thought that if the B knobs were fairly near together, a spark at A might precipitate a spark at B instead of making J_B overflow ; but it is not so. The event is not indeed impossible by any means, if the B knobs are pretty near together; but it is easier for the jar to overflow by direct discharge between its coatings over a space of some six inches than it is for it to discharge through the wire and rods of the discharger and an air-space of an inch or even less. It is not easy to help a jar to overflow by discharging tongs ; even a foot of conducting wire is a great obstruction to the passage of the flash ; it greatly perfers direct discharge through air unobstructed by the self-induction confinement of a conductor.

This is also illustrated by the extraordinary length of insulating surface which is found necessary in the Leyden jars supplied to Holtz and other such machines, and by the fact that such jars often flash even over a foot instead of through a few inches of air space led up to by the proper discharging knobs. Though indeed it must be noticed, as it was by Franklin, that the overflow of a jar by no means necessarily robs the proper circuit of its flash. The two things occur together. It is usually the spark which causes the overflow. Perhaps one may say that the case of discharge direct between coatings without any conductor, accounts in some measure for the extraordinary length and unexpected paths of some lightning flashes.

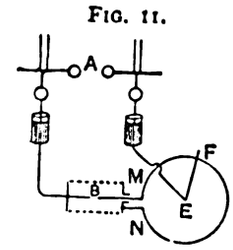
These electrical oscillations and overflows, which it is thus easy to set up in a charged conductor, manifestly explain what is known as the "return stroke." I pointed out in Lecture I. that the ordinary explanation of the return stroke, the recovery of electrical equilibrium disturbed by static induction, was by no means able to account for effects of the least violence ; but this fact, that a discharge from any one point of a conductor may cause such a disturbance and surging as to precipitate a much longer flash from a distant part of it, at once accounts for any "return stroke" that has ever been observed.

It is for this reason that I think it possible a tall chimney or other protuberance in one's neighbourhood may be a source of mild danger ; inasmuch as if it is struck it may be the means of splashing out some more discharges to other smaller prominences, which otherwise were beyond striking distance. It is in this way, also, that I imagine multiple flashes, such as those referred to in Lecture 1, are produced. I liken them to the cascade of flashes rushing over the sides of a jar, when connected up with a long lead, and when the A spark is pretty long.

Experiment of the Gauze-House.

Finally, we have to ask is it possible for the interior of a thoroughly enclosed metal room to be struck ; or, rather, can a small fraction of a lightning flash find its way into a perfectly enclosed metal cavity ; for instance, a spark strong enough to ignite some gun-cotton in a metal-covered magazine which might happen to be struck ?

Fig. 11.



It is not easy, but it can be done ; at least under such conditions as are likely to obtain in practice it can be done. My friend Mr. Chattack, to whom I am indebted for much kindly assistance and suggestion, has made the experiment in the form shown in Fig. 11.

A metal gauze cylinder, with tin-plate ends, has a couple of conductors, one soldered to each end, protruding into the interior, so as to approach very near each other, and these are the conductors put into the path of the discharge. If both conductors are entirely enclosed in the metal chamber, we have not yet succeeded in getting a spark between them ; but if either of them protrude any portion of their length outside the chamber, then sparks in the chamber can be obtained.

In Fig. 11 the conductor N M B is shown thus protruding, penetrating the chamber through a small glass tube near M, but soldered to it near N. E F is a movable arm or radius, making contact with this conductor. If contact is made near N, it takes a very strong A spark to give any spark at B inside the gauze cylinder ; but as the contact is shifted towards F or M it becomes very easy to get a small spark at B.

* "Franklin's Works," by Sparks, 1840. Vol. V., page 475.

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The application of this to powder magazines is that if any conductor (like a gas pipe) pass out of a building before being thoroughly connected with its walls, it is possible for a spark to pass from something in the interior of the building to this conductor whenever a flash strikes the building, even though perfectly connected outside. We thus find that the complete and certain protection of buildings from lightning is by no means so easy a matter as the older electricians thought it.

In many cases we may be content to fail of absolute security and be satisfied with the probable safeguard of a common galvanised iron rod or rope. But for tall and important buildings, for isolated chimneys and steeples, and for powder magazines, where the very best arrangement is desirable, what is one to recommend? I prefer to call attention to principles rather than to advocate any particular nostrum; but inasmuch as my present opinion is not likely to carry any undue weight, there is no harm in my saying that I see nothing better than a number of lengths of common telegraph wire. I think a number of thin wires far preferable to a single thick one, and their capacity must be increased when possible by connecting up large metallic masses, such as lead roofs and the like. But the connection should be thorough, and made at many points, or sparks may result. Balconies and other prominent and accessible places should not be connected.

The earth should be deep enough to avoid damage to surface-soil, foundations, and gas and water mains. As to the roof, I would run barbed wire all round its eaves and ridges, so as to expose innumerable points, and the highest parts of the building must be specially protected; but I would run no rods up above the highest point of the building, so as to precipitate flashes which else might not occur, in search for a delusive area of protection which has no existence.

The conductors must not be so thin as to be melted or deflagrated by the flash, but really melting is not a very likely occurence, and even if it does occur the house is still protected; the discharge is over by the time the wire has deflagrated. The objection to melting is twofold; first, the red-hot globules of molten metal, which, after all, are not usually very dangerous out-of-doors; and, secondly, the trouble of replacing the wire. I should be content to put up a great number of telegraph wire conductors, and wait till one is melted, before thinking too much of the likelihood of such an occurrence. The few instances ordinarily quoted of damage to lightning conductors by a flash do not turn out very impressive or alarming when analysed.

In conclusion, I trust that the men of experience in these matters who are present will consider the facts and suggestions I have brought forward as objects worthy of attention and further inquiry, and will study them in the light of their experience.* But as to the quack recipes and dogmatic statements which I may incidentally and without authority have provisionally given, there is no need for me to ask practical men to treat these with the contempt they no doubt deserve.

THE PROTECTION OF BUILDINGS FROM LIGHTNING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The enclosed letters, which I received from Prof. Hughes shortly after the delivery of my lectures at the Society of Arts, are of general interest, and, having obtained his consent, I therefore ask you to publish them as a sort of appendix to the lectures which you have reprinted.

The experiments he describes are conducted on the "steady strain" principle, rather than on the "impulsive rush" method; for any practicable motion of discharging tongs must be regarded as infinitely slow. For the rest, the experiments are like mine on the "alternative path," except that instead of measuring directly the E.M.F. needed to drive a current through a conductor by observing the length of spark corresponding to it, these experimenters make use of a fine wire as their shunt circuit. [I also have experimented in this way, but found it less rapid and convenient in practice.] The slight divergencies of results are interesting. The letters, I think, speak for themselves, and require no further comment. I would certainly have quoted these experiments in my lectures had I known about them, as I ought to have done.

* At the second lecture I learnt that some experiments on lightning protectors, something like those of mine on "the alternative path," had been made previously by Prof. Hughes and M. Guillemin ("Address to Telegraph-Engineers"). Also I find that Dr. Hertz has made experiments on electric oscillations very like those of mine on "the surging circuit" (Wied. *Ann.*, 1887). In a subsequent communication I hope to notice some of the observations of Prof. Hughes.

Just one remark about one of the concluding sentences in the third letter, "however much we may doubt the Wheatstone-bridge method I employed." Any observations of mine derogatory to Wheatstone-bridge methods as applied to lightning-conductor-testing relate solely to the time-honoured practice as learnt by schoolboys from what seems time immemorial. The methods with alternating currents devised by Prof. Hughes stand on a different footing altogether, and if only the frequency of alternation were made great enough (I fear, however, that the telephone would be then giving a note immensely too high to be audible), they might very well be used to give the information about any conductor which is needed. But, perhaps, a Leyden jar system of testing would be found easier. Though, indeed, it by no means follows that the path chosen by a weak spark will also be chosen by a strong one. I can get sparks to jump in altogether different places according to their strength, nothing at all being varied except energy of spark.

Perhaps I may take this opportunity to refer to an altogether different matter. One of the facts to which I call special attention in the lectures is the mode in which currents increase and decrease in a conductor—changes commencing always at the outside and penetrating inwards, so that alternating currents tend to keep to the outside altogether. I have spoken as if this fact were discovered independently by several persons working from various points of view, and expressing the result each in a different fashion. I am now informed that Mr. Oliver Heaviside published this fact, as deduced mathematically by himself, a year before Prof. Hughes' experiments, which illustrated it and brought it into prominence, were published, and also before Lord Rayleigh had written on the matter; and that to Mr. Heaviside, therefore, the priority is distinctly due. I have no opportunity just now of verifying this statement, but I have not the slightest reason to doubt it; and probably to readers of *The Electrician* it is a familiar fact.

I preferred to leave the matter vague, because it is no part of my business to play the historian of science, and because questions of priority concerning recent discoveries are apt to be burning ones. That is no reason for shirking their treatment when one has a full knowledge of the matter; but it is precisely that essential full knowledge that I at present lack. It is a matter easy to verify, however, and before the lectures are republished I shall hope to verify it.

The phenomena connected with alternating currents are peculiar and often surprising, and I believe there is no person now alive who has anything like the intimate familiarity with their idiosyncrasies that Mr. Heaviside has attained to. Considering the extraordinary magnitude of the leaders of physical science at the present time, this is a strong thing to say; nevertheless, I believe it would be heartily endorsed by all those most competent to judge.

The experimental genius of Prof. Hughes is a matter of notoriety; the mathematical genius of Mr. Heaviside is equally striking, and will shortly, I expect, be as cordially recognised.—Yours, &c., OLIVER J. LODGE.

University College, Liverpool, July 1, 1888.

The following are the letters referred to above:—

"108, Great Portland-street, W., March 17, 1888.

"Dear Prof. Lodge: I was very much interested in the beautiful experiments you made in your lecture at the Society of Arts this afternoon, and I regret that I was unable to be present at your first lecture, which no doubt would have enabled me more completely to understand your present view of 'lightning conductors.'

"The great portion of the experiments showed by you yesterday entirely agree with those obtained by Prof. Guillemin and myself, whilst those relating to the use of iron and copper seem to disagree. Your experiment certainly demonstrated your view, whilst mine seems to me to demonstrate just the opposite.

"In 1864 the Administration des Lignes Télégraphiques of France, through the Commission de Perfectionnement, of which

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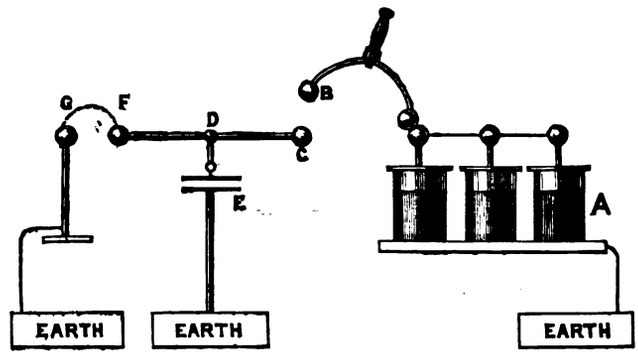
Prof. Guillemin and myself were members, charged us with the mission of verifying experimentally the merits of different lightning protectors in use for the protection of the telegraph instruments from lightning. These experiments were carried out at the laboratory of the Ecole de St. Cyr, of which Prof. Guillemin was the Professeur de Physique.

"We tried to imitate as nearly as possible the conditions which occur in practice.

"The general idea of our experimental arrangement was the following:—



"In order to have a powerful source of electricity at high tension we made use of a large battery, A, of 12 large jars, and as we found it took too long to charge these with the ordinary electrical machines, we used a powerful Ruhmkorff coil, which would give a spark of 15 centimetres. The jars were charged to a fixed degree, and could be discharged through our apparatus by means of the universal discharger B. An insulated rod of brass, C D F, served to conduct the charge to the experimental protector E, and by a derivation, F G, to earth. At G F we could place a telegraphic electro-magnet, a fine iron wire, or an electrometer, the object being to try and save the fine wire at G F from destruction by the protective action of the protector E.

"We found that with a high charge no protector would entirely protect G, even if a small air space intervened between F and G; and we also found that if D was directly connected to earth by a copper rod of one centimetre diameter, there would still be sufficient electricity pass D to G to burn a fine iron wire.

"This result proved that we could not in all cases expect absolute protection from any known protectors.

"By gradually diminishing the charge we arrived at a point where we could make comparative experiments.

"The protectors have all a small air-space, in order not to weaken the ordinary working current.

"The received idea that two plates with innumerable points near each other would protect in a far greater ratio than simple plates separated by a thin sheet of paraffin paper or gutta percha was disproved; for the simple flat plates known as the 'American protector' were invariably better than those with points. The plates formed a small condenser, the surfaces of which could be brought far nearer to each other than is possible in practice with points.

"In a report which I made as reporter, I pointed out all these experimental facts, and it was published in the *Annales Télégraphiques*, 1865, and I again gave these facts in my inaugural address to the Society of Telegraph-Engineers, January 28th, 1886, and published in their *Journal*, No. 60, p. 17.

"We tried numerous experiments as to different kinds of wire at E, and if we placed a very large condenser at E in place of a protector it seemed to have a far greater effect.

"Having been called to Russia I was unable to continue these experiments at that time, but Prof. Guillemin having taken a great interest in them, he continued them, and published his results in the *Comptes Rendus* (I forget what date). He found that if he united D to earth by a thin flat plate, even tinfoil, a very large measure of protection had been obtained, and that flat conductors were evidently superior for a sudden charge of high-tension electricity. He supposed that this effect was due to its electrostatic capacity thus forming a specie of condenser. Later experiments by myself have pointed out the advantage of the flat conductors, but my results lead me to suppose that, in addition to the reasons of Prof. Guillemin, it is because a flat conductor has far less self-induction.

"The experiments which you showed yesterday also seemed to point out the advantage of flat conductors, and your views seemed to agree with those of Prof. Guillemin, and you have experimentally proved this in the beautiful experiment where you show the different results obtained from a tinfoil sheet conductor where it is arranged so as to have more or less self-induction.

"The greatest and perhaps the only difference in your results was the superiority of iron over copper. The methods used by you fully demonstrated it, and it also resembled the method used by Prof. Guillemin and myself, except that we had one large battery discharged to earth, whilst you seemed to have two batteries, one at A and the other at G. If I am correct, there may be some peculiar phenomena due to our different arrangements.

"That self-induction is injurious to rapid transmission of electrical currents of low potential is shown in practice by their different behaviour. Practice has shown that copper alone is suitable for long-distance telephony and telegraphy, and I still believe that the same marked difference holds good with high-tension currents for the same reason.

"However, there is nothing like experiment to prove a fact, and I shall read your paper and future experiments on this subject with the greatest interest, knowing that you are a most careful experimenter. The subject is one of vast importance, and it is astonishing that with the innumerable experiments that have been made, from Franklin to Faraday, in all countries, and with apparent irreproachable methods, there should be still such a wide division of opinion as to the merits of round or flat conductors and of iron or copper.

"Excuse this hastily-written letter, which does not require an answer, and believe me, with the highest esteem both for yourself and your researches, sincerely yours,

"D. E. HUGHES.

"Prof. O. J. Lodge, D.Sc., &c., &c.,
University College, Liverpool."

"108, Great Portland-street, London, W.
"March 20th, 1888.

"Dear Prof. Lodge: Many thanks for your kind letter, which I have received this evening.

"My letter was written not with a view to publication but as a friendly discussion on a subject in which I was extremely interested several years since. If, however, you think there is anything in it worthy of publication as an appendix to your Paper I can have no objection, leaving to your judgment to select the portion you deem worthy of publication.

"You believe that the difference between our results is due to the use of a discharger, and this may explain the difference.

"The object of Prof. Guillemin and myself was to send a powerful charge through a wire with the utmost possible suddenness.

"By the use of the discharger we could charge our battery to the desired point, then disconnect the Ruhmkorff, and then bring our discharger as suddenly as possible in connection with the experimental apparatus.

"It is evident that we could never do this with the rapidity that we desired, as the spark would jump across the air before full contact was made. We believed, however, that we came nearer than if we had a fixed distance, allowing the charge to spark across the interval, as then our experimental apparatus or any change made in it seemed to have an influence on the *time* discharge of the battery. It is so long, however, since these experiments were made that I cannot discuss this point, and probably your views or method may be more in accordance with the actual conditions of a sudden discharge than ours were.

"We certainly agree in our results and views on the most important points. For I quite agree with you that Wheat-

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stone's bridge, or any apparatus used for steady currents, does not indicate what passes at the first moment of contact.

"Judging from our experiment where we could not protect the fine iron wire by a direct thick copper, iron, or any short metallic contact, and from later experience on self-induction with low-tension currents, I believe that at the very first instant all bodies offer an infinite resistance, copper being no better than air. I believe you also take this view, as you well illustrated it by the flow of water, the hammer blow, inertia, &c.

"The effect is so marked with discharge from a good Leyden jar battery that it becomes a serious question if any lightning conductor yet made could convey the whole of a lightning discharge quietly to earth without its seeking other channels through substances having an infinitely higher ohmic resistance; and the whole question would be discouraging were it not for the fact that we have undoubted proof that lightning conductors do protect in spite of the experiments cited.

"I have tried to gain some exact information from the Report of the Lightning Rod Conference, 1882, in the numerous cases there cited, and I find that in most cases the rods have protected, but many have failed, mostly from bad earths; but numerous cases are there cited in which rods were melted, both of copper and iron—in fact, the cases cited do not show any marked preference for either metal, except that there seems a stronger testimony in favour of Sir W. Snow Harris's copper tape conductor than any other.

"It is quite possible that all the researches that have been made have never yet approached the true condition of things. Evidently experiments made with simple sparks from machines never approach the true conditions. A very large Leyden jar battery or powerful condenser seems nearer; but even this must be weak compared with a true lightning discharge. But still it ought to teach us, as it has done in your case and others, myself among the number, that an enormous inertia or apparent resistance is offered by the best of metallic conductors at the first instant of discharge.

"I shall read your experiments and views on this interesting subject as soon as they appear in print, and I hope that your new series of experiments will clear up any mystery, if there is any. With many thanks for your kind letter, and with best wishes, believe me, sincerely yours,

"D. E. HUGHES.

"Prof. O. J. Lodge, D.Sc., &c., &c.,
University College, Liverpool."

"108, Great Portland-street, W., March 29th, 1888.

"Dear Prof. Lodge: Excuse me for writing again, but I find that I have not fairly represented Prof. Guillemin's views—due to only reading an abstract. I have found his Paper entitled "Sur la Décharge de la Batterie Electrique et sur l'Influence de la Configuration des Conducteurs," *Comptes Rendus*, 1866, pp. 1,083 to 1,085.

"In this Paper he believed the advantage of thin flat sheets to be due to the mutual reactions of each portion of the current on each other, and although he does not use the term he evidently means self-induction.

"I find also that he demonstrated this, noting the difference of several copper wires when twisted together or separated as in a sheet; in fact, an identical result which I obtained later with low-tension currents and Wheatstone's bridge (No. 60, p. 15, *Journal* Society of Telegraph-Engineers, 1886). Thus, he did not attribute the advantage of sheet conductors to electrostatic or mere surface conduction. The experiments made by Prof. Guillemin and myself, which I have already mentioned, were made in 1864, but not published until 1865 (*Annales Télégraphiques*, 1865, pp. 290 to 302, Tome VIII.).

I believe that Sir W. Snow Harris also attributed the advantage that his experiments showed in sheet conductors to the same reason and not to mere surface conduction, as I had previously read, for I find in an abstract of his Paper, 1843, published in "Report of the Lightning Rod Conference, 1882," p. 86, these words:—'He says the beneficial effect of superficial conductors appears to depend on the removal of the electrical particles further out of the sphere of each other's influences.'

"This evidently means the same explanation as given later by Prof. Guillemin, and still later by myself in my Paper on "Self-Induction," so in justice to them both I feel it my duty to point these out to you; and I find now that however much we may doubt the Wheatstone bridge method I employed, it certainly gave identical results for a similar experiment with those obtained by sudden discharges from Leyden jar batteries. I have suggested to the editor of *The Electrician* that he should translate and reprint Prof. Guillemin's remarkable Paper, as it would be only justice to him, as I know he suffered severely from the sneers of Messieurs *les Savants* on the publication of his Paper.

"Do not trouble yourself to reply to this, as my only object is to correct my remarks as to Prof. Guillemin's views made in my first letter.—With best wishes, sincerely yours,

"D. E. HUGHES."

The following is a translation of the Paper referred to by Prof. Hughes in his last letter to Dr. O. Lodge:—

LEYDEN JAR DISCHARGES AND THE INFLUENCE OF THE SHAPE OF CONDUCTORS.*

Some lightning-guard experiments, conducted last year by MM. Hughes, Bertsch and myself at the instance of the "Commission de Perfectionnement des Lignes Télégraphiques," afforded us an opportunity of observing a phenomenon which it seemed to me could not be reconciled with the laws of electric conductivity. A continuous copper wire did not conduct perceptibly better than a similar wire into the circuit of which a lightning-guard of the point pattern had been introduced. I now present to the Académie des Sciences the result of researches undertaken by me with a view of ascertaining to what extent this phenomenon really does deviate from the ordinary law.

According to Ohm's law, the intensity of a stable current is independent of the surface of the conductors. My experiments show that in the case of Leyden jar discharges (where the current is variable and never sensibly steady) increasing the surface of the conductors facilitates the passage of the discharge.

To show this, I arranged two conductors in parallel so that they should be simultaneously traversed by the discharge from a large 6-jar battery, having a total condensing surface of about 1 sq. m. One conductor was an iron wire, ·1mm. in diameter, and of variable length; the other conductor was a thin sheet of tin, 2 metres long and 6 cm. broad, insulated on a glass table. This conductor was altered in shape without alteration of cross-section. The effect of these alterations could be gauged by the length which could be given to the iron wire without its being melted.

The first thing I did was to arrange matters so that the sheet of tin took a sufficient proportion of the discharge to prevent 15cm. of the iron wire attaining red heat. Then the sheet was bent back upon itself lengthways, diminishing the surface without alteration of length or cross-section; the iron wire then became dull red. If the surface of the sheet was still further reduced the iron wire fused along its entire length. The two conductors were then put in series, and the tin sheet still had the best of it.

This phenomenon arises apparently from the inductive action of conductors upon one another. Increasing their surface facilitates the discharge by increasing the distance between the mutually opposing forces. This view is confirmed by the following experiment:—

Sixty wires, 2m. long, and 25mm. in diameter, were now placed in parallel. When the wires were 1cm. apart the iron wire was well protected, and did not heat to 400° C.; the closer, however, the 60 wires were brought together, the hotter the iron became; first it got warm, then red hot, and finally, when the wires were in close proximity, melted. When

* Translation of a Paper read by M. C. M. Guillemin before the Académie des Sciences, 14th May, 1866. *Comptes Rendus*, pp. 1,083-85.

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the wires were twisted into a cable the effect was a maximum. By exaggerating the conditions of the experiment, it is easy to see that a conductor of large surface may have a much higher resistance than a round wire, so far as voltaic currents are concerned, and yet be a better conductor of static discharges.

The original phenomenon was this. In the case of two short, thick conductors, the interposition of a thin layer of air in the circuit of one did not greatly affect the relative quantities of electricity sent through them by an instantaneous discharge.

These results naturally lead me to think that it would be advantageous to substitute copper bands, 2 to 3cm. broad and at least 1mm. thick, for the copper wires at present used on our land lines to connect lightning guards to earth. The presumption is that the protection afforded would be far more thorough.

In these experiments the Leyden jars were changed from a Ruhmkorff coil of large size, and 5 or 6 seconds sufficed to highly charge the 6 jars. The great power of this apparatus permitted me to carry out with ease experiments which it would be very difficult to perform with ordinary apparatus. The Reiss thermometer was used in conjunction with these researches.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER IX.—*Magnetic Fields.*

(Continued from page 247.)

118. *The "Moment" of a Magnet.*—Looking at the expression, just derived, for the "moment of the couple," acting on a magnet when placed in a magnetic field, it will be noticed that the factors "m" and "l" (strength of pole and length between the poles of magnet) are properties belonging to the magnet itself, and, moreover, the moment of the couple exerted on the magnet depends directly upon the product "$m\,l$." For these reasons, the product "$m\,l$" is designated the "*moment of the magnet,*" and is usually denoted by the letter M. Putting this in the above expression, we have the moment of the couple exerted on a magnet of moment M, when placed in a uniform magnetic field H, is

$$H\,M \sin a,$$

where a is the angle between the magnet and the direction of the lines of force of the field. We are here considering the poles of the magnet as situated at its extreme ends. Although this is not strictly the case, the poles being a little nearer together than the distance between the ends, we may practically regard them as being at the ends, and not introduce any appreciable error. Whatever shape the magnet has, its moment is always the strength of one pole (m) multiplied by the distance between the poles (l), irrespective of what length of metal actually exists between the poles. For example, the moment of a semi-circular magnet is the strength of pole multiplied by the distance between the poles, viz., the diameter of the circle of which the magnet forms part. Or if we suppose a split steel ring, such as a piston ring, to be magnetised, the moment is very small, although the ring may be strongly magnetised, because the distance between its poles is very small; and if the magnetic circle be completed by inserting a piece of soft iron in the gap between the poles, there will be a continuous magnetic circuit through the mass of the metal, and the magnetic moment will be reduced to zero, because there no longer exist any free poles.

119. *Two Uniform Magnetic Fields Superposed at Right Angles to Each Other. The Tangent Principle.*—It is of great importance in all measurements of magnetic fields and in the measurement of electric currents by means of galvanometers to comprehend the resultant action on a magnetic needle suspended in a region where two magnetic fields, whose directions are at right angles to one another, are superposed. The following example will be easily understood. Take a bar magnet, N S (Fig. 79), and place it horizontally at right angles to the magnetic meridian.

The magnetic field surrounding it is indicated generally by the dotted lines. It will be observed that where these lines cross the lines of force H of the earth's horizontal field we have within a limited space two magnetic fields superposed at right angles. Considering the line through the centre of the magnet, it will be noticed that near the region of the magnet the lines

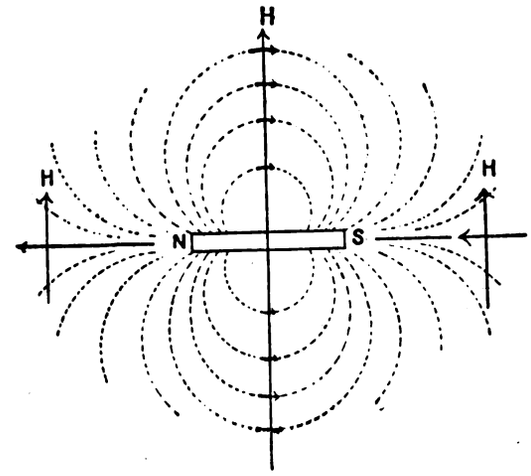

FIG. 79.

of force form small circles, and therefore that portion of a circle which crosses the earth's field H can only be regarded as straight or uniform for a very short length. As we take points further removed from the magnet, however, the circles of force are larger, and that portion of them which cuts H may be taken as straight or uniform for a greater length. At greater distances away from the magnet, however, the intensity of the field becomes lessened.

Now at any given point in this magnetic field there is a *resultant direction* of the lines of force and a *resultant intensity*, which is, in fact, the resultant of the two forces due to the earth and the magnet acting on unit pole at that point. We shall, however, for the present only consider the resultant intensity and direction of the field at points where the two component fields may be considered at right angles to each other. Let us consider a unit pole placed at the point o

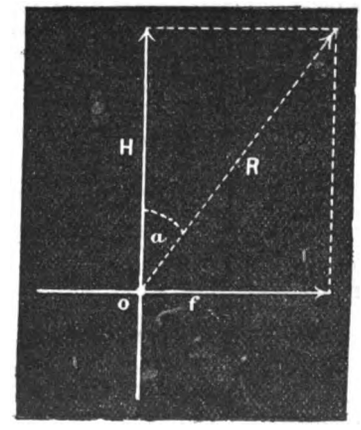

FIG. 80.

(Fig. 80) under the influence of two magnetic fields of H and f units of intensity (para. 109 and 111). Now, these two fields will act on the unit pole with forces equal to H and f dynes (para. 114) in their respective directions, and we may find their resultant in direction and magnitude by the parallelogram of forces. Let the length of the lines H and f be proportional

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to the respective strengths of the two forces. On completing the parallelogram we get the resultant force R by drawing the diagonal, and if we can determine the angle a, we shall ascertain the *direction* of this resultant. From the parallelogram it is seen that

$$\tan a = \frac{f}{H},$$

and, therefore, the strength of the two fields, or the relation between them, being known, we can determine the direction of the resultant field. This is, in fact, the direction of the lines of force due to the two fields H and f, and a freely suspended magnetic needle will always set itself in the direction of the lines of force of a field when the latter is uniform—that is, when the lines of force are parallel in the region of the needle, which is what we are now considering. If the lines of force are in curves, the needle will set itself as a tangent to the curve. Experimentally, therefore, we may observe this resultant direction by setting up a horizontally-suspended magnetic needle, and first allowing it to come to rest under the influence of one of the fields, say H, the earth's horizontal field, and then bringing into action the superposed field f by placing the magnet N S (Fig. 79) at right angles to the meridian line on which the magnet is suspended. The tangent of the angle moved through by the needle is then equal to the ratio of the two fields, *i.e.*, f : H, and if we know the strength of one of those fields, say that of H, we can find that of the other (f) by

$$f = H \tan a.$$

This is the tangent principle which comes so frequently in use in the measurements of magnetic fields, not only those fields due to permanent magnets, but also electro-magnets, solenoids, and galvanometers. We shall, therefore, refer again to this principle, as proved above, when we have these other magnetic fields under consideration.

Example.—A very short magnetic needle is suspended by a long torsionless silk fibre, so that it is free to move in a horizontal plane. A long light non-magnetic pointer is attached to it, the end of which moves over a scale graduated in degrees, by means of which the angle through which the needle moves may be observed. As soon as the needle has come to rest in the earth's magnetic meridian, a bar magnet is placed at a given distance from the centre of the needle, its position being such that its length is bisected by and is at right angles to the meridian line through the needle. The latter is then observed by the pointer to move through 60 degrees. What is the intensity of the field (f) at the centre of the needle due to the bar magnet?

Answer. $f = H \tan 60$
$= \cdot 18 \times 1 \cdot 7321 = \cdot 31177$ C.-G.-S. units.

Similarly, the intensity of the resultant field may be determined from the same parallelogram (Fig. 80), from which it is evident that

$$\text{resultant field (R)} = \frac{H}{\cos a} = \frac{f}{\sin a},$$

the intensity of which in C.-G.-S. units may, therefore, be found when the strength of one of the fields and the direction of the resultant field, or the angle a of deflection, are known.

Example.—In the last example what is the intensity of the resultant field—

(1) Having given that H = ·18 C.-G.-S. units?

Answer. Intensity $= \frac{H}{\cos 60} = \frac{\cdot 18}{\cdot 5} = \cdot 36$ C. G.-S. units.

(2) Having given that $f = \cdot 31177$ units?

Answer. Intensity $= \frac{f}{\sin 60} = \frac{\cdot 31177}{\cdot 866} = \cdot 36$ C.-G.-S units.

It follows, therefore, that the lines of force surrounding a magnet cannot be symmetrical throughout, since they are really the resultant lines of two fields, that of the magnet and that of the earth. If we only consider the horizontal field of the earth and lay the magnet down horizontally, say at right angles to the meridian, as in Fig. 79, we should not expect to find its magnetic field perfectly symmetrical about its own figure, as drawn in that diagram. When, however, the field is examined by the iron filing method it does appear quite symmetrical, simply because the want of symmetry is only apparent *outside* the area of field made visible by the filings. What the filings reveal to us is really the resultant field, but the earth's field is so weak in comparison to the field in close proximity to the magnet, that the resultant direction is practically that of the magnet's field. It is interesting, however, to detect by a somewhat more delicate means the state of the field from points near the magnet up to distances so far away that the field is no longer apparent. This may be done very well by observing the angles of deflection of a small compass needle placed in succession at various parts of the

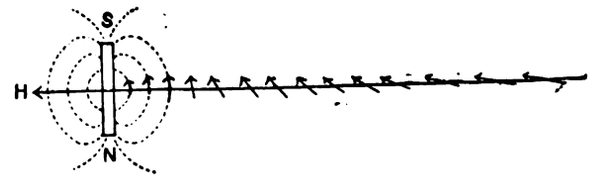

FIG. 81.

field. In Fig. 81 is shown a field so analysed along one direction, viz., the earth's meridian. The small arrows represent the approximate direction of the compass needle when placed at those points, the arrow heads being the needle's north pole, and therefore representing by the direction of the arrows the direction of the lines of force. At a distance from the magnet equal to about six times its length, the needle took up, as nearly as could be observed, the direction of the meridian, showing that the field of the magnet was at this point practically *nil*. The dotted curves close to the magnet N S cover about the area of the field usually indicated by iron filings, the field appearing symmetrical within these limits. A line was drawn on a flat surface corresponding with the magnetic meridian, and divided out into inches. The magnet was then laid down at right angles to the line, being bisected by it. The small compass needle was then placed at each inch mark along the line, and the directions taken up by the needle noted down as nearly as possible as shown in the figure. At the point where the compass needle stood at 45 degrees the two superposed fields were equal, because tan 45° = 1, and therefore $\frac{f}{H} = 1$.

(To be continued.)

THE MAGNETIC QUALITIES OF NICKEL.*

BY J. A. EWING, F.R.S.

The Paper is a supplement to one with the same title by Prof. Ewing and Mr. G. C. Cowan, which was read at a recent meeting of the Royal Society. It describes experiments, conducted under the author's direction, by two of his students, Mr. W. Low and Mr. D. Low, on the effects of longitudinal compression on the magnetic permeability and retentiveness of nickel. The results are exhibited by means of curves, showing the relation which was determined between the intensity of magnetisation of the metal and the magnetising force, when a nickel bar, reduced to approximate endlessness by a massive iron yoke which formed a magnetic connection between its ends, was magnetised under more or less stress of longitudinal compression. Corresponding curves show the relation of residual magnetism to magnetising force for various amounts of stress; and others are drawn to show the relation of magnetic permeability to magnetic induction. Initial values of the permeability, under very feeble magnetising forces, were also determined. The experiments were concluded by an examination of the behaviour of nickel in magnetic fields of great strength. Magnetising forces ranging from 3,000 to 13,000 C.-G.-S. units were applied by placing a short bobbin with a narrow neck made of nickel between the poles of a large electro-magnet, and it was found that these produced a practical constant intensity of magnetisation which is to be accepted as the saturation value.

* Abstract of a Supplementary Paper read before the Royal Society, June 21, 1888.

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GAULARD AND GIBBS v. FERRANTI.

The decision of Mr. Justice Kekewich by which the patent granted in 1882 to Messrs. Gaulard and Gibbs for "a new system of distributing electricity" has been declared null and void will scarcely surprise anyone who was present in court during the hearing of the case or who may have read even the first portion of the proceedings which we reported last week. At a comparatively early stage it became evident that in the legal aspect of the case, the claim set up on behalf of the patentees for the exclusive right to employ the method of distributing electricity by the inductional transformation of potential rested upon a very slender basis. In order to strengthen their contention for the possession of a wide-sweeping monopoly the patentees had amended their original specification by abandoning the claim which related to a special mode of constructing the transformer. By this means they hoped to show that the specification entitled them to the sole use of any and every system which included the combination of a high-tension alternating-current dynamo with a transformer yielding a lower tension at the secondary terminals, substantially as described. It is, however, solely in virtue of this disclaimer that the patent has now come to grief.

In its original form the third claim for an induction coil of special construction was sufficiently clear and intelligible, even although the details of the construction were not set forth in language of such unmistakable character as to form a model specification. But with the abandonment of this claim the difficulty of determining what is and what is not within the scope of the patent becomes very great indeed. For, notwith-

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standing the disclaimer, the patentee still retains as part of his combination the *use* of coils of special construction. "He does not," said the learned judge, "claim to construct, but he requires to use certain instruments, and those only when constructed." In other words, Messrs. GAULARD and GIBBS would have been content to allow the whole world to make transformers—even with divided cores and "equal quantities of metal in the two coils"—provided that they alone had the right to use them in combination with an alternate-current dynamo of high tension.

But the amendment of the patent in this particular, apart altogether from the very important question of conformity with the provisional specification, was, said the learned judge, "a very difficult task. I am disposed to think that it could not have been performed without destroying the patent—could not, that is, have been so performed as to leave a supportable residue. But whatever was possible, I hold that it has not been done, and that with the abandonment of the third item of claim the whole specification falls to the ground." The reasons which led the learned judge to this decision were stated in clear and forcible terms. As a condition of being entitled to restrain other operators from producing the required result by the same means, a patentee is bound to disclose in his specification precisely what it is which the public cannot do except under penalty of an injunction; and in the case where the patent rests upon a combination of previously known parts it may reasonably be held that this obligation becomes all the more imperative. Now, taking the specification in its amended form with the disclaimer of the special mode of constructing the coils, a manufacturer might fairly gather that he was still debarred from the user of coils constructed as described; but he might well be in doubt as to whether or not he was entitled to employ in this manner an induction coil whose construction differed in detail from that of the patentees. On behalf of the patentees it was maintained that the use of the divided iron core constituted the special features of the patent. It was not denied that this was in itself an old and well-known construction, but its "combination" with the other features of the system was relied on. Now to make this contention valid it would have to be shown that the specification explicitly referred to the use of this species of transformer *as a class;* but no such reference is made, and all we have is the detailed description of two coils in which divided cores are employed. Similarly, it was urged that the special construction to be used in combination referred also to the "step-down" arrangement—that is, to the diminution of the potential at the terminals of the secondary compared with that of the primary. But it was not pretended that the specification said in so many words that coils of this class were to be employed, and the learned judge held that "nothing less than this would suffice" to maintain the validity of the patent.

It will thus be seen that the patent has succumbed in virtue of its own inherent weakness, and not to the superior claims of any one of its opponents. But although the learned judge abstained from pronouncing a deliberate opinion upon the merits of the patents in which Messrs. GAULARD and GIBBS' device is alleged to have been anticipated, he nevertheless made some remarks which show pretty clearly the view which the Court would probably have taken if it had become necessary to enter upon this side of the case. Mr. ASTON, on the part of the patentees, relied a good deal upon a judgment of Lord WESTBURY'S, in which a clear distinction is drawn between "paper anticipation" and anticipation by manufacture or use. Upon this the learned judge remarked that it became a question whether the various documents which had been referred to did not separately or together add so much to the stock of common knowledge that nothing remained for invention within the limits of Messrs. GAULARD and GIBBS' specification. "As at present advised," said his lordship, "I fail to see how Messrs. GAULARD and GIBBS made any discovery in the technical sense of the word." We do not construe this statement as in any way an impeachment of the *bona fides* of the patentees, who, if they were ignorant in 1882 of the proposals of JABLOCHKOFF, HARRISON, DE MERITENS, and the rest, were only in the same position as Sir WILLIAM THOMSON himself. But we believe that his lordship's view will be endorsed by the majority of our readers who have made themselves acquainted with the facts. For our own part we have always held that Messrs. GAULARD and GIBBS are entitled not only to admiration but also to the gratitude of the electrical world for the plucky way in which they have insisted upon the commercial possibilities of this method of distribution. In the early development of the system they had to face the marked incredulity of the great majority of "practical men," and it is with some satisfaction that we remember that this journal did not take part in the attacks which were repeatedly made upon the efficiency of the system. But our sympathy with the men who fought this battle with ignorance and prejudice cannot lead us to ignore the foresight of earlier labourers whose misfortune it was to be still more markedly in advance of the age. It must also be admitted that the "series" method of working as carried out by Messrs. GAULARD and GIBBS was never a thorough success, and that in the construction of their earlier transformers they showed a conspicuous lack of appreciation of the scientific principles involved. This, however, is but a very mild reproach; and come what may, the names of GAULARD and GIBBS must always occupy an honourable position in the history of the great electrical developments of the nineteenth century.

We may say a word, in conclusion, as to the effect which this decision is likely to have upon the American patent. As our readers are probably aware, the Gaulard-Gibbs patents in America are in the hands of the Westinghouse Company. According to the United States law, a patent in that country expires whenever the same patent terminates in any other country in the world. By the operation of this—as it seems to us—unreasonable law, it will be remembered, a number of EDISON'S patents have recently met with a premature decease. We believe, however, that in the present case the annulment of the English patent will not necessarily involve the United States patent in the same untoward fate. The American specification was drawn up expressly in view of the somewhat uncertain tenure of the English patent, and its claims have been made to rest upon an entirely different footing; so that, as far as the present action is concerned, the Westinghouse Company are probably perfectly secure. The leading claim in the American patent is for the distribution of electricity by means of a (primary) circuit consisting wholly of metal throughout its entire length.

Since the above was written we have received an intimation from Messrs. GAULARD and GIBBS that it is their intention to carry the case to the Court of Appeal.

EFFECTS OF DIFFERENT POSITIVE METALS, &c., UPON THE CHANGES OF POTENTIAL OF VOLTAIC COUPLES.*

BY DR. G. GORE, F.R.S.

In this research numerous measurements were made, and are given in a series of tables, of the effects upon the "minimum point of change of potential of a voltaic couple in distilled water" (Roy. Soc. *Proc.*, June 14, 1888), and upon the "changes of electromotive force attending variation of strength

* Read before the Royal Society, June 21, 1888. Abstract.

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of its exciting liquid" (*ibid.*), obtained by varying the kind of positive and of negative metal of the couple, and by employing different galvanometers. The measurements were made by the method of balance through a galvanometer, with the aid of a suitable thermo-electric pile (Birmingham Philos. Soc. *Proc.*, Vol. IV., p. 130; *The Electrician*, 1884, Vol. XI., p. 414). The kinds of galvanometer employed were an ordinary astatic one of 100 ohms resistance, and a Thomson's reflecting one of 3,040 ohms resistance.

The following were the proportions of hydrochloric acid (HCl) required to change the potential of different voltaic couples in water :—

TABLE 1.—*Hydrochloric Acid.*

Astatic Galvanometer.

Zn + Pt	between	1 in	9,300,000 and	9,388,185
Cd + Pt	,,	1 ,,	574,000 and	637,000
Mg + Pt	,,	1 ,,	516,666 and	574,000
Al + Pt	,,	1 ,,	12,109 and	15,000

Reflecting Galvanometer.

Zn + Pt	,,	1 ,,	15,500,000 and	23,250,000
Cd + Pt	,,	1 ,,	1,162,500 and	1,550,000
Mg + Pt	,,	1 ,,	775,000 and	930,000
Al + Pt	,,	1 ,,	42,568 and	46,500

With iodine and the astatic galvanometer the following proportions were required :—

TABLE 2.—*Iodine.*

Zn + Pt	between	1 in	3,100,000 and	3,521,970
Mg + Pt	,,	1 ,,	577,711 and	643,153
Cd + Pt	,,	1 ,,	200,431 and	224,637

With bromine and the astatic galvanometer :—

TABLE 3.—*Bromine.*

Mg + Pt	between	1 in	310,000,000 and	344,444,444
Zn + Pt	,,	1 ,,	77,500,000 and	84,545,000
Cd + Pt	,,	1 ,,	3,470,112 and	3,875,000

The magnitudes of the minimum proportions of bromine required to change the potentials of the three couples in water, varied directly as the atomic weights of the three positive metals.

With chlorine the following were the minimum proportions required :—

TABLE 4.—*Chlorine.*

With the Reflecting Galvanometer.

Mg + Pt between 1 in 27,062,000,000 and 32,291,000,000.

With the Astatic Galvanometer.

Mg + Pt	between	1 in	17,000,000.000 and	17,612,000,000
Zn + Pt	,,	1 ,,	1,264,000,000 and	1,300,000,000
Zn + Au	,,	1 ,,	518,587,360 and	550,513,022
Cd + Pt	,,	1 ,,	8,733,585 and	9,270,833
Zn + Cd	,,	1 ,,	55,436 and	76,467

In the case of chlorine, as well as that of bromine, the magnitude of the minimum proportions of substance required to change the potential of magnesium-platinum, zinc-platinum, and cadmium-platinum, varied directly as the atomic weights of the positive metals.

The examples contained in the paper show that the proportion of the same exciting liquid, necessary to disturb the potential of a voltaic couple in water, varied with each different positive or negative metal; and that the more positive or more easily corroded the positive metal, or the more negative and less easily corroded the negative one, the smaller usually was the minimum proportion of dissolved substance necessary to change the potential.

By plotting the results in all cases it was found that the order of change of potential, caused by uniform change of strength of liquid, varied with each positive metal.

The results also show that the degree of sensitiveness of the arrangement for detecting the minimum point of change of potential depends largely upon the kind of galvanometer employed.

As a more sensitive galvanometer enables us to detect a change of potential caused by a much smaller proportion of material, and as the proportion of substance capable of detection is smaller the greater the free chemical energy of each of the uniting bodies (Roy. Soc. *Proc.*, June 14, 1888), it is probable that the electromotive force really begins to change with the very smallest addition of the substance, and might be detected if our means of detection were sufficiently sensitive, or the free chemical energy of the uniting bodies was sufficiently strong.

TEXT OF THE OFFICIAL INSTRUCTIONS FOR THE EXAMINATION OF APPARATUS ISSUED BY THE POSTAL TELEGRAPH DEPARTMENT.

(Concluded from page 278.)

POLE REVERSER.

The two German silver contact-levers must be insulated from the body of the instrument, and the armature lever, in working through the slot must be quite clear of the surrounding metal. The springs attached to these contact levers must be sufficiently flexible to allow the armature to work freely. The instrument should reverse the direction of the current in exactly the same manner as a double current key.

Resistance 40ω

Figure of merit, 83γ (5 large Daniell cells—each of 4ω resistance—without external resistance).

SINGLE CURRENT OR DUPLEX TRANSMITTER.

The stud immediately above the contact spring must be insulated from every other part of the instrument when the armature is at rest. When the armature is attracted it must be insulated from every other part of the instrument. The contact spring must be carefully examined to see that it is not soft. If pressed down by the finger it should be sufficiently flexible to return to its original position and make good contact there.

Resistance 40ω

Figure of merit, 83γ (5 large Daniell cells—each of 4ω resistance—without external resistance).

INKERS.

The ends of the coils must be protected from accidental mechanical injury.

Direct Inker.—The speed of slip should be not less than 6ft. nor more than 7ft. per minute.

Resistance of electro-magnet..... 300ω

,, galvanometer 30ω

Figure of merit: Electro-magnet, 4·9γ (5 Daniell cells through 650ω external resistance). Galvanometer, 10γ (5 Daniell cells through 135ω external resistance), with which the needle should deflect not less than a quarter of an inch, the deflection being to the right hand when copper is connected to the down line terminal.

Differential Coils.—Should be differential (when adjusted for their figure of merit) with 50 Daniell cells without external resistance, care being taken that the current is passed through the coils in both directions.

Resistance of electro-magnet..... 200ω + 200ω

,, ,, galvanometer..... 30ω

Figures of merit: Electro-magnet, 4·9γ (5 Daniell cells through 550ω external resistance). Galvanometer, 10γ (5 Daniell cells through 35ω external resistance), with which the needle should deflect not less than a quarter of an inch, the deflection being to the right hand when copper is connected to the down line terminal.

Local Inker.—The speed of slip should be not less than 6 nor more than 7ft. per minute.

Resistance..... 40ω

Figure of merit, 67γ (5 Daniell cells without external resistance).

AUTOMATIC APPARATUS.

Transmitters.—The speed of slip with old form transmitters should range from not more than 7 to not less than 40ft. (200 words) per minute; and with new form from not more than 7 to not less than 80ft. (400 words) per minute. The thickness of the upper contact arm in the new form single battery transmitter should not exceed 17 mils at the base and 12 mils at the top. The space between the paper roller and the platform should be from 8 to 10 mils wide. The tops of the vertical rods should be flat, and when in their lowest position they should be just level with the upper surface of the platform.

Good signals should be produced on the receiver when a punched slip is passed through either form of transmitter at any speed from the lowest to the highest, the current employed being the figure of merit of the receiver in use. Marking and spacing contacts of equal

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duration should be made for "reversals." This should be proved by the needle of an induced galvanometer temporarily placed in circuit remaining at zero or moving equal distances on each side of it whilst the instrument is running at any speed. The battery must not be shortcircuited during reversal; nor must it be joined through to the receiving apparatus when the switch is being turned from one position to the other. The connections with the switch in position to receive must be tried by battery and galvanometer.

Receivers.—The printing disc, being dry, should pick up ink promptly when the train is set running at lowest speed. The standard breadth of marks is 16 mils. The standard thickness of Morse paper—an important matter in connection with high-speed apparatus—is 3½ mils. The coils of double-wound receivers should be differential with 50 Daniell cells without external resistance, care being taken that the current is passed through the coils in both directions. A properly adjusted transmitter should be used for the following working tests:—

Receiver, Spring, "For Repeater."—The speed of slip should range from not more than 8 to not less than 36ft. per minute.

Resistance 1,000ω

Figure of merit, for working sounder at key speed, and for printing at 200 words per minute, 3·06γ (50 Daniell cells through 15,000ω external resistance).

Receiver, Spring, old form.—The speed of slip should range from not more than 3 to not less than 36ft. per minute.

Resistance ..... 100ω+100ω

Figures of merit, for working sounder at key speed, the coils being in parallel circuit, and tongues in neutral position, 10γ (20 Daniell cells through 1,800ω external resistance). For printing at 200 words per minute, coils being in series, 17·5γ (20 Daniell cells through 800ω external resistance, a condenser of 2 m.f. capacity being joined across the external resistance).

Receiver, Spring, new form.—The speed of slip should range from not more than 8 to not less than 40ft. per minute.

Resistance ..... 100ω+100ω

Figures of merit, same as for old form spring receiver, but 300 words per minute should be obtained as highest speed.

Receiver, Motor, and Train.—The speed of slip should range from not more than 8 to not less than 60ft. per minute.

Resistance ..... 100ω+100ω

Figures of merit, same as for old form spring receiver, but 400 words per minute should be obtained as highest speed.

Perforator.—Each perforator must be carefully adjusted to the following standard:—If a length of slip be taken containing 121 centre perforations (which number may be obtained without counting by punching the word "telegraph" three times, including the double space between the words), then the distance between the centres of the first and last holes must be exactly one foot. A gauge half an inch wide and nine mils thick should pass freely between the front plates. The standard width of perforator paper is from 460 to 480 mils, and its thickness 4 to 4½ mils.

Rheostats and Resistance Coils

Must be measured coil by coil to see that they agree with the standard set, from which they should not differ more than one per cent. when corrected to the same temperature. Battery testing instruments and Wheatstone bridge coils must not differ more than one-tenth per cent. from the standard set at the same temperature. A letter or letters indicating the description of wire with which the bobbins are wound must be engraved on the ebonite slab of bridge coils, P. being used for platinoid, P.S. for platinum-silver, and G.S. for German silver. (*See* also under Switches.)

Condensers

Must have the capacity of their several sections, and their total capacity, compared with the standard. It should be not more than 5 per cent. above or below the nominal value. The insulation-resistance between the plates must be not less than 300 megohms per microfarad when tested with 400 volts. (*See* also under Switches).

Lightning Protectors.

Plates and bobbins must be tested for insulation. The resistance of the coil of a cable protector must not exceed 4ω. Vacuum tubes must be tested for vacuum by means of the sparks from an induction coil. If the vacuum be good the discharge is blue and glowing; if bad, the spark is white and sharply defined as in air.

Induction Coil for Bottle Battery.

Resistance of primary coil ..... ·1ω
,, secondary coil 160ω

Figure of merit: A spark $\frac{1}{10}$th of an inch long should be obtained when two No. 1 Leclanché cells, parallel, are joined to the primary coil.

Repeaters

Should be joined up with sets of apparatus representing up and down stations, and tried in all ways in which they are required to work. The parts should be tried separately before being mounted on the board.

Electro-Magnetic Switches.—These should be joined up with a single-current key and five Daniell cells, and the armatures should be attracted and remain so when the key is worked in the ordinary way, the adjustment of each armature being such that a piece of Morse paper will just draw freely from between it and the cores when the current is on. Each contact-point should be separately screwed into the levers. Dimensions of adjusting-spirals of ordinary electro-magnetic switch: 32 turns, exclusive of loops, of 14½ mils German-silver wire, outside diameter of spiral $\frac{3}{16}$th of an inch.

Resistance { Electro-magnet..... 60ω / Shunt (copper wire)..... 60ω } 30ω

Relaying sounders "A" are used in some cases as electro-magnetic switches. The resistance of the coils and shunt must be as above.

Indicator Tablet for Repeaters.—These tablets should have the ordinary form of local connections.

Resistance { Indicator, 50ω+50ω, parallel, 25ω / Shunt ..... 2ω } 1·85ω

Figure of merit, 478γ (1 No. 1 Leclanché cell without external resistance), which should release the shutter and close the local circuit through the armature.

Multiplex Apparatus.

Distributor.—Each four corresponding teeth of the driving wheel should meet their respective pole-pieces simultaneously, a difference of $\frac{1}{64}$th of an inch being the largest error allowed. The spaces between the contact segments should be brushed out by means of a tooth-brush, the plate with intervening segments being removed for the purpose before the electrical tests are applied. The connections of the terminals should be proved by pony sounder and five Daniell cells, and the insulation by horizontal galvanometer and 60 Leclanché cells. The arm must be fixed in such a position on the axle that the brush shall rest on the centre of the first segment of one of the sets of receiving correcting segments when a permanent current through the driving coils is holding the wheel stationary. At the end of the tests the mercury box must be carefully examined to see that no leakage has occurred.

Resistance (50ω+50ω, parallel) 25ω

Figure of merit for driving, 400γ (say 30 Daniell cells—three sets of 30 large cells, parallel—through a total resistance of 75ω); the brush being raised so as not to touch the segments.

Reed.—The reed when driven by 5 large Daniell cells, and having the slide-weight midway in its range, should give not less than 5,200 nor more than 5,300 vibrations per minute; the speed being ascertained by the number of dots produced in a quarter of a minute as shown by a Wheatstone receiver, which, with its coils in parallel circuit and having a bias of opposite effect to the current, should be joined up with 5 Daniell cells to the distributor terminals of the reed. A shunt of 500ω should be joined across the driving coils to save the contacts. The slide-weight must be so tight that it will not shake out of position when the reed is working.

Resistance of driving coils 20ω
,, correcting coils { Electro-magnet. 5ω / Shunt ..... 0ω } 3·3ω

Reed Stand.—There must be a space of not less than ¼ of an inch between the top of the ·2 m.f. condenser and the bottom of the base of the reed.

Telephone Apparatus.

Gower-Bell Telephone.—These must be tried with a standard instrument, two No. 1 Leclanché cells being used for speaking.

Resistance of primary coil ..... ·5ω
,, secondary coil 250ω
,, receiver 200ω
,, relay ..... 50ω+50ω

Figure of merit of relay, coils being in series, 6γ (3 No. 1 Leclanché cells through 700ω external resistance).

Bell Telephone:—
Resistance 80ω

Crossley's Transmitter (Microphone, Induction Coil, and Press Button).—These should have the Gower-Bell microphone, and mouthpiece and bend, but the original induction coil.

Resistance of primary coil 1ω
,, secondary coil..... 200ω

Switch-Board Telephone (Microphone and Receiver and Press Button for Short-circuiting Secondary Coil).—Resistance of receiver, between 60 and 100ω.

Each of these instruments, having been provided with the additional parts rquired to make them complete, should be tried in connection with a standard instrument.

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Switch-Board Telephone Tablet (Reversing Lever, Induction Coil, and a pair of Double-Contact Switch Springs, and Plug).—The connections and insulation of the various parts should be proved by a battery and galvanometer. The lever should go down when a weight of 12 ounces is hung upon it.

Resistance of primary coil ..... ·5ω
,, secondary coil 250ω

Telephone Relays.—The coils should be differential with 50 Daniell cells without external resistance, care being taken that the current is passed through them in both directions : the play and position of the contact-arm being the same as for the figure of merit test, but the tension of the spring being taken off.

Resistance ..... 50ω+50ω

Figure of merit, coils in series, 6γ (5 Daniell cells through 700ω external resistance).

Drop Indicator, Polarised, No. 1—

Resistance 100ω

Figure of merit : 11·5γ (5 Daniell cells through 300ω external resistance), with which the pointer should deflect to the stop on either side, the shutter being held up at the same time. The shutter when down must close the local circuit.

Drop Indicator, Polarised, No. 2—

Resistance 1,000ω

Figure of merit : 3γ (20 Daniell cells through 5,500ω external resistance, with which the pointer should deflect not less than $\frac{5}{16}$ths of an inch to the right hand of zero, the shutter being down. The left hand deflection may be neglected. The shutter should afterwards hold up with a current of the same strength (3γ) in either direction. A current of 10·3γ (20 Daniell cells through 800ω external resistance) should then be passed through the coils in opposite directions alternately, and the pointer should return to within $\frac{1}{16}$th of an inch of zero when the current ceases. The shutter when down must close the local circuit.

Drop Indicator, Non-polarised—

Resistance..... 50ω+50ω

Figure of merit, coils being in series, 11·5γ (5 Daniell cells through 300ω external resistance), which should release the shutter, and close the local circuit through the armature.

Annunciator—

Resistance.....40ω

Figure of merit, 30·3γ (5 Daniell cells throngh 90ω external resistance).

Indicator-Relay, Polarised—

The permanent horse-shoe magnet is intentionally left weak. The polarity of its long upper pole, and that of the bottom of the pointer, should be S. The pointer should be made of steel.

Resistance..... (single wound) 500ω+500ω

Figures of merit, coils being in series : Relay, 1·65γ (10 Daniell cells through 5,000ω external resistance), current entering from right hand. Indicator, 2·46γ (10 Daniell cells through 3,000ω external resistance), with which the pointer should deflect ¼ of an inch on either side of zero ; the deflection being towards the terminal at which the current enters.

Indicator Relay, Non-polarised :—

Resistance..... 50ω+50ω

Figures of merit, coils being in series : Relay, 6γ (5 Daniell cells through 700ω external resistance). Indicator, 4·8γ (5 Daniell cells through 900ω external resistance), with which the pointer should deflect ¼ of an inch on either side of zero, the deflection being towards the terminal at which the current enters.

Drop Indicator Tablets.—The connections and action of each indicator should be proved (*see* respective figures of merit). Tablets for non-polarised indicators, and for not more than nine polarised indicators, should be fitted with the ordinary local connections to each base and insulated contact. Those for more than nine polarised indicators should have the copper strap connecting the bases only ; the small centre screw usually fixing each indicator being left out, and the screw holes being continued through the copper strap and tablet, in line with the centre holes of the indicators.

Indicator Tablets for Repeaters (*see* under Repeaters).

Telephone Switches (*see* also under Switches).—These must be tested for continuity and insulation in their various positions. In hole switches the springs must be clear of the woodwork, and must meet truly. Open springs must be held ⅛th of an inch apart by the stops. Pairs of plugs for switches with closed springs should have their opposite sides connected ; and those for switches with open springs their similar sides. The numbers of plugs to be provided are as under :—

2 hole switch	.....	1 pair
,, intermediate	.....	4 plugs
4 hole switch	.....	2 pairs
6 ,, ,,	.....	3 ,,
9 ,, ,,	.....	4 ,,
12 ,, ,,	.....	6 ,,
16 ,, ,,	.....	8 ,,
20 ,, ,,	.....	10 ,,
25 ,, ,,	.....	12 ,,
50 ,, ,,	.....	13 ,,
100 ,, ,,	.....	25 ,,

Speaking Tablets for Telephone Switches—

The top side of each plug (that having the stop-piece) should be joined to the right hand terminal of each pair. The connections and insulation should be proved by battery and galvanometer.

Press Buttons (Three Forms :—Ordinary ; with Back Stop ; and D.C. Reversing)—

These must make their respective connections properly. In that with back stop the lower contact must be made before the upper is broken. In all cases the button should be free when at rest, and not held against the top of the cover by the spring, which might prevent reliable back contact.

Bells.

Trembler :—

Resistance (single wound) ..... 50ω+50ω

Figure of merit, coils being in series, 13·5γ (3 No. 1 Leclanché cells through 250ω external resistance).

Trembler, large :—

Resistance (single wound 50ω+50ω parallel) 25ω

Figure of merit, 60γ (1 No.1 Leclanché cell without external resistance).

Single Stroke (Trembler Form).—These bells have the contact-spring of the ordinary trembler bell removed from the armature, and a steel banking screw substituted for the contact-screw ; the coils being also joined direct to the inside terminal-plates so that the circuit shall not be broken when the armature is attracted.

Resistance (single wound, 50ω+50ω, parallel)..... 25ω

Figure of merit, 114γ (2 No. 1 Leclanché cells without external resistance).

Single Stroke (with or without key) :

Resistance..... 100ω

Figure of merit, 27γ (5 Daniell cells through 50ω external resistance).

Single Stroke Bell for Pneumatic Tubes (with red and white indicator and with or without press buttons) :—

Resistance 108ω

Figure of merit, 46γ (3 No. 1 Leclanché cells without external resistance).

Block Instruments for Pneumatic Tubes, Single or Double.

The stems of the plungers should be quite free in their slots, and they should also have a small amount of play clear of the springs, so as not to prevent the springs from making back contact. In the double form the front upper spring on either side should break contact before contact between the two lower springs is completed. The pointers should have equal magnetic bias towards each side.

Resistance of indicator	.....	12ω
,, Bell	.....	12ω
,, compensating resistance coil (in special form only)	.....	30ω

Figures of merit.—Indicator : Should be first reversed by 106γ (five Daniell cells without external resistance), and should afterwards reverse with 53γ (one Daniell cell without external resistance). Bell, 53γ (one Daniell cell without external resistance).

Wire Finders.

Should deflect between 40° and 50° when a foot of No. 20 G.P. wire short-circuiting a No. 1 Leclanché cell is placed close to the glass and parallel with the needle at zero.

Numbering Machines.

Each machine must be accompanied by

A piece of india-rubber for replacing the printing pad.
One small spanner.
A small wooden rod for setting the machine to zero.

The machine should be set to zero by first bringing the unit-wheel into such a position that the next depression of the wheel will print the figure "1." This must be done by working the machine in the ordinary manner, as the unit-wheel cannot be shifted round in the same way as the other wheels. The locking lever must be examined to see that it acts properly, and the machine must be

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thoroughly tested by being set to zero and worked several times perfectly.

PREECE'S BLOCK SIGNALS.

	O.F.		N.F.
Resistance of line coils.....	50ω	...	120ω
,, local coils	10ω	...	50ω
,, locking coils	10ω	...	50ω
,, Annett's coil (if provided).		...	80ω

Switch.—Left hand terminal should be connected, under the base, to the switch handle, the centre terminal to the "on," and the right hand terminal to the "off" side.

Bell Semaphore.—Must work well and promptly with 5 Daniell cells.

ELECTRIC LIGHTING ACT, 1882: BOARD OF TRADE REPORT.

The following report by the Board of Trade respecting the applications to, and proceedings of, the Board under the above-mentioned Act during the past year has just been issued :—

"The following application for a provisional order has been received by the Board of Trade since the date of the last report :—

Name of Company Applying.	Name of District.
South Metropolitan Electric Supply Company (Limited).	The whole or portions of the following parishes and districts :— Parish of St. James, Westminster. ,, St. Martin-in-the-Fields. ,, St. George, Hanover-square ,, Lambeth. The City of London. District of Strand Board of Works. ,, St. Giles ditto. ,, Westminster ditto. With certain extra-parochial places.

Several of the local authorities of districts comprised within the proposed area of supply objected to the grant of the order, and after considering their objections the Board of Trade eventually decided to restrict the order to the parishes of St. James, Westminster, and St. Martin-in-the-Fields, with Waterloo Bridge and a small portion of the Victoria Embankment.

The application for a further extension of time for the deposit of capital in respect of the Fulham District Electric Lighting Order, 1884, referred to in the last report, was not proceeded with.

LICENSES.

The following applications for licenses have been received since the date of the last report :—

Name of Place.	Description of Applicant.
Portions of the City of Liverpool.	Liverpool Electric Supply Company (Limited).
A portion of the Parish of St. Margaret, Westminster.	The Kensington Court Electric Lighting Company (Limited).
The City of Dublin (public purposes only).	The Corporation of Dublin.
The District of the Wimbledon Local Board.	The Wimbledon Local Board.
The Parish of St. James, Westminster.	The St. James and Pall Mall Electric Light Company (Limited).

Of these applications, that relating to Liverpool has been granted by the Board of Trade. The remainder are still under consideration.

The license to the Kensington Court Electric Lighting Company (Limited) referred to in the last report was issued by the Board of Trade on the 11th October, 1887.

(Signed) HENRY G. CALCRAFT."

Board of Trade, 29th June, 1888.

Lightning in an Electric Light Installation.—The necessity for having efficient lightning protectors in electric light installations has been once more made apparent. At Servair, in Nebraska, where there are 600 incandescent lamps run off Westinghouse transformers, seven tranformers were destroyed by lightning on the 7th June last.

GAULARD AND GIBBS v. FERRANTI.

THURSDAY, JULY 5TH.

The first witness called for the defence was

Sir WILLIAM THOMSON, who stated that the induction coil was a very old instrument, and for years before 1882 had been made with wire cores. In 1882 it was known how to regulate the quantity and tension in induced currents. Starting with any current in the primary it was known how to produce practically any tension or quantity in the secondary current, and it was known not only to scientists but to instrument makers. The induction coil as ordinarily constructed in 1878 and 1882 would have efficiently produced a secondary current with a certain loss of energy, which they could measure better now than then. There was a loss by reason of magnetic friction, but the coils of that day worked practically with efficiency. Jablochkoff and others carried out the system of putting several induction coils on the same circuit, and there was nothing novel in so doing in 1882. Du Moncel's description of Jablochkoff's arrangement was a perfectly practicable plan of distributing electricity by induction coils from an alternating-current machine. Alternating-current machines were well-known in Jablochkoff's time, and some makers made both continuous and alternating machines. A continuous current was continuous in point of time and direction, but the alternating-current machines were at that time best known and most used. The machine (produced) was a model in general principle of the "Alliance" and De Meritens machines. The induction coil (produced) was an ordinary coil. The core consisted of a bundle of small wires bound together, and could be slipped into the hollow of the non-metallic bobbin. The four ends of the two coils were visible. Either coil could be used as the primary coil, indifferently, and that was known as far back as 1847 or 1848. Noad, in his lectures, explained how to increase or decrease quantity or tension, and his book had been known for very many years. The machine in court was a fair representation of Jablochkoff's machine, though the lamps were different. (The machine was worked in court, and a lamp made to glow.) With the knowledge of 1878 an electrician could have arranged that machine so as to produce any current in the secondary. There was nothing in Du Moncel's description to restrict the current in the primary. An induction coil, properly constructed, was not restricted to high or low tension in the primary. If it had been wished in 1878 to use the machine produced, and described in Du Moncel, over a large area there was no difficulty in the way of doing so. Du Moncel showed that Jablochkoff understood how to produce lights of different intensities. In Jablochkoff's specification there was a substantial disclosure of this arrangement, and from that specification the electricians of 1877 could have arranged a similar system of distribution. There was nothing there to limit the tension of the primary.

His LORDSHIP: As a matter of fact did any electrician apply this system? They had the secret in their hands.

Mr. MOULTON: Not in England my lord.

His LORDSHIP: Why was it not applied?

Witness replied that there was not a demand at that time for electric lighting. Afterwards large districts were lighted in London with arc lights by different companies. It was about 1880 or 1881 that incandescent lamps came into the market. In following out Jablochkoff's specification a competent electrician would certainly have used a divided core. He had no doubt of that from his knowledge of the trade in induction coils at that time. He had made himself acquainted with Imray's specification, and he believed that any electrician reading that in 1881 could have carried out the invention. If the electricity were taken from a battery, several hundred or thousand cells would be necessary to work up the tension. If a machine were used it would certainly have been an alternating machine, and the current could have been sent a long distance by means of a fine wire and an induction coil. Secondary generators would also have been employed, although they were not called secondary generators. He did not think the system either wasteful or impracticable. It was the best system then, and he was not sure it was not the best system now. He had read the provisional specification of Messrs. Gaulard and Gibbs. In his opinion it did not disclose any novel invention at that date. Many inventors at that time had an idea that they could apply an unlimited number of generators, without taxing the power of the dynamo machine, and that idea he believed was present in the minds of Messrs. Gaulard and Gibbs. It was something akin to perpetual motion. There was nothing novel in the patentees' construction of the induction coil. It was not correct to say, as the patentees did, that the diminution of value suffered by the primary current was the sum of the resistance offered by the induction coil. It made no difference in the action of an alternating current whether it was produced by an alternating machine or any other means; but the usual mode of obtaining an alternating current in 1882 was by an alternating-current machine. The patentees said their secondary generators were to be of "special construction," and they were of special construction in the sense that they consisted of coils with the secondary wire divided. From beginning to end of the provisional or complete specification he could not find any indication that the tension of the secondary current was to be lower than the tension of the primary. The secondary generators did not differ from ordinary induction coils in regard to the tension of the secondary, and there was nothing to make the patentees' induction coil more efficient than the induction coils commonly in use at that day. He did not find anywhere in the specification any suggestion that the generators should be put in parallels between the mains; on the contrary, the suggestion was that they should be arranged in simple series. Again, there was nothing in the directions for making the divided cores which was novel at that time, nor was there anything which limited the character of the secondary generators or of the source of the alternating current. Lake,

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in his complete specification, described in his letterpress an induction coil which appeared to be perfectly efficient. The drawings seemed to represent induction coils with continuous iron cores, which made it defective. With better cores, which were to be had in the market at that time, Lake would have got a practicable induction coil, and an efficient system of distributing electricity. Edwards and Normandy's publication described also a practicable system of distributing electricity by means of secondary generators.

His LORDSHIP: Would you give the same reason for this system not coming into general use which you gave in regard to Jablochkoff's invention?

Witness replied that he would. Moreover, there were no practicable incandescent lights in those days. There were in his opinion sufficient directions in Messrs. Edwards and Normandy's specification to enable an electrician to carry out the system. The same remark applied to Bright's specification, and in his belief there was nothing in these specifications to restrict the tension either in the secondary or the primary. An electrician would always regulate the tension according to the requirements. Harrison's specification was, too, an intelligible direction for carrying out a system of distributing electricity. Deprez gave the clearest indication of the necessity for using high tension if the electricity was going to a considerable distance. In 1882 the advantage of high tension in respect to sending electric energy to a great distance was well known. He did not find in Gaulard and Gibbs's instruction any intimation with regard to this high tension other than common knowledge. The induction coil described by Messrs. Gaulard and Gibbs was not the best form for their purpose, and there were better forms existing prior to their patent. The method of curing Foucault currents was well known in 1882. The relation of the number of turns in the primary to the number of turns in the secondary was well known to Faraday.

Cross-examined by Mr. ASTON: He could not refer to any publication in which the rule as to the number of turns in the primary and secondary was made known prior to 1882. There was nothing new in Gaulard and Gibbs's provisional specification.

Do you find in the provisional specification of Messrs. Gaulard and Gibbs the following elements combined:—An alternating dynamo, connected with a high-tension main, on which are placed at intervals generators to supply local installations?—Yes; but I do not know what high-tension mains are. No doubt high-tension mains would be used for sending a current fifty kilometres. The intention of the patentees was, no doubt, to have a system that could be worked over long distances, and to supply high-tension mains. I saw the system at work for the first time at the Edgware-road station.

Was that the first time you ever saw a system combining a generator consisting of a high-tension dynamo, a high-tension main, a long circuit and local secondary generators or induction coils?—Yes.

When you saw it working you thought it a very nice thing?—It was very interesting.

And apparently the problem of distributing electricity over fifteen miles for lighting purposes was solved by that arrangement. You saw the incandescent lamps at work?—Yes.

You had yourself given some attention to the problem of distributing electric energy so as to supply local installations over a long circuit?—Yes.

I am sure you were highly gratified at seeing that somebody had to a certain extent solved the problem?—It met some practical requirements, but did not meet all the requirements which seemed to Mr. Swan and myself to be essential.

You, with your great practical knowledge, could have done better?—I do not say that, because neither Mr. Swan nor myself could see a better solution. In 1881 I delivered an address to the British Association at York on the subject of the distribution of electrical energy.

And you told us you proposed to use continuous currents with very high tension?—Yes.

And you told your hearers that to use a high tension sufficient to supply installations on a long circuit, say 50 miles, would be a tension which would be very dangerous if used locally in a house?—Yes.

And you told your hearers that you had been occupied in solving the problem, and that you proposed to do it by means of the Faure secondary batteries?—Yes. The Faure battery was a number of cells constituting a reservoir for the reception and storage of electrical energy.

And your idea was that if you had the electricity going along a long circuit with local installations and high tension you would be able to charge your reservoirs with electrical energy?—Yes.

You were very much pleased with the Faure system of storing electricity, and you thought it had solved the problem?—I thought it might possibly solve it.

Prior to that you had endeavoured to work out in your own mind a system of what you called the "step-down" dynamos?—Yes.

At the time you delivered your speech did you know all the electrical devices contained in these prior specifications?—Yes, but not the combinations.

And combinations may sometimes constitute inventions?—Yes.

Witness, continuing, said he should have known at that time how to construct a secondary generator. At the time of his lecture he proposed a very high tension. Witness did not propose to use an alternating dynamo, but a high-tension direct-current dynamo, or several dynamos in tandem or in series. He knew the system at the Grosvenor Gallery. They had there an alternating dynamo, with high-tension main and secondary generators, and the secondary generators were in parallel, not in series. Witness heard of another system at Colchester, but it did not remain long at work.

At the Paris Exhibition Congress, in 1881, the object was to prove the exact position of the science of electricity and its applications, and to compare the results of researches, was it not?—The practical object was to determine on a unit of measurement.

You sat for forty days?—Yes. None of the gentlemen whom he met there showed witness his system of distributing electricity.

There was another important gathering of eminent electricians, when evidence was taking by the Select Committee on the Electric Lighting Bill. Sir William Siemens' idea was that a quarter mile radius was a convenient area for lighting a town, and that was witness's idea also. That was in 1882. Witness did not believe there was any practical way of solving the problem of electric lighting by induction coils to supply the wants of a town until the parallel arrangement of lamps came into force. In 1882 lamps in parallel arrangement were perfectly well known.

Witness read a report from Prof. Fleeming Jenkin, who in 1884 examined Messrs. Gaulard and Gibbs's apparatus at the request of Sir Geo. Elliott. Dr. Fleeming Jenkin, in his report, said the secondary generators employed by Messrs. Gaulard and Gibbs were likely to be of considerable value in electric lighting by lamps over a considerable distance, and that he was not acquainted with any other system by which this could be done. Prof. Jenkin added that the system was based on sound and well-known principles, and that the secondary generators were excellent and greatly in advance of those previously in use. Witness agreed that the system by which energy from a high-tension main could be produced in houses at a low tension was a valuable arrangement.

His LORDSHIP said he was at a loss to know whether Mr. Aston claimed to use secondary generators of "special construction."

Mr. ASTON: Not specially constructed, but specially selected, my lord.

Witness, continuing, said there were two kinds of secondary generators, those with solid and those with divided cores. The solid core instrument was not practically used in 1882. Messrs. Gaulard and Gibbs's specification therefore described in both cases an induction apparatus with divided cores and separate bobbins capable of being grouped for quantity or tension.

And that type of induction apparatus would answer all purposes in connection with a high-tension main, and an alternating dynamo?—Provided the tension in the secondary was greater or at least equal to the tension of the primary. For household purposes it was perfectly well-known that the secondary circuit must have a comparatively lower tension than the main wire. The use of a solid core would cause a considerable loss of energy by reason of the occurrence of Foucault currents.

In Du Moncel's description of Jablochkoff's patent will you point out to me where you can find any direction to use an alternating-current dynamo supplying a high-tension current to the main?—I do not see the word "high-tension."

To save time I will ask you which of these prior specifications most nearly proposes that system represented by the combined operation of an alternating-dynamo machine sending electricity into an electric main in a state of high tension and supplying local installations with electricity to be utilised by means of induction coils with divided cores?—Several of the prior specifications come absolutely to it.

Does Jablochkoff tell you to use high tension?—He does not name it, but it would be necessary to have a high tension in order to carry out the system.

Is it not true that in Jablochkoff's system the tension in the secondary is enormous?—The tension in the secondary is high.

You are not told in Jablochkoff's specification to be careful to have a high tension in the main?—You must have had a high tension.

Does he say anything about a long circuit—50 kilometres, for instance?—No, so far as I am aware; but he mentions an arrangement for distributing electricity over a large building.

Witness, continuing, said he believed an alternating-current machine was intended to be used in Edwards and Normandy's system.

The Court then adjourned.

FRIDAY, JULY 6TH.

On the reassembling of the Court on Friday,

Sir WILLIAM THOMSON's cross-examination by Mr. ASTON was continued: Harrison's specification proposed to send a current from the primary through one conductor of an induction coil, and to light from the secondary wire of that coil. Harrison used a bad induction coil, but that did not vitiate it as an anticipation of Gaulard and Gibbs's invention.

But none of these prior specifications contained any new principle which you did not know when you delivered your address to the British Association at York?—The whole of them applied the induction coil in a way I had never thought of at all.

In your address at York you advocated a dynamo machine, a long wire, and you had in your mind two methods of obtaining a step-down effect in the local installation?—It never occurred to me to use an induction coil, and it never occurred to me that it would be advisable to use an alternating current.

Therefore you would have had to introduce two elements into your system—an alternating dynamo and the induction coil?—Yes.

Where in the specification do you find the three elements which co-operate in Messrs. Gaulard and Gibbs's patent?—I find induction coils; I find a magneto-electric machine with alternating or reversed currents.

But they are to be rapidly broken first?—It is not rapidly broken.

But on page 4 the inventor says, "to get the full effect out of these coils I use a rapidly broken current to charge them?"—Broken is a bad expression. In a magneto-electric machine there is no break in the circuit. The inventor says, "I prefer as source of electricity a magneto-electric machine with an alternating-current. The current is rapidly stopped and sent back, that is all."

His LORDSHIP: The inventor says, "I want a rapidly broken current, and to get that current I prefer to use a magneto-electric machine with an alternating-current."

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Mr. ASTON: Well, if that is your lordship's view I will not press it.

Can you mention one of these prior inventions which you would not have had to modify in order to make it a success?—Edwards and Normandy's invention required no modification in order to make it a success.

What do you say in regard to De Meritens' system?—De Meritens requires that something should be taken off. It is perfect with the exception of the iron connector between the two parallel bundles of iron wire.

Is that a matter of opinion?—It is matter of knowledge.

And you would also do away with the character of solidity?—I do not advise a liquefaction of the apparatus (laughter).

I mean in contradistinction to laminated?—I would do away with the iron altogether, or else take it off and put on a laminated connector.

Johnson does not tell you that the instrument on which his appliance is based can be replaced by an alternating-current machine?—Yes, he does. On page 6, from line 20 to the end, he speaks of nothing else but an alternating machine.

I am asking where he says that an alternating-current machine can be used in the place of the Bunsen battery on which he bases his discovery?—He bases his discovery on an experiment with a Bunsen battery, and he leaves it to the electrician to go to the best source for his electricity.

Mr. ASTON: If he has the wit to do so.

Witness, continuing, said that so far as Lake's patent was concerned, he would do away with the solid iron core. He had never seen the invention at work.

Re-examined by Mr. MOULTON: In 1884 Prof. Fleeming Jenkin reported that the secondary generators in Messrs. Gaulard and Gibbs's patent were likely to be of great value in electric lighting. Witness was not aware that at the time Messrs. Gaulard and Gibbs had taken out a special patent for secondary generators. Any competent electrician referring to Messrs. Edwards and Normandy's specification would gather that the currents produced by the magneto machines were alternating currents.

Mr. SEBASTIAN Z. DE FERRANTI, the petitioner, said that from 1885 he had given great attention to the distribution of electricity by induction coils, and had taken out patents. He had read the prior specifications, and had heard Sir Wm. Thomson's evidence. Messrs. Gaulard and Gibbs's specification taught the world nothing that was not contained in the prior specification. He agreed with Sir William Thomson's evidence as to the prior specification. After Jablochkoff's invention, in his opinion, the next real advance in electric lighting was placing secondary generators or induction coils in parallel, and altering all the details to agree with that change.

Cross-examined by Mr. ASTON: It was after you saw what was done at the Grosvenor Gallery that you gave your attention to this system of electric lighting?—No, I had given my attention to it before.

When did you see Messrs. Gaulard and Gibbs's invention first?—At the Grosvenor Gallery in 1884.

Was it not after that you took out your patent?—Yes, in 1885.

I believe the real petitioner is Sir Coutts Lindsay?—I am the actual petitioner, and am most affected.

His LORDSHIP: I do not think we can go into that.

Does the solicitor who represents you represent Sir Coutts Lindsay?—For convenience he does.

Prof. JOHN AMBROSE FLEMING stated that he had made himself master of the prior specification, and, generally speaking, he agreed with what Sir William Thomson had said.

Cross-examined: The law of winding induction coils for the purpose of raising or lowering the tension was well known in 1882. In electric lighting experiments very small changes often made all the difference between failure and success. He had never before 1882 seen the three elements disclosed in Messrs Gaulard and Gibbs's specification in co-operation.

Major-General CHARLES EDMUND WEBBER, said he had a practical as well as a theoretical acquaintance with electricity, and he agreed generally with Sir William Thomson's evidence in chief and in cross-examination.

Mr. MOULTON summing up for the petitioner argued that Messrs. Gaulard and Gibbs's specification was necessarily bad if the patentees had not told the public wherein consisted the "special construction" of the generators which he proposed to use. It was a fatal objection that the patentee who claimed the use of a certain apparatus of special form had never told the public what kind of apparatus was within his claim and what was not. The duties of a patentee were clearly defined. He was bound to tell the public fully how to carry out his invention, and bound to let any person who read the specification know what was within the claim, and he should urge that Dr. Hopkinson's evidence had shown clearly that the public, reading Messrs. Gaulard and Gibbs's specification, would not know that they were to use a high-tension current or what special kind of secondary generator they were to employ. The specification ought to be so clear that a manufacturer who was making these kind of instruments would be able to see at once whether he was infringing the patent. There was nothing whatever in Messrs. Gaulard and Gibbs's description to inform the public what things were essential to the success of the apparatus and what were not. It was evident that the patentee himself did not know, and the manufacturer was left to find out what Messrs. Gaulard and Gibbs themselves did not know. That, he submitted, was entirely against the principles of patent law. It was an objection which was a fatal objection, because the public could not be wiser than the patentee. Moreover, the patentee had not given the general principles of his invention; he had simply taken an instance, and had not even given that instance fully or sufficiently, but had left it without any instructions to vary it under different circumstances, and he maintained that that was not a discovery for which the patent laws allowed a patent. It was not sufficient merely to say, "Take a machine of such and such a size," and not to give any instructions how under different circumstances to vary its dimensions. If the patentee had discovered a principle, and given sufficient directions for getting the good effect which his invention produced, he (Mr. Moulton) would be the last person to say he ought so give every rule for getting the best effect. But the inventor here had discovered no new principle; he had simply given an instance of a machine, and most imperfectly described it, and now he wanted to restrain the public from doing what he had never taught them to do. He was perfectly at a loss to know what his learned friend would have to say as to the claim to use special kinds of generators. In the second instance the patentee did not even say it was necessary to use divided cores.

His LORDSHIP: I think it is implied.

Mr. MOULTON remarked that if that were so the patentee had described two generators, both of them with an ordinary divided core, which every witness had said was the ordinary way of making induction coils in those days. It was impossible under those circumstances to say that the generators were of "special construction." There was only one other thing suggested, and that was that the patent should be supported because when Dr. Hopkinson tested it at Edgware-road he found 87 per cent. of efficiency. That, however, would clearly depend upon the proper adjustment of the number of coils, and of the size of the main that took the electricity. Sir William Thomson carried it even further, and said there was nothing which would make the generators any more efficient than the ordinary induction coils. He was not surprised that Sir William Thomson was struck with this system of distributing electricity when he first saw it. He (Mr. Moulton) had not the slightest doubt that the system was of great use. He believed that the exposé of Du Moncel and the specification of Jablochkoff were publications to the world of a thing of real value, but he did not believe that that publication needed any supplement. Jablochkoff started with an alternating-current which passed through up to fifty of these induction coils, and from each of these he drew the supplies for his lamps. The reason why that system did not come into use was that there was no available lamp, and the result had been that that which was really the pioneer had not survived a large number of formidable rivals which had come up since. He failed to see anything in Messrs. Gaulard and Gibbs's specification which was an enlargement of Jablochkoff's system, or anything which entitled them to a patent. Deprez in his specification told them to take a high-tension alternating-current along the main and turn it into a low-tension current when it got to the end. Messrs. Gaulard and Gibbs never said "turn it into low-tension current," so that Deprez really went a great deal further than any other patentees. To try to prove that there was any invention in taking as the source of their high-tension what the witnesses all said was the most natural source of high-tension in the world seemed to him to be a perfectly hopeless task. The two most striking anticipations by far were Edwards and Normandy's and Johnson and De Meritens'. He was not suggesting any bad faith, but the resemblance which Messrs. Gaulard and Gibbs's patent bore to Edwards and Normandy's specification was exceedingly striking. Johnson's system possessed all the elements of success in 1878, but unfortunately there were no incandescent lamps. Johnson pointed out that all they had to do was to get tension enough, and they could send the current to any desired distance, not only along a public road, but into the houses, and he contended that in that specification they had a publication of all that was valuable in the system. Lake, again, clearly showed a complete publication of the ordinary induction coil with divided cores; but none of these systems were adopted, because they were born into the world before there was any need for them. Messrs. Gaulard and Gibbs were more fortunate. In 1882 those gentlemen, and the people who backed them and found the money, did practically apply this system, and Sir William Thomson said he never saw these things practically applied till he saw them at work at the Edgware-road Station; but a man could not support a patent by showing that he had been fortunate enough to get for the first time people to put money into it in order to show the system. The question whether before 1884 this system was used had nothing to do with the issue. No doubt Messrs. Gaulard and Gibbs were entitled to the advantage of those patents which were really new to the world, but they were not justified in doing what that patent, if it were upheld, would enable them to do—that was prevent the rest of the world, and prevent patentees like Jablochkoff and others using in the very best form that method of electrical distribution which they had so clearly put the world in possession of. The thing which had made this system of distribution take this great stride was this—the system of putting generators one after another, so as to drive the current straight through them, had its defects, but someone discovered that by constructing the generators in a suitable manner and arranging them in parallel a great part of the tension of the main had been got rid of. From that moment the system had taken a most important place in electric lighting; but that was a step which was not in any way attributable to Messrs. Gaulard and Gibbs. Their patent must be judged by what it was—a suggestion in 1882 to use a source of electric supply which was well known, to use secondary generators that had no novelty, and simply to take that which others had shown the world before how to use. Looking at all these considerations he asked his lordship to declare that the patent was not a good patent, and that the petitioner had succeeded.

Mr. ASTON then opened his reply on behalf of Messrs Gaulard and Gibbs, and addressed himself first to the question as to whether they did or did not claim generators of special construction. They did not claim generators of special construction, but they did claim a combination in which generators of an indicated class form one of the elements.

His LORDSHIP: It will take sharper eyes than mine to see the difference.

Mr. ASTON said a generator of special construction was not claimed, but the patentee, in claiming his combination, indicated a class of generator which he used in connection with his high-tension main and his alternating dynamo, and that was a claim which he should be prepared

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to justify. His case was that not one of these prior specifications disclosed any system or any combination of parts that the patentee ever did work or ever could work without some change. On the authority of Lord Westbury, he should argue that the degree of change was in no way material. If a prior specification did in fact describe a combination, then any subsequent patentee who used that combination could not hold his claim; but if there were half-a-dozen prior specifications, and of those prior specifications number one omitted part "A" of the patentee's combination, number two omitted part "B," and number three omitted part "C," then not one of those three specifications was an anticipation of the combination. Messrs. Gaulard and Gibbs's patent possessed three distinct elements in combination, and any alleged anticipation which was to be relied upon must contain these three elements in that form. Sir William Thomson said, and said truly, that all those prior specifications required respectively something to be done to them to make them successful, but he added that that something was obvious. He (Mr. Aston) submitted that the obviousness of these defects was entirely due to the later state of public knowledge. Messrs. Gaulard and Gibbs's patent consisted of a number of induction coils of a character which the patentees indicated, placed at intervals in such position in relation to the main wire that the induced currents could be utilised for lighting or other purposes. He submitted that that was not pointed out in a single one of the prior specifications. In no single case had they an alternating generator like Messrs. Gaulard and Gibbs's combined with a high-tension main like Messrs. Gaulard and Gibbs's, combined with secondary generators such as were described in Figs. 2 and 3 of Messrs. Gaulard and Gibbs's specification. Witnesses had said, it was true, that Jablochkoff's secondary would not answer, but they added that divided cores were well known, and that anybody would have discovered the defect and put in the exact core. He (Mr. Aston) said they must not do that, and in saying that he relied upon previous decisions which had been given by his lordship, and which had been supported by the Court of Appeal. In not one of the prior specifications did they find the patentee saying "I am going to distribute the electric light by a long main wire, and I will tell you how to do it." They did say they were going to sub-divide the light, but not one put on the front of their specification the clear and intelligible statement, "Now the time has come when we can use lamps upon a long circuit, and I will tell the public how to do it." Messrs. Gaulard and Gibbs clearly described what they were going to do, and all the witnesses said that at the Edgware road Station they saw Gaulard and Gibbs's system at work. They saw an installation with a secondary generator of the class described in Messrs. Gaulard and Gibbs's specification working in connection with a main wire. Dr. Hopkinson tested that system, and he found that the tension in the secondary generator was lower than the tension between the terminals of the primary circuit. When Sir William Thomson saw this system at work at Edgware-road he for the first time knew that an induction coil could be used for the step-down purpose which he had proposed to achieve by the Faure accumulator on the dynamo motor.

The learned counsel had not concluded when the Court rose.

SATURDAY, JULY 7TH.

On the re-assembling of the Court,

Mr. ASTON continued his address on behalf of Messrs. Gaulard and Gibbs. The system which Sir William Thomson saw at work at Edgware-road was quite new to him, and the report which Prof. Jenkin made was one which he endorsed. Sir William Thomson did not know anything of the prior specifications before his visit to the Edgware-road, but now that he had seen those specifications, and brought his skill as an electrician to bear upon them, they told him the same tale. Would they have told that tale if he had had his attention called to them without seeing the apparatus at work at Edgware-road? There was not a single witness who was asked whether, after reading the specification of Jablochkoff, of Imray, of Edwards and Normanby, of De Meritens, they could have constructed an apparatus containing the three elements which were contained in the patent of Messrs. Gaulard and Gibbs, and used in the same way. What would a practical electrician have produced if told to construct a machine from either of those descriptions? His friend said that it was not till 1881 that there were any incandescent lamps suitable for either of these inventions. In November, 1879, and in January, 1880, there came upon the world propositions for a perfect incandescent lamp. Jablochkoff's system was never applicable to incandescent lights put upon a long circuit. He did not use high tension in his main, he did not use an induction apparatus to step down; but used it to step up and increase the intensity of the current. Sir William Thomson said he would take out Jablochkoff's solid core and put in a divided core. It was a small thing to do after seeing the Edgware-road installation, or being told to use an induction coil; but it was nevertheless true that down to 1884 Sir William Thomson had never thought of it. Moreover, it would be contrary in every sense to Lord Westbury's ruling to substitute a divided core for a solid core in Jablochkoff's system. In order to make the specification an anticipation Jablochkoff must tell the public that what he wanted to do was what Messrs. Gaulard and Gibbs had tried to do, and that the means he employed were the means which Messrs. Gaulard and Gibbs employed. Jablochkoff's system differed materially from the patent which was the subject of that action in three respects. They were: Want of proper induction coils, and positive directions to use a wrong one; no reference to a long main circuit wire; no reference to the proper kind of tension to be employed. If Messrs. Gaulard and Gibbs's system had been used to drive dynamos, and they attempted to claim it for electric lighting they would be out of court. That would be simply a new use for an old machine; but in this case there was no old machine, and there never was—until it was exhibited at Edgware-road—that combination of parts which produced a successful distribution of electricity for electric lighting on the Gaulard and Gibbs system. Deprez, his learned friend said, had got the very thing. That was in September, 1881, a year and a-half after the incandescent lamps had been upon the market, and yet the only reason his learned friend could suggest why nothing was heard of the Deprez system was that it was before the time. Why did not Sir Coutts Lindsay adopt the most economical course, and choose the Imray system? Messrs. Gaulard and Gibbs could not have said a word, because that system was not within their claim. What he wished to impress upon the Court was that Messrs. Gaulard and Gibbs used the induction apparatus as a step-down instrument. He did not deny that the Ruhmkorff coil could be used alternatively for that purpose, but in no practical installation had it ever been employed as a step-down producer of high-tension. Imray, it was perfectly clear, had intended to use a Bunsen battery. Sir William Thomson would have put into the invention an instrument which Imray had never described; but that was not a fair reading of the specification. Edwards and Normandy did not even point out the object of their invention. The main objection to Lake was that he had described what Sir William Thomson himself admitted would be a very bad arrangement, namely, the solid cores. Sir William Thomson and all the other witnesses declared that if solid cores had been used, those cores would have declared their inefficiency for the purpose. If Messrs. Gaulard and Gibbs had infringed any of these former patents why had they not been brought to book? There was Jablochkoff, with a large company behind him; why did not he say, "You are infringing my patent?" He was aware that that was not a conclusive argument, but it helped his case that none of these prior patentees were able to point to Fig. 1 in Messrs. Gaulard and Gibbs's specification and say, "That is mine." Harrison's specification would, with a few alterations, he was prepared to admit, come very near that of Messrs. Gaulard and Gibbs, and more particularly if it had contained a secondary generator applicable to a group of lights; but Harrison did not show the means by which his invention could be carried into effect. Read by the light of present knowledge, and with alterations and improvements, some of the prior specifications came very near to that of his clients; but they were bound to take the specifications as they were, and he asked his lordship to hold that his learned friend had failed to prove there was any anticipation of Messrs. Gaulard and Gibbs's patent. The next point he had to address himself to was as to whether he was justified in claiming that the specification described Fig. 1, consisting of the combination which he had referred to over and over again. It would be absurd for him to say that Sir William Thomson did not know how to use an induction coil so as to produce a step-down as well as a step-up effect. He thought he was justified in asking his lordship to hold that the first defining clause, in speaking of generators of "special construction," referred to generators having special characteristics, though they were not new *per se*. in Figs. 2 and 3 they had that class of induction apparatus which would supply a current of lower tension than that in the main wire. Prior to the date of the patent, down to the very latest specification, that of Imray in 1881, the use of the induction coil was to increase tension, and therefore he contended that the patentees were justified in saying that it was a new system which they were going to adopt. He quite admitted the patentees in the beginning of the specification referred in terms to a special construction of a generator, and that they intended, because they thought the generators were new, to claim a "special construction;" and he (Mr. Aston) thought he would be able to justify the claim. First, the generators had divided cores, and, secondly, they had a step-down effect. Messrs. Gaulard and Gibbs solved the problem which had been occupying men's minds from the introduction of the incandescent lamp at the latter end of 1879, and that they had solved it was proved by a number of witnesses to whom he was sure his lordship would give credence. Fairly construed, the specification described a combination; that combination was new, it was sufficiently described, and had never been anticipated. It was urged that the apparatus was not sufficiently described, but an inventor was not bound to give what would be without as well as what would be within his patent.

His LORDSHIP: But he is bound to state so clearly what is within it that a workman may know what is without.

Mr. ASTON said that if the workman departed materially from Figs. 2 and 3 of the patentees' specification he would undoubtedly be without the description.

His LORDSHIP: The patentees do not say "Take step down generators," but merely generators of "special construction."

Mr. ASTON said they must be according to Figs. 2 and 3. Messrs. Gaulard and Gibbs conferred upon the electrical world that benefit which the electrical world was waiting for, and which even Sir William Thomson could not supply. Messrs. Gaulard and Gibbs were not bound to point out the salient features of all the parts of their apparatus, and he ventured to sum up the case as being one where there had been no anticipation, where the invention was very useful and beneficial, and where the specification sufficiently described it. It was perfectly well known at the date of the patent that the generators could be placed in parallel, and if the substitution of the parallel for the series system was a thing which anybody could do, then there could be no objection to the specification on the ground that it did not describe the more useful of the two plans. He believed he had dealt with every point raised on the other side, and he submitted that this was a patent which ought not to be revoked.

The Court then adjourned.

JUDGMENT.

Mr. JUSTICE KEKEWICH, in delivering judgment, after referring, on the question of nonconformity of the complete with the provisional specification, to the observations of Lord Blackburn in Bailey *v.* Robertson ("L.R." 3, App. Cases, 1,055), said that the amendment of the com-

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plete specification had the effect of substituting the specification in its present form for the original ; but in its amended form it must comply with the provisions of the law, including those as to conformity with the provisional specification, as explained in Bailey *v.* Robertson. The provisional specification in the present case spoke of an "unlimited number of induction coils," whereas the complete specification spoke of "a number" only. Was this an essential difference? His lordship decided this question in the negative. One passage of the provisional specification was as follows :—"When an electric current approaches or recedes from a circuit of solenoidical form, it determines in this latter a current of induction without in any way modifying the value of the primary current." It had been said that the provisional specification depended on the statement "without in any way modifying the value of the primary current," and that this was false and was abandoned in the complete specification. His lordship continued as follows:—That that is false is conceded, and for the present purpose it may be assumed that it is abandoned in the complete specification, but I do not think that that fact is fatal to the patent. It may be important as regards utility and also relevant on the question of novelty, but it does not establish nonconformity between the two documents. The most that can be said is that the provisional specification contains, but the complete one omits, an erroneous statement respecting the patented invention which, if scientifically true, would add greatly to its value. That to my mind is not enough. But it is said that, whereas the provisional specification rests the invention on induction coils of a special construction, the complete specification as amended applies it to induction coils of every character, and this makes the latter different in the sense of being more extensive. This is a formidable objection if true. The foundation of it is the abandonment of the claim for special construction. But the patentee, though he has done this—though he has said, "I do not claim to have any special form of induction coil"—has retained, as part of his combination, the use of those of a special construction. He does not claim to construct, but he requires to use certain instruments, and those only when constructed. What is the effect of this on the complete specification standing alone is another question, but on the question of conformity I hold there is no such difference as is alleged between the two documents. Each asserts the necessity for a secondary generator of a special construction. So far, I have dealt with mere questions of language, so as to enable the Court to read the documents for the above purpose. In further examining the specification (and henceforward I deal with the complete one only) one depends much on evidence. There are still questions of construction to be solved, but evidence is required not only to explain terms of art, but to prove what was known at the date of the patent. I may mention here one objection, out of order, to get rid of it. It has been stated by the patentee (Gibbs) that the invention is not thoroughly successful unless there is an equal mass of metal in the primary and secondary wires, and it is urged that, whether true or not, which is said to be immaterial, this ought to have been in the specification. If true, it might, with advantage, have been stated, but it only comes to this, that what is possible with unequal masses and is more feasible as you approach equality, can only be made a thorough commercial success when that equality is practically attained. I do not think that the omission to make such a statement can defeat the patent. Another objection urged respecting secondary generators was that a divided core is essential, and that this is not stated. It is, without doubt, stated as regards the first, and the evidence has satisfied me that it is sufficiently implied in the language describing the second, and further, that no electrician would stop to inquire whether a solid or divided core is intended. But, putting aside these two objections to the description of secondary generators, and assuming, of course, the soundness of my view that they are of special construction, how does the specification stand as regards the information given for their selection? And, in order to get an answer to this question, first consider what information is reasonably required? A patentee is bound to tell the public in his specification, not only what his invention is, but how practical effect is to be given to it, and if the invention be a machine, how that machine can be manufactured. I have paraphrased the statute. If there are many different ways of effecting the entire object, or any particular part of it, he is not bound to specify them all in detail, but he is bound to give such instances—selections it may be from a class—as will enable a competent workman to know what he ought to use. And he is further bound to refer to these instances, or the class from which they come, in language which leaves no doubt what articles are and what are not applicable to the production of the intended result. This is important for two reasons—first, in return for his monopoly, a patentee is bound to put the public in possession, as far as description can do it, of his invention in principle and detail ; and, secondly, as a condition of being entitled to restrain other operators from producing his result by the same means, he is bound to tell them precisely what they cannot do except under penalty of an injunction with its serious consequences, and thus to indicate what can be done safely. This is not less true where the patent is for a combination than in any other case. Indeed, I am not sure that the obligation ought not, in such a case to be particularly strict. If a man says, "I claim to have protected, as my invention, three things combined which, though separately well known, have not been before used together," it is reasonable and right that he should state exactly what each of those three things is; and if any one of them belongs to a class comprehending several varieties, then also which of the varieties are intended. And this, of course, he can easily do, as, admittedly, the combined items are well known. What is the combination, several times described, with some variation of language, but none of substance? Take it from Mr. Aston's statement to his own witness Dr. Hopkinson. The combined elements are three in number—(1) an alternating dynamo supplying a main wire ; (2) a current in that wire of high tension ; (3) a secondary generator such as is described. The description there mensioned is that of the witness, but of course he could only explain or illustrate, he could not go beyond the specification. In passing, let me observe that I am not satisfied that there are really three elements, but I will not dwell on this. Let it be assumed for the present purpose that there are three items—the alternating dynamo, the high tension, and the secondary generators described in the specification. There is no difficulty about the first or second, but how has the patentee fulfilled his obligations as regards the third? It is conclusively proved by the petitioners, and not denied by the respondents, that there is nothing special about the secondary generators described, that they differ from others of their class only in unessential details, and that any other instrument of the class—induction coils with divided core—would answer the purpose equally well. So completely is this admitted by the respondents that they contest the conclusion that a special construction is intended. No more about that. Is it reasonable to hold that the divided core is the special construction? I think not. It would to my mind be pressing the maxim *ut res valeat* too severely to construe the words "electrical generators of special construction" to mean those belonging to one of two well-known and exhaustive classes, especially when one finds no reference to that class as a whole, but an elaborate description of two particular specimens. If the intention had been to refer to electrical generators having a divided core, that might have been easily done in a single line, and the examples would have been needless and out of place. Then it is urged that the special construction refers to the diminution of tension to those which, receiving an electric current of high tension, pass it on as a current of low tension. It is not pretended that this is said in so many words ; no counsel or witness has ventured to put his finger on an expression which states plainly that the secondary generator employed must be of what is styled the "step-down" character. It is conceded that no other will do, and it may be assumed that no other would be attempted by a competent workman ; but this is because of a well-known scientific fact, and not because of information given by the patentee. There is no occasion to examine the provisional specification on this point or to inquire whether the complete specification in its original form is agreeable to the view now taken of it as amended. I hold that, as amended, it does not say one of the elements of the combination is a step down induction coil. That is what you are to use with an alternating dynamo and a high-tension primary wire, in order to produce the desired result. Nothing less than this would suffice. It is not enough to say, as the patentee does, that the qualify and value of the induced currents depend on the special construction of the electrical generators without giving a plain statement in what the special construction consists. It is not suggested that the examples are exhaustive of the class of machines which would answer its purpose. I think that a manufacturer is placed by this specification in a difficulty. He knows, of course, that he cannot use either of the induction coils described, but if he wishes to use one of the same class, but differing in detail, he cannot ascertain from the specification whether he may safely do so or not. Changing the phrase, the patentee has not in his complete specification ascertained the nature of his invention, and how it is to be performed, in that he has not explained what constitutes the third item in his combination. Mr. Aston says, of course the use of equivalents would be an infringement, but I do not think that doctrine can be called in aid of a patent which professedly rests on a special construction. In its original form the specification claimed the special construction of the secondary generators required to produce the desired result. Apart from any question respecting conformity with the provisional specification, the patent could then have been supported, so far as language was concerned ; but the patentee was driven to abandon this part of the claim and to amend by way of disclaimer. This was a difficult task. I am disposed to think that it could not have been performed without destroying the patent—could not, that is, have been so performed as to leave a supportable residue. But whatever was possible, I hold that it has not been done, and that, with the abandonment of the third item of claim, the whole specification falls to the ground. This holding makes it unnecessary to go into the question of anticipation. The evidence on this point is conflicting, and I have the testimony of men of acknowledged eminence and truthfulness on either side. Besides this there are many documents, and the criticism of them has been long and minute. Before pronouncing a deliberate opinion on the question I should be obliged again to examine those documents by the light of the evidence, which would have to be perused for the purpose, and of the arguments, which would have to be recalled and weighed with regard both to documents and evidence. I do not consider myself called upon to do this ; but it may be convenient for me to state what, subject to such revision as I have just mentioned, is the result of my best attention during the trial. I do not question—nobody could successfully question—the accuracy of Mr. Aston's distinction between anticipation by documents only—what is sometimes called paper anticipation—and that by manufacture or use. It is grounded on common sense and established by the authorities to which he referred and many others. Guides for the application of the distinction are also to be found in those cases, and notably in the judgment of Lord Westbury, which Mr. Aston quoted. But the distinction concedes that there may be a paper anticipation, and the question here seems to be whether the documents which have been referred to did not separately or together add so much to the stock of common knowledge that nothing remained for invention within the limits of Messrs. Gaulard and Gibbs's specification. Mr. Aston observed that about the years 1878-9 there was an avalanche of patents, and he accepted my suggestion that many inventors were buried in it. He did not pursue the analogy further, and perhaps forgot that a congealed mass has a law of motion of its own which after a time again brings to light, capable of recognition, though it cannot revivify, buried limbs. So here science has progressed, and in its progress has again called attention to discoveries of bygone years, long buried and forgotten, and of which Sir William Thomson was in 1881 either ignorant or oblivious. Being brought to light, they are recognised as bearing a striking resemblance to others since called into

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existence, and there is at least some ground for arguing that there is no substantial difference between the past and present. There is often a genuine and complete answer to an argument of that kind. Why, says the patentee of later date, why was not this old invention put in practice if, as you say, it anticipated mine, which has been proved to have been feasible and useful? It is frequently difficult—it is sometimes impossible—to give a satisfactory reply to such an objection, but I think that Sir William Thomson gave one in this case. He says that at that time, the period of those numerous patents, there was no demand for electric lighting—no encouragement, that is, for inventors to persevere and put their inventions in practice. That would scarcely have sufficed; but he added, in effect, that there was not then known any lamp to which those inventions could be usefully applied, that failing any such lamp they necessarily slumbered, but that, such a lamp having been now discovered, their character and value are apparent. That reply, to my mind, detracts largely from the force of the objection to which I have referred. As at present advised, I fail to see how Messrs. Gaulard and Gibbs made any discovery in the technical sense of the word, or, rather, what they published to the world which was not already disclosed by some one or more of the earlier specifications. As I do not propose to examine any of them in detail I will not mention more than one, which was not, I think, the one mostly relied on by the petitioner, and possibly is not the best example. I refer to the specification of Charles W. Harrison, of March 1, 1879. You cannot, it seems, take his description of the third part of his invention any more than you can take any other of the specifications and therefrom build a complete machine according to Messrs. Gaulard and Gibbs's patent—that is, some ingenuity would be required to supplement the directions given. But are not all the necessary directions given? Do they not all concern well-known tools capable of producing well-known effects, and are they not combined precisely as Messrs. Gaulard and Gibbs combine them? Mr. Aston's answer is that the secondary regenerator was employed to alter the tension, not by diminution, but by increase, not by stepping down, to adopt his favourite expression, but by stepping up. This may be true, but it was common knowledge that an induction coil might be used for alteration in either direction, and the application of it in one way instead of the other cannot be deemed invention. Again, Messrs. Gaulard and Gibbs's patent may have taught the electrical world for the first time that high-tension in the primary wire is essential to successful work—in other words, that they have discovered that the best, if not the only useful, mode of using the dynamo for electric lighting is by the creation of high tension. If so, they are entitled to credit for having first seen what other labourers in the same field have failed to see, but ascertaining the best use of a known tool does not fall within the proper definition of invention. The reasons which have prompted me to dispose of this case at once on the point on which I have come to a definite conclusion, and not further to consider those requiring further consideration if my judgment were to be rested on them, render it also unnecessary to deal with the question of utility, but on that I have formed a definite opinion, and it is better that I should express it. Having regard to the great and rapid advance made in this particular branch of science during the last few years, one would expect an invention of 1882 to have been ere this improved upon, if not superseded, and it is not surprising, nor is it any discredit to Messrs. Gaulard and Gibbs's ingenuity, to hear that arrangements on the parallel system are found to be far more effective than those on the series system adopted by the patentees. The evidence indicated, if it did not prove, that the latter would soon give way, if it has not already given way, to the former. On the other hand, I have sufficient evidence that the series system has been successful—not only tried but used and found to work with at least a large measure of success. If, therefore, I could hold the patent to be good on other ground I certainly should not hold it to be bad on the point of utility. For the reasons which I have given I am of opinion that what Messrs. Gaulard and Gibbs describe in their amended specification as their invention, and for which they claim a monopoly, is not the proper subject matter of a patent, that therefore the patent granted to them ought to be revoked, and I must make an order for revocation as asked by the petitioner. The respondents must pay the costs, to be taxed on the higher scale.

PHYSICAL SOCIETY.

At the meeting of this Society, held on the 23rd ult., the President (Prof. Reinhold) in the chair, Prof. S. P. Thompson read a note on

"Continuous Current Transformers."

The author pointed out that continuous-current transformers are of two types. The first of these is the motor-generator, which in its original form consisted simply of a motor driven by the supply current, mechanically geared with a generator producing the outgoing current, and this gradually developed into a single machine having two sets of armature windings on the same core, each set being furnished with a commutator and collecting brushes; one winding receiving the primary current, while the other produced the secondary current. To effect the transformation the armature may be allowed to rotate between the poles of a field-magnet, or the field-magnet and brushes may be made to rotate in the opposite direction while the armature remains fixed. The other type is the commuting transformer, which may consist of a doubly-wound armature, with commutators and collecting brushes as before; but in this case the polarity of a fixed field-magnet is rotated round the armature, which remains fixed. An external fixed ring of the Gramme or Pacinotti type, provided with a commutator, may be used for the method last given, the current being supplied through a pair of mechanically rotated brushes.

In the case of alternate-current transformers Clerk-Maxwell showed in 1867 that the effect of the mutual induction of the two circuits would be equivalent to adding to the resistance of the secondary circuit an apparent resistance equal to that of the primary multiplied by the square of k, the ratio of transformation of the E.M.F., and diminishing the coefficient of self-induction of the secondary circuit by a quantity equal to the coefficient of induction of the primary circuit multiplied by k^2. Where M is the coefficient of mutual induction, n the number of alternations per second, L_1 the coefficient of self-induction of the primary circuit, R_1 its resistance, Maxwell found that

$$k = \frac{2\pi n M}{\sqrt{4\pi^2 n^2 L_1^2 + R_1^2}}.$$

In a Paper read before the Society last year the author showed that in a well-constructed machine the ratio of transformation k is equal to the ratio of the number of secondary windings to the number of primary windings in the transformer.

The object of the present communication is to show that the mutual induction in the two circuits of continuous-current transformers produces effects of the same kind as in the case of alternate-current transformers.

Consider the case of a motor-generator with a doubly-wound armature rotating between the poles of a field-magnet, the magnetism of which is supposed to remain constant. Let C_1 and C_2 be the number of armature conductors on the primary and secondary circuits respectively. Let r_1 be the resistance of the coils of the primary winding, i_1 the current, and E_1 the induced E.M.F., and let r_2, i_2, E_2 be the corresponding quantities for the coils of the secondary winding. Let N be the number of lines of magnetic force passing through the armature, and let e_1 and e_2 be the potential differences at the terminals of the primary and secondary respectively.

Then we have
$$E_1 = n C_1 N 10^{-8},$$
$$E_2 = n C_2 N 10^{-8}.$$

So that
$$\frac{E_2}{E_1} = \frac{C_2}{C_1} = k,$$

independently of the speed and of the strength of field.

Again,
$$E_1 = e_1 - r_1 i_1$$
$$E_2 = e_2 - r_2 i_2.$$

Therefore,
$$e_2 = k e_1 - r_1 i_2 - k r_1 i_1.$$

The author then assumes that $E_1 i_1$, the work done in unit time by the primary current, is equal to $E_2 i_2$, the work done in unit time on the secondary current. This will be very nearly true in a well-constructed machine. This gives $i_1 = k i_2$, and therefore,

$$e_2 = k e_1 - (r_2 + k^2 r_1) i_2.$$

So that the internal resistance of the secondary circuit undergoes an apparent increase of amount equal to $k^2 r_1$.

If there are equal weights of copper in the primary and secondary windings $k^2 r_1 = r_2$, so that the internal resistance of the secondary circuit is apparently doubled.

The author recalled the well known fact that in an ordinary single-wound dynamo the effect of self-induction is an apparent increase in the resistance of the armature owing to the current in each section being stopped and re-started twice in every revolution.

In the double-wound transformers the effect of mutual induction will clearly tend to counteract the effects of self-induction if commutation occurs simultaneously in both the primary and secondary coils wound on the same portion of the core. In practice this neutralisation can never be made complete, but the almost complete absence of sparking in these machines shows that it must be very nearly realised.

If a continuous-current transformer be supplied with a constant potential difference at the terminals of the primary, it will be self-regulating, and give a constant potential difference at the terminals of the secondary, provided the internal resistance of the secondary winding is small, which affords another analogy with an alternating current-transformer. In the case of commuting transformers, precisely similar relations hold good as for motor-generators, as the mutual actions between the primary and secondary windings will be the same whether the common core be mechanically rotated, or the polarity of the field-magnet be electrically rotated.

Mr. KAPP said that the study of continuous-current transformers had been very much neglected, Prof. S. P. Thompson being the only scientist who had taken up the subject. This was doubtless due to their being more expensive to construct and less economical in use than alternate-current transformers. Transformers with two windings on the same armature had been made practically. Commuting transformers of an imperfect kind had been made by Edison.

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Motor-generators had the great advantage of not sparking, but on account of the necessity of having both the windings on the same armature the insulation was a matter of great difficulty. The surface was necessarily large, and the risk of contact was great, owing to the interlacing of the windings. There was, therefore, great temptation to leakage, and he would not, for example, attempt to transform down from 2,000 volts to 100 volts. There was also a mechanical strain between the windings, though this strain did not take effect on the shaft. There would thus be as much leakage as in a high-tension dynamo. Commuting transformers have the advantage that as there are only the two sets of brushes to rotate, a higher speed can be used than when the whole armature rotates. He considered that Prof. Thompson's plan would, however, lead to a great deal of sparking, and he thought that the commutators would be melted. This difficulty, however, could be overcome by taking advantage of the discovery of Prof. Galileo Ferraris that a rotation of the magnetic field of exactly the kind required could be produced by means of two coils at right angles carrying alternating currents. Mr. Nikola Tesla, in America, had made a practical machine to do the same thing.

Prof. THOMPSON did not think that the difficulty of insulation would be so serious as Mr. Kapp anticipated. He would not attempt to use a potential difference of 2,000 volts with an ordinary Gramme collector, but with the Brush pattern of commutator he did not think there would be any difficulty.

The Existence of an Undulatory Movement Accompanying the Electric Spark.

In the absence of the author, a Paper "On the Existence of an Undulatory Movement Accompanying the Electric Spark," by ERNEST H. COOK, D.Sc., was taken as read.

When sparks pass between two points placed above a plate on which some powdered substance has been scattered, the particles arrange themselves in circular lines, approximately concentric with the projection of the middle line joining the two points. The proximity of the lines is found to be very nearly constant for the same powder, independent of the intensity of the spark used, or the material of the plate. Different powders give different numbers of lines per inch, and mixtures, numbers between those corresponding to their constituents. A great number of substances have been tried, giving numbers between 40 and 88 per inch. These extreme numbers were obtained for chalk and silica respectively. The author has found no satisfactory hypothesis by which to explain the results. A number of photographs accompany the Paper, showing the character of the figures produced.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June 30th*, 1888.

A little while ago I took occasion to remark on the many advantages which attended the quick appreciation by the daily press of all electric novelties and developments. This marked attention to electrical matters is, however, not without its inconveniences, a fact of which we have had a striking exemplification during the past week, over in the outskirts of Brooklyn, on a Van Depoele electric road, about four miles long, operated by overhead conductors. On this road there happened to be riding during a thunderstorm a German matron, who, according to the testimony of one of her family friends, had spent the sultry afternoon in cooling herself with copious draughts of lager beer. As she was returning home a severe thunderstorm came up, accompanied by heavy rain. The road was once operated by horses, and as the track is still in execrable condition the trolley now and then jumps the wires, especially after the rain has washed out the support of the sleepers below. Thus it occurred that just after a very heavy peal of thunder one of the hangers overhead broke from the strain on it, and the trolley dropped to the roof of the car with a loud noise. The woman immediately became terribly frightened, and it took her some time to recover to any degree from the scare. As soon as she came to she declared that she had received a shock from the current operating the car, and that it had paralysed her. She was confirmed in her belief by a medical man, who, after diagnosing the case, declared that a ball of electricity had passed into her, and was still there! This really amusing incident has been filling columns of the papers for days, and some of the stories have been of the most ludicrous kind imaginable. Of course, it goes without saying that it was utterly impossible for the woman to have received any shock, but at the same time the publicity given to the incident, and the extraordinary yarns in which it is served up to the public make it somewhat difficult for electric railway men to show that after all theirs is the safest means of locomotion in the world. So far as I am aware, no accident of any kind whatever has happened to any of the millions of passengers on the thirty or forty electric roads now in operation, although I believe that in one case a southern mule was rendered *hors de combat*. However, I suppose that, like all new and good things, electric traction must fight its way against misrepresentation, springing as often from ignorance as from dishonesty.

New York has for some time been familiar with the idea of an underground road operated by electricity. A similar scheme has now been presented to the public in Chicago. There it is proposed to carry the road down a distance of 100 or 150ft. deep, and from a central terminus run tunnels in various directions, connecting the business portion of the city with its residential suburbs. This road it is proposed to light by electricity and operate by electric motor. It would be about 27 miles long, and cost about $27,000,000. The road itself would be reached from the surface by means of large passenger elevators, capable of holding 50 or 100 passengers. The depth to which it is proposed to carry the road may seem unusual and objectionable, but it is pointed out that the stratum at the depth of 100ft. is a desirable one of soft limestone, and that no rights of way would have to be purchased. Such a road would be cool in summer and warm in winter. While the passengers might not enjoy much of a view, the dwellers along its route would be saved the horrible noise and dust and steam which distinguish our much-vaunted elevated roads in New York.

Once more the subject of electrical executions is up for discussion, and it cannot be said that the latest developments are very encouraging. It appears that an application was made to Mr. Edison for advice as to the best manner of carrying out the provisions of the law, and that certain experiments were undertaken at the Orange Laboratory by Mr. Batchelor and Mr. Kennelly, with the object of ascertaining as far as possible what was the effect on animal organisms of a strong shock sharply administered. A dog was utilised as a victim, and was placed in the circuit of an alternating machine, giving a potential somewhere in the neighbourhood of 2,000 volts. The dog did not realise his grave position, but the moment the circuit was closed he fell as dead as a doornail. The actual time of execution was two seconds. A notable incident was the flowing of blood from the ears of the dog; and another feature that struck many of the observers was the extreme difficulty of keeping the dog in attitude to receive the shock. Although the experimenters were as humane as the case allowed, the results were altogether such as to dissuade one from the advocacy of such electrical executions with human beings. At the same time it does not follow that the execution of human beings need be so horrible in its attendant circumstances. Mr. Edison suggested last week that it would be enough to manacle the criminal in handcuffs attached to the respective poles of the dynamo, preferably an alternating machine. Mr. Kennelly was pretty much of the same opinion, believing that it would be rather hard to accomplish the intended results very speedily or effectively with the proposed electrical chair.

The hunt after the dead wires in this city has begun in good earnest, although I think that during this hot weather the Subway Board might have allowed us to bask in their shade for a little longer. The point of attack seems to be the tangle of wires representing old and defunct messenger systems, covering the city from one end to the other. These wires roam in every direction, touching countless housetops, and find their way into hundreds of stores and residences, and the conditions under which they become dangerous to life and property may be conceived. Every now and then a new tenant coming into a house goes up on the roof and finds them cumbering it, and at once throws them into the street, probably

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across electric light wires running below. Here, again, they become a nuisance, till some one at last twists them around the nearest pole; even there they are capable of great mischief, and the only proper thing to do is to clear them out completely.

An interesting little work on municipal lighting has just been issued by Mr. F. H. Whipple, of Detroit, Mich. Mr. Whipple was employed to look into the subject by a special committee of the Detroit Common Council, appointed to examine and report on the feasibility of owning and operating its own electric lighting plant. Mr. Whipple gathered a large amount of information, which was not only laid before the council, but has now been utilised in the work spoken of. The section which deals with the question of the city owning its own plant embraces a large number of examples in which it has been found economical to adopt that course. Thus at Bay City, Mich., allowing for cost of depreciation, it is reported that the city is running 120 arc lights for $6,870 a year from its own plant, while the cost for running gas lights would be nearly $2,000 more. At Lewiston, Maine, the city is operating a plant of 100 lights by water power, and finds that its lights burning all night cost only 15 cents a piece, all charges included. At Hannibal, Mo., the city operates a plant for commercial as well as for street purposes, and in this way gets 52 lights all night long at a total cost per annum to the city of only $2,063. At Paris, Ill., the city plant has been in operation since September, 1885. At Madison, Ind., according to the report of the city clerk, five square miles are lighted by 81 arc lights on mast arms at street intersections. The lights burn all night and every night of the year. The total cost to the city is $4,500 a year. Previous to the adoption of electricity, gas was used with much poorer results, at a cost of $8,000. In a similar manner might be quoted the testimony of Topeka, Kan.; Champaign, Ill.; Huntington, Ind.; Decatur, Ill.; Aurora, Ill.; Portsmouth, O.; Little Rock, Ark.; Sherman, Tex.; and many other places, all of which are getting the utmost satisfaction out of their plant. Such evidence is very significant, and the enthusiastic way in which the City authorities, none of whom are interested in electrical affairs, speak of their electric lights settles the question as to the superiority of the illuminant. I should think that in many places in England where there is yet little hope of starting a company for general commercial business some of your manufacturers of arc apparatus might at least gain a foothold by inducing the City authorities to buy plant for street lighting. The results here are indisputable, and the number of cities owning plants of their own in this country is destined to grow rapidly. The book, I might add, contains also a number of statistics as to the rates paid by the towns and cities running their electric lights on contract. It also contains a large section on the subject of underground wires, showing what has been attempted or proposed by various cities in this matter.

NOTES FROM BERLIN.

(FROM OUR OWN CORRESPONDENT.)

July 11*th*, 1888.

The Allgemeine Elektricitäts Gesellschaft, which has undertaken the lighting of Unter den Linden and the Pariser Platz, commenced the preliminary work some weeks ago. The lead-covered cables are run underground in narrow channels under the pavement at a depth of 18in. The supports for the lamps are 418m. apart, and consist of handsome tapering wrought-iron tubes. Some of the lamps are suspended across the centre roadway on chains.

At the last meeting of the Association of German Electricians, Dr. Rühlmann, of Chemnitz, read a Paper upon the points which determine the particular system that should be adopted on starting a central station. Taking an ideal circular district of 750mm. radius, with a maximum of 10,000 incandescent lamps, Dr. Rühlmann came to the conclusion that the prime cost and annual working expenses were much the same for the different systems in vogue. In compact districts the three-wire system gave the best results, and for dispersed areas the transformer system was the most advantageous.

Dr. Rühlmann also drew attention to the very different conditions under which central stations were worked in Germany and in America. In the States profit alone was thought of; in Germany the public welfare was paramount, no installation being countenanced which had not sufficient chance of success to justify the granting of way-leaves and the possible dangers to life. On the whole, a continuous-current system was the best, since it allowed the station plant to be fully utilised during the day, supplying motive-power and charging batteries, &c. A good meter was an absolute necessity, and each consumer should be independent of the others. A great point was not to charge more for the light than its superiority over other illuminants warranted. In order to do this and yet make the station pay required very careful working and a correct estimate of the maximum number of lamps which might have at any time to be simultaneously supplied. In England and America this maximum was usually taken at about 65 per cent. of the total number of lamps wired. Diagrams taken from the actual working of the two Berlin central stations gave this maximum as 81 per cent. in December, and 16 per cent. in July. Authentic diagrams showing the fluctuations in demand during the day were difficult to obtain. The one obtained from the Markgrafenstrasse Station, and which was in close accordance with the one from Mr. Crompton's station in London, gave the daily average consumption of current at 15·2 per cent. of the possible maximum. This meant an average daily duration of illumination of 3·6 hours or 1,314 hours per annum. Siemens and Halske estimated this figure at 2·5 hours per day, or × 912 hours per annum; Ganz and Co. estimated it at 800 hours per annum.

NOTES FROM PARIS.

(FROM OUR CORRESPONDENT.)

10*th July*, 1888.

In a few days a part of the city of Montpellier will be exclusively lighted by electricity. Before the end of the year the light will be extended to the remaining streets. The present installation consists of forty 2,000 candle-power Thomson-Houston arc lights and 2,000 incandescent lamps. The new theatre, which is to be lit by 1,400 incandescent lamps, fed by a battery of accumulators, will be opened on the 1st September. The plant is being erected by the Victor Popp Company, under the management of Mr. L. Naze, who has already fitted up the Central Station at Tours.

It is said that two applications relating to the installation of central stations for electric lighting in Paris have recently been handed to the Conseil Municipal, but up to now neither the names of the companies nor the quarter they intend to light have been communicated to the public.

The French representative of the Khotinsky Company, from Rotterdam, has entered into a contract with the Rheims Gas Company for fitting up a small central station of 1,200 incandescent lamps, supplied with Khotinsky accumulators. The dynamos will be driven by gas engines. The plant is to be ready for the 1st September next. It will be the first station erected in France on this system, which is said to give satisfaction at the station which this company has fitted up in Berlin.

The lift which will take passengers from the second platform of the Eiffel Tower up to the top will be worked by electricity; the system has been designed by M. Backman.

I hear a good many rumours about a new accumulator introduced by the Société du Travail Electrique des Métaux (the Rothschild Company). This accumulator, known under the name of its inventor, Laurent Cély, is made with melted chloride of lead, reduced by zinc in a solution of sulphuric acid. The inventor says that metallic lead prepared by this process has a density of only 5, and that the plates may be peroxidised without altering their surface.

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The military papers of last week make some extraordinary statements with regard to a new microphonic apparatus invented by a lieutenant of the Territorial Army.

This apparatus, contained in a wooden box, is placed two or three feet deep in the ground on the roads which surround forts or camps, and is connected by wires underground with the interior of the fort or camps. By this means the passage of troops, hostile or friendly, is at once made known. According to the statements published, it is also possible to form a very good idea of the strength and the composition of the approaching force. During the experiments made with this apparatus at the manœuvres of the 17th French Corps d'Armée, it is said that the passage of the infantry, cavalry, or artillery was clearly distinguished. It was even possible to estimate the number of men in each corps so approximately that in a body of 5,000 men the error was only 300.

These results are very encouraging, and as the apparatus is probably nothing more than an ordinary microphone, and is therefore neither costly nor liable to get out of order, it is intended to experiment on a large scale.

At the banquet to be given to the Maires de France on the 14th July on the Champs de Mars the electric light will be employed. The current will be furnished from the works of Messrs. Sauter and Lemonnier, Avenue de Suffren, which is adjacent to the Exhibition.

NOTES FROM BRUSSELS.

(FROM OUR CORRESPONDENT.)

THE ELECTRIC LIGHTING OF THE EXHIBITION.

As I have already informed you, the electric lighting of the Exhibition has been subject to many delays and difficulties. In addition to the questions of general administration there were heartburnings among the contractors, and even now some of them are complaining in the papers of the favours shown by the authorities to certain foreign firms. Moreover, the first trials that took place after the opening of the Exhibition left much to be desired; and it is only within the last fortnight that better results have been attained. The technical staff made a great effort, and their work has at length been crowned with success. The lighting is divided into two distinct portions, the lighting of the building and the lighting of the grounds. The first leaves nothing to be desired, and is a very interesting installation from the point of view of economy of light. The machinery annexe, for instance, which has a superficial area of 15,000 square inches, is quite sufficiently well lighted by 68 10-ampere arc lamps; that is to say, by one arc to every 230 square metres, which is, I think, a most economical result. Another point well worthy of notice is the artistic effect of the arc lights, placed high up in the dome. The gardens are lit by arc lamps placed about 15 metres apart on masts. The installation, taken as a whole, is running well, and gives one a good impression. It is to be hoped that there will now be no further difficulties I will conclude with a query—Why has the committee mingled the sacred with the profane, and in some cases called in gas to the aid of electricity? The technical staff, composed of experts convinced of the value of the electric light, are not responsible for a measure so completely unnecessary in the present state of electrical knowledge.

CORRESPONDENCE.

WORKING ALTERNATORS IN PARALLEL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As the problem of parallel running of alternate-current dynamos on the same circuit has been for some time the object of discussion at various meetings, as well as the cause of some controversies in the papers, I think it will be of some interest for your readers to learn that the above-mentioned mode of operation is no more a problem, but an industrially-accomplished fact. At the central station in Rome I have run in parallel two alternate-current dynamos of 2,000 volts and 45 amperes each, which are separately driven at 250 revolutions by two 150 horse-power steam engines. Also two other generators for 2,000 volts and 160 amperes each, independently driven by two 600 horse-power compound steam engines at 125 revolutions. Due precautions and some care were sufficient to assure a constant uniform tension and light, no "jumping" or other irregularities taking place. Public and private lights were for whole nights supplied from the dynamos in parallel; this would not have been attempted if parallel running of alternate-current dynamos was still in the experimental state. Parallel running of alternate-current generators driven by belting from a common shaft has been done more than two years ago, and offers no points of special interest.—Yours, &c.,

OTTO T. BLÁTHY.

Rome, July 3, 1888.

[We should be glad if M. Bláthy could give further details as to the way in which the arrangements are carried out.—ED. *E.*]

THE CONDITIONS OF REGULATION IN DYNAMOS FOR CONSTANT POTENTIAL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Fricker, in referring to my article on the above subject, expresses his opinion that, due to the meagre dimensions of the field-magnets, the discrepancy with which the article mainly dealt was very much exaggerated.

The machine, of the single-magnet type, with cast-iron magnets, was stated to have a magnet cross section of 62 square inches, and an armature cross section of 22 square inches, the latter giving the *two sides of the core added*, each half having an area of 11 square inches. Mr. Fricker thinks I refer to one-half of the ring only in my article, he taking 44 instead of 22 as the total core section. The misconception is due to my having added both sides to give the section, a practice usual in describing single-magnet machines, in order that the respective inductions may be comparable at a glance. The induction in the armature, instead of being 8,630, as given by your correspondent, is 17,260, or in Kapp's notation 18·7 lines per inch. The ratio of the sections of armature and field cores is 1 : 2·82 instead of 1 : 1·41, a proportion which Mr. Fricker will doubtless acknowledge as suitable for the type of machine described.

I quite agree with Mr. Fricker that self-induction may be rendered innocuous by saturating the armature core, but with the armature so saturated the necessity for extra excitement from the series coils, due to self-induction, is practically negligible. To prove this, one has simply to run the machine with no lead, when it will be found that to produce the same E.M.F. in the armature practically the same excitement is required for full load as for no load. In the machine described no difference in the excitement was noticeable, and though for the sake of scientific accuracy self-induction was mentioned as one of the factors producing the discrepancy its influence as compared with other influences necessitating waste excitement may be neglected. The extra excitement is required simply because a lead has to be given to the brushes.

Mr. Fricker having been misled as to dimensions his criticism necessarily loses much of its force; but in case he may, in common with other readers, consider as anomalous the results obtained, I am able, thanks to the courteous manner in which my friends have tendered the information at their disposal, to compare my results with those obtained by other experimenters.

Drs. J. and E. Hopkinson have probably done more towards establishing a complete theory of the reactions of the armature than have any other workers, and the latter reminds me that the term $\frac{m\lambda}{v\pi}$ * has a greater magnitude in ring than in drum armatures. To compensate this is one of the chief objects of the compound winding, and for perfect regulation in the Manchester machine the number of ampere-turns added by the series coil is speaking generally equal to the number of ampere-turns furnished by the shunt. Mr. Kapp informs me that he generally allows 5 per cent. excess excite-

* "Dynamo-Electric Machinery," by J. Hopkinson, M.A., D.Sc., F.R.S., and E. Hopkinson, M.A., D.Sc., *Phil. Trans.*, Part I., 1886, p. 346. Also reprint in *The Electrician*, Vol. XVIII., p. 64, 1886.

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ment to compensate the armature reactions. Thus, if v be the difference of potentials required at the dynamo terminals and V the loss in volts due to the dead resistance of the armature and series coils the excitement at full load must be such as would produce on open circuit an E.M.F. of $(v + V + 5)$. In the Phœnix machine the excitement required for full load was such as to produce 111 volts on open circuit, and calling S_2 the series turns actually put on the machine, S_1 being the turns inductively useful, we have the ratio $\frac{S_2}{S_1} = 2{\cdot}16$. The ratio in the Kapp dynamo is about the same. Mr. Swinburne finds the ratio $\frac{S_2}{S_1} = 2$ generally applicable, and a good average value for Gramme-wound machines. In very large machines, however, the value of $\frac{S_2}{S_1}$ may become $= 3$. Mr. R. P. Sellon instances a 9,000-Watt Victoria dynamo in which the ratio reaches the high value of 4·15, and assures me that this is representative of any medium-sized Victoria machine.

The figures here given represent the best dynamo practice, and show that the series turns must be from two to four times those given by Prof. Thompson's amended formula. Whether a knowledge of these values will induce Mr. Fricker to be still more mercifully disposed towards that formula I cannot say, but as regards myself, I confess the figures have had a hardening rather than mollifying influence.—Yours, &c.,

W. B. Esson.

DELANY'S KEY ANTICIPATED.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your number for the week ending the 29th June you mention as a novelty a key constructed by Mr. Delany for working submarine cables by means of alternate currents of equal duration.

This apparatus was anticipated by a similar key for the same purpose which was invented by Sir Charles Wheatstone or Mr. Stroh and successfully tried between London and Amsterdam 20 years ago.

It was observed in working from that form of Wheatstone's apparatus, which transmitted signals like those from an ordinary reverse-current key, that the signals were more liable to delay and distortion from electrostatic induction than those which resembled the signals from the original form of hand-worked magneto transmitter, in which each dot and dash of the Morse alphabet were produced by two short discharges in opposite directions separated by intervals of time which differed with the length of signal required.

The receiving apparatus was adjusted to remain as deflected by the last discharge.

The contact-maker in the key of Sir C. Wheatstone was controlled by a spring in such a way that after having been tilted in either direction by the motion of the key, it continued to move in the last direction until the contact was broken, and the length of the signal transmitted was determined by a fan geared with the contact-maker, which restrained the speed of motion of the contact-maker as required. Thus on depressing the key a marking current of short duration and upon raising it a spacing current of similar length would be transmitted to line.—Yours, &c.,

F. Higgins.

July 9th, 1888.

MAXWELL'S THEORY OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your last issue Prof. Lodge points out that the representation which I gave of Maxwell's theory of the magnetic field in Fig. 17 of my fourth article was not taken from Maxwell's Paper, and as it is similar to one of his own given in the Paper in *Nature* to which I subsequently referred, he assumes that it was taken from it. When writing the Paper I had not the opportunity of referring to Maxwell's original Paper, which I read some ten years ago, and only had before me the summary in his "Electricity and Magnetism," Vol. II., page 427 (2nd edition), and a German abstract. In Maxwell's summary he merely states that he supposes some connecting mechanism between the electric whirls, and points out that its determination necessarily admits of an infinite number of solutions. In the original Paper the special solution assumed is that each electric whirl is surrounded by a number of small connecting particles, or idle wheels, and if I had remembered this I should have drawn attention to the much greater simplicity of Prof. Lodge's representation. I had been accustomed to represent Maxwell's theory to myself by the diagram given in my Paper, which appears to represent the simplest form of connecting mechanism which can be imagined, and, therefore, when I read Prof. Lodge's Papers, the only point which struck me as novel in this particular case was his suggestion that alternate whirls might consist of positive and negative electricity respectively.—Yours, &c.,

G. W. de Tunzelmann.

UNIPOLAR INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am obliged to Mr. De Tunzelmann for the explanation given. What really misled me was the application of Faraday's law as expressed in italics, paragraph 6, page 203. "Passing through the circuit" does not appear to me to sufficiently define the action of cutting the conductor only once, either on entering or leaving, and "rate of decrease in the number of lines, &c.," would seem to imply a decrease in the number during any given interval of time, as compared with another; whereas we know that in unipolar or symmetrical induction effective E.M.F. may be produced, though the rate remain constant, or, what is the same thing, though the number of lines passing as above through a circuit moving with uniform speed be the same for each revolution.—Yours, &c.,

N. G. Thompson.

4, Queen Victoria-street, July 11th, 1888.

FINSBURY TECHNICAL COLLEGE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am anxious to place on record my grateful sentiments towards the Principal of the Finsbury Technical College and those of his staff from whom I received instruction during the last two years.

Being a stranger in a strange land when I entered the college two years ago, I can with pleasurable feelings assert that the unvarying kindness of Dr. Thompson has been of the greatest value to me, inasmuch as it has acted as a stimulus in the pursuit of my studies. It would be invidious to single out any individual name among the gentlemen of the staff whose instruction I enjoyed, for they have, one and all, been most painstaking teachers. I beg them to accept this public acknowledgment of my thanks, with the assurance that none can be more sincere.

I hope, Mr. Editor, you will kindly accord me space for the purpose of giving expression to my feelings; and in anticipation of your compliance I also ask you to receive my thanks.—Yours, &c.,

Herman Koerner.

Finsbury Technical College, Leonard-street, E.C.,
July 9th, 1888.

UNITED TELEPHONE COMPANY v. EQUITABLE TELEPHONE ASSOCIATION (LIMITED).

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Having been under the impression that it was a gross impropriety to express an opinion on the merits of a case *sub judice*, we have hitherto, as far as possible, studiously refrained from dealing in a public manner with the persistent efforts made on behalf of the United Telephone Company to damage our interests in the eyes of the public, as well as of their own shareholders, and to try and intimidate those to whom we have supplied instruments. But as the chairman of the United Telephone Company has not hesitated to make

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public through his speech on the 3rd inst., as reported in your issue of 6th inst., a legal opinion on the probable result (from his company's point of view) of the action now pending between the United Company and ourselves, we think we need no longer hesitate to say that we have as much confidence in the result being in our favour as the United Company's solicitor professes to have on his side, and that we have the opinion of counsel, if not quite so eminent, at any rate as painstaking as the Attorney-General, that our instruments are not infringements of the United Company's patents. As regards our Association fighting the case out, the solicitor of the United Company may certainly be complimented on his sagacity in this respect.—Yours, &c.,

A. A. C. SWINTON, Director,

The Equitable Telephone Association (Limited.)
75, Queen Victoria-street, London, E.C., July 11th, 1888.

ANOTHER ELECTROPATHIC FRAUD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Would you kindly give your readers the benefit of your experience with regard to the enclosed advertisement? Would socks of this description have the desired effect?—Yours, &c., MAGNET.

Glasgow, 4th July, 1888.

[The advertisement enclosed by our correspondent relates to some "electric socks," which are guaranteed to cure all the ills that flesh is heir to. We are happy to say that we have never had, and trust that we never shall have, any "experience" of this or any other electro-medical quackery. We have, however, no hesitation in denouncing the thing as a fraud of the customary description.—ED. *E.*]

REVIEWS.

Sur l'Emploi de l'Electricite pour la Transmission du Travail a Distance (On the Use of Electricity for the Transmission of Power to a Distance). By J. BOULANGER, Captain of Engineers. (Paris: Gauthier Villars.) 134 pp.

This is a small work, in three chapters, devoted respectively to "The Theory of the Transmission of Power to a Distance," "The History of Electromotors and of the Transmission of Power," and "An Account of the Experiments carried out by Marcel Deprez at Creil."

The introductory general exposition is clear enough, as far as it goes, but brief and incomplete. The statement that Marcel Deprez was the first to show that for economical transmission of power currents of high E.M.F. and small quantity should be used is unfortunately by no means a new one in French books. M. Deprez was the first to show the practicability of the electrical transmission of power on a large scale, and it is a pity that French writers persist in discounting the merit really due to him on this account by the absurdity of crediting him with the discovery of what is simply an immediate consequence of Ohm's law, in conjunction with Joule's law, of the development of heat in an electric circuit.

The "History of Electromotors" consists, with only one or two exceptions, of a history of French electromotors.

Continuous versus Alternate Currents for Measuring the Resistance of Electrolytes.—In a recent number of *Wiedemann's Annalen* S. Sheldon describes a series of experiments made with solutions of potassium chloride, sodium chloride, potassium sulphate, and magnesium sulphate of nine different degrees of concentration, in order to obtain a comparative test of the advantages of the continuous and alternate-current methods respectively. The author found that both methods gave closely concordant results, and his conclusion is that they are both equally accurate and reliable when properly carried out; but he decides in favour of the alternate-current method on the ground of its greater simplicity and convenience.

LEGAL INTELLIGENCE.

The United Telephone Company v. Tasker Sons and Co.

On Friday week last, in the Chancery Division of the High Court of Justice, before Mr. Justice Kay, Mr. Aston, Q.C., on behalf of the plaintiff company, moved to vary the minutes of an order made by his lordship when granting an injunction in the action on a former occasion. Mr. Aston stated that when before the Court on a former occasion the motion was for an interim injunction to restrain the defendants, Tasker, Sons and Co. from using at Sheffield certain telephones which his lordship held were infringements of the plaintiffs' rights. The ground of defence set up was this, that the defendants bought a lot of instruments, and that when they were worn out they replaced them with others, and in respect of the replaced ones the Court held the defendants were not entitled to use them. The defendants at that time represented to the Court there were 52 of these instruments, and an order was therefore made, on the plaintiffs undertaking to supply telephones to replace those wrongfully used, that the defendants should be restrained from infringing plaintiffs' rights. The plaintiffs were prepared to act upon that undertaking, but it now turned out, according to a correspondence that had taken place, that the defendants gave a wrong number, and required 44 instruments over and above the 52 they previously mentioned. Depending upon the defendants' original statement as to the number, the order had been drawn up in too general terms, and the application to-day was to have the minutes varied to the extent of limiting the number of instruments to 52.

Mr. JUSTICE KAY said the order made appeared to be quite right, and he should certainly not alter it, though he would allow the motion to be taken as one to be relieved from their undertaking. In his order he made no limit; he merely restrained defendants from using any instruments that were a contravention of the plaintiffs' rights.

Mr. ASTON: In that case, if they were using 1,000, we should have to supply that number.

Mr. JUSTICE KAY: Yes, that is my order: but you may treat this as a motion to be relieved from your undertaking, on the ground that there was a misstatement in the number.

Mr. ASTON said that if he went into the evidence he could show that not only was there a difference in the number, but a difference in the class of instrument. The learned counsel then read the correspondence that had taken place between the parties since the injunction was granted, after which

Mr. JUSTICE KAY asked why the defendants should not be allowed the use of the extra 44 instruments until the trial.

Mr. ASTON replied that it was contrary to the principles on which the plaintiffs' firm was being conducted.

Mr. JUSTICE KAY: You have got to consider now the principles on which the business of this Court is conducted.

Mr. ASTON: Quite so; and we now ask to be relieved from the undertaking.

Mr. JUSTICE KAY: If I relieve you from the undertaking I shall discharge the injunction.

Mr. ASTON: That is a very heavy penalty.

Mr. JUSTICE KAY: I am not going to allow you to put a stop to their business by refusing to supply them with your patent articles on the usual terms. All I ask you to do is to supply them on the usual terms till the trial of the action.

Mr. ASTON said the plaintiffs were prepared to give the defendants the 52, but would not have them extend their business; therefore the plaintiffs could not undertake to supply the extra 44.

Mr. JUSTICE KAY: If you ask to be relieved of the undertaking, I must relieve the other side of the injunction.

Mr. ASTON: I must accept your lordship's decision to relieve us of the undertaking.

Mr. JUSTICE KAY, in delivering judgment, said: In this case an order was made upon a motion which came on before me the other day, granting an injunction restraining the defendants, who are in possession of a business of an electric telephone agency, from using in that agency any receivers which were infringements of the plaintiffs' patent. There are questions raised which have to be tried at the trial of the action as to the validity of the patent, and so on. The injunction sought for is to restrain the use in the meantime, and it seemed to me fitting that under all the circumstances the use should be restrained in the meantime, which is an order the Court only makes in exceptional cases. Then it was suggested that the object was really a collateral object, that the plaintiffs were themselves setting up a similar agency in Sheffield, and that the real object of the motion was to destroy the business of the defendants, in order to encourage the plaintiffs' own business in that town. Under those circumstances I suggested to the plaintiffs, as a test of their good faith in the matter, that it would be proper that they should upon the granting of any such injunction enter into an undertaking that they would supply on their usual terms—the minutes are very accurate indeed as to that—that they would supply to the defendants, until judgment in this action or further order, on the usual terms as to costs or otherwise, by way of hire, sale, or loan, or letting at their pleasure, so many instruments as shall be sufficient to supply the telephones now in use, which this order will prevent the defendants from using. It seemed to me under all the circumstances that would have been a very fair order, because it is impossible to see how it can harm the plaintiffs in any way unless it interferes with the rival business which they are setting up, and was one

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they ought to accede to, and they did accede to. The injunction accordingly went, and the order was made in the largest terms "to restrain the defendants until judgment or further order from making, using, or selling, or otherwise disposing of, any telephones which are an infringement of the plaintiffs' patent in the writ of summons mentioned." It is in the largest possible terms, restraining any kind of infringement, and of course the undertaking applied to every instrument the use of which is at the time thereby restrained Then this contest is raised before me. Well, but we are not going to supply them with instruments to extend their business. Certainly not; it is the instruments *now in use*, the instruments they are now using, and which this injunction would prevent them from using. Upon that I think the order is quite explicit, sufficient to supply the place of the telephones now in use. The order is very carefully worded. There was evidence at that time that there were 52 of these instruments in use which this order would prevent their using. A correspondence has now been read which has taken place since this order was made, in which the defendants say they have discovered there are other instruments to which the order would apply. Then they ask them to supply 96—that is the 52 plus 44. Then there is a further correspondence, saying that these instruments were supplied upon a guarantee that they were royalty-paid instruments, but since that the defendants have reason to believe, and have ascertained, that that is not so. I have no evidence before me showing that in the least degree that is an untrue statement. There is nothing to suggest that in making that statement they have discovered since the hearing of the motion there has been any bad faith on the part of the defendants. Now, if the plaintiffs are acting in good faith, I cannot conceive any reason why they should not continue that undertaking. If the purpose of this motion is not to destroy a rival business there is no reason why they should not continue that undertaking. The undertaking as to the 52 was given; that shows there is nothing in the world to prevent their giving it as to the 96. And why the undertaking should not continue as to the 44 extra which the defendants are by that order prevented from using I cannot understand, nor has any reason at the bar been suggested; therefore I come to the conclusion—and it is the only conclusion to which I can come—that this is a device on the part of the plaintiffs to destroy *brevi manu* before the trial of that action a rival business. That I shall not allow. Accordingly, if the plaintiffs now insist upon the right to withdraw from their undertaking it can only be upon the terms that the injunction from this moment is discharged, or that the operation of it is suspended; therefore, I give the plaintiffs the choice. If the plaintiffs choose to withdraw from the undertaking, and not to extend it, not to allow it to include, as in terms it does, these 44 instruments which the defendants now contend are within the same category as to the question of infringement as the 52 mentioned at the hearing of the motion, if they now insist that their undertaking shall not extend to them, then I say the condition upon which this injunction was granted fails, and I refuse to continue the injunction. The matter is entirely for them. I leave it to them. The order which I now make is that if the plaintiffs insist on withdrawing from their undertaking, it can only be on the terms that the injunction is no longer enforced. This motion is brought on quite irregularly—it is a motion to vary the minutes of the order. That motion can only be entertained when the minutes of the order do not correctly express the order the Court made, and there is no ground for saying these minutes do not correctly represent the order the Court made. They are exactly the order the Court made. I am quite satisfied the plaintiffs would be the last persons to be satisfied with the statements that only 52 instruments were an infringement. They sought the injunction in the largest terms, to prevent the infringement of *any*—not of 52—and the injunction was granted, in those terms, to prevent the use of any instruments which were an infringement of the plaintiffs' patent; and it was part of the order that that injunction should only be granted upon their giving that undertaking. Therefore, the motion in the form in which it was was quite irregular; but I have allowed it to be made as a motion to ask the leave of the Court to withdraw from the undertaking that was given, and I grant that leave upon the terms I have stated.

COMPANIES' MEETINGS & REPORTS.

United River Plate Telephone Company.

The second annual ordinary general meeting of this Company was held yesterday (Thursday) at Winchester House, 50, Old Broad-street, under the presidency of the Right Hon. Lord Thurlow.

The SECRETARY (Mr. J. Owen Unwin) read the notice convening the meeting, and the report of the Directors (which was given in our last issue) was taken as read.

The CHAIRMAN: It gives us all very great pleasure to have this opportunity of meeting the body of shareholders again, and it affords us additional gratification to be able to meet you under what I think you must admit to be very satisfactory conditions. You will remember that when we last met neither the Board nor the shareholders themselves could be considered to be quite free from anxiety as to the present or the future. At that time, however, I ventured to express the opinion that the difficulties we were then beset with were of that transient character that might fairly be looked for as one of the necessary and inevitable results of the amalgamation of two hitherto rival companies. Well, gentlemen, I think that what has happened since, happily, has proved the correctness of that forecast, and that, so far at any rate the statements that were made at our last meeting have been fully justified and substantiated. I also expressed at that meeting, if you remember—and I think it was fully shared in by the shareholders—a general feeling of confidence in the ability of Mr. Fels, with the assistance of Mr. Krabbe, to carry us through the difficulties of the amalgamation. That view has also been satisfactorily borne out, and I think you will be glad that I should take this opportunity of bearing some testimony to the ability, the zeal, the energy, and the success which have attended Mr. Fels's administration. You must remember that his position has never been an easy one during these sixteen months, and it is a source of satisfaction to us in these circumstances to reflect that, at any rate, the arrival at Buenos Ayres of the European mails has never added to or tended in any way to increase his anxieties; on the contrary, we never failed to express our confidence in him, and to give him every encouragement in our power and the promise of further assistance if he required it. I think you will all admit that if we had adopted a different course, and had taken any step to restrict his powers at that time, we might have greatly prejudiced your interests. Perhaps I need not say anything more about that, especially as I know that several, if not most of the gentlemen present, and a large body of our shareholders, are intimately acquainted with the difficulties of telephone management generally, and above all of telephone amalgamation. I am bound to say that I think what has been done has been accomplished with a minimum of friction. I do not intend to prophesy or endeavour to forecast at all what may happen in the future, but I will say this much—that I believe that a vigorous and generous policy, such as we have pursued up to the present, of insisting on giving our customers the best service in our power, placing the best instruments in their houses that money will procure, and paying every attention to details, in order to secure the utmost efficiency, will succeed, as it deserves to succeed, in such a business-like community as that we have to deal with in the Argentine Republic. I also think you will agree with me, that while we should exercise, as we have exercised, a due regard to economy in management, still, as occasion may require, it is not our duty to shrink sometimes from what may appear heavy expenditure in order to attain the important result of satisfying our customers. In telephone administration it is true, as it is in most things, that nothing succeeds like success. The greater the number of your subscribers undoubtedly the firmer the hold you have over them, and in my humble opinion it is only by completing the network of that web which we are now spinning in those far-distant lands that we can successfully control and arrive at a position to enable us at all times to defy opposition and any rival schemes. That would be true in any country where the telephone exists; but you must remember that we are dealing with a country where the telephone is an essential part of the daily life of the population, and where the instrument is, as near as may be, exactly ten times as much used as it is in this country. We, therefore, feel sure that it is absolutely necessary to satisfy that large body of the public, and that if you do not succeed in satisfying them to the maximum in a country where no patent rights exist and no exclusive rights can be obtained, undoubtedly opposition and rival schemes will be set forth, and you will have to come to terms. With reference to the development of our business, you were informed before that we have established an exchange at La Plata, we have established a small exchange at Corrientes, and we have entered into a provisional contract for acquiring a very important rival exchange at Rosario. Now, Rosario is no common place; it is remarkable for the energy of its people, for the financial success of all its undertakings, for its rapid increase of population and wealth, and for the general spirit of enterprise which prevails in that city, even to a greater extent than in other parts of that prosperous and go-ahead community of the River Plate. I do not desire to-day to enter into the particulars of that provisional agreement; there are reasons, indeed, why I am unable to do so, but I will say this much, that you may rely upon it that the conditions of that agreement in themselves are of a highly favourable character to the shareholders of this Company. In addition to that it is difficult to exaggerate, in my opinion, the extent to which this purchase will consolidate our position throughout the whole country, will conciliate important interests and increase our hold over the goodwill of the public. It is not necessary for me to trouble you now with any elaborate details as to our large capital expenditure during the past sixteen months. It has undoubtedly been heavy and exceptional, and I shall be happy to reply to any question respecting it as to which I can give an answer without jeopardising any of the interests entrusted to our care. But for the information of the uninitiated it may be interesting that I should state one figure which may appear perhaps somewhat large to those who do not understand the business. I want to say that we have recently erected at Buenos Ayres what is well known to all telephone managers as a multiple switch-board. That multiple switch-board was designed and contrived by some of the most competent experts in the world. It was erected by some of the most competent men sent out to the River Plate for that purpose. It is a very delicate and expensive instrument, and I believe that this newly erected multiple switch-board at Buenos Ayres will favourably compare with anything of the kind that has been erected anywhere. The total cost of that, including erection and other attendant charges, is as near as may be £10,000. Now, comparisons are sometimes useful, and it may be interesting to you to know that so far from that being an unduly high figure, I have recently ascertained that the multiple switch-board erected in New York cost over £50,000. When one is dealing with items of that sort it enables you to form some opinion as to whether our capital expenditure during the last 16 months is very far out of the way or not. I am bound to say, considering what we had to do in connection with the amalgamation of the two systems, that I do not think our capital expenditure can be considered as anything extravagant, though I am free to admit that it is unusual and not at all likely to

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recur. Of course, with the extension of our system further capital will be required from time to time, but not in the same ratio or to the same extent as during the past sixteen months. As regards our profits and the proposed appropriation of them, I think, considering all things, that the figures representing our trading profits during the last sixteen months cannot be held to be other than satisfactory, especially if you consider that we have had to write off a sum of £10,776 for loss by exchange. Then we have also been able to put a considerable sum to what is practically a reserve, and we have been enabled to do an unusual thing, which is to write off the whole of the preliminary expenses of the formation of the Company, both in England and in Buenos Ayres, during the first sixteen months of our administration, instead of dividing them over a period of years, as is commonly done. Of course, it is unsatisfactory that these figures represent a broken period of sixteen months. In future we hope to be able to render you the accounts in July, which will represent the year's expenditure and profits from March to March. Those dates may be somewhat unusual to select, but in reality we have little choice in the matter ; they suit the fiscal arrangements of the River Plate, and there is no particular inconvenience in our agreeing to them when we have once established that as the date for rendering the accounts. I now come at once to what is always one of the most important, if not the most important, question in the conduct of public companies—I mean the management of the Company and the composition of the Board. You are aware how originally the Board of the Company was selected ; it was supposed to consist of seven members. Three of each of the hitherto rival companies were to be nominated, and those six Directors were to elect an independent Chairman. Those gentlemen did me the very high honour to elect me as their independent Chairman, because I was conversant to a considerable extent with telephones in this country, and because they felt that they could rely upon me at any rate for absolute impartiality if any question should fall to be considered by the Board in connection with the interest of one company or the other. I desire to take this opportunity of stating that as regards the management of the Company and the proceedings at the Board meetings I have absolutely nothing to conceal from the shareholders. Our meetings have been of the most harmonious and friendly character, and though differences of opinion would occasionally prevail where seven gentlemen met to discuss questions of policy, on no occasion have we had to record on our minutes the vote of a minority. I desire to take the opportunity of expressing to my colleagues in your presence my hearty appreciation of the unswerving courtesy that I have met with at their hands. I feel sure also that they would wish me to take this opportunity to express to you, on their part as well as on my own, our high appreciation of the confidence that has been reposed in us by our shareholders in the last sixteen months, and I think it will be found in nine cases out of ten that the prosperity of a company may very fairly be gauged by the extent of the confidence which you find reposed in a Board by the great body of the shareholders. There is one more matter I have to point out. I know there is a feeling abroad, which is shared in by the members of this Board, and has been felt from the commencement, namely, that as opportunities occurred it would be desirable in the selection of new Directors to strengthen what is known as the River Plate element on the Board. That desire has never been absent from our minds. You must remember, however, we have had a Board the bulk of whom have been familiar with River Plate undertakings. We had on our Board, and still have, the father of this enterprise, Mr. Jones, who had intended to be here to-day, but who to his great regret, was obliged to return to America a few days ago. He hopes, however, to be back in two or three weeks, when we shall again have the great advantage of his counsel and advice. Mr. Jones has spent nearly half of the period of sixteen months during which this Company has existed in this country, and it has so happened that very nearly always during his absence we had the advantage of the assistance of another local adviser, Mr. Krabbe, and I find it difficult to express in words the feelings I entertain of the value of Mr. Krabbe's services to this Company.

The Chairman then referred with satisfaction to the provisional election to the Board of Mr. John Coghlan, who was so well known in connection with enterprises in the River Plate. He afterwards expressed regret at the resignation of his seat at the Board by Mr. Bateman, whose services he warmly recognised, expressing also a hope that they would again see that gentleman a member of the Board ; they felt now that there was such a growing responsibility in connection with the large development of their business that they had decided to ask the shareholders to sanction the appointment of two further Directors, increasing the number to nine, although temporarily, it being their intention to reduce that number, as opportunities might occur, certainly to seven again, as at present, and possibly to seven including the local Director at the River Plate. In adopting the report he asked them at the same time to consider that they had sanctioned the appointment of two additional Directors as a temporary measure, and the two gentlemen they proposed to invite to seats at the Board were Mr. George Cooper and Mr. Alfred Le Rossignol. All those who were connected with the affairs of the River Plate would recognise those names as belonging to two of the most able business men that could be selected. He concluded, after expressing his desire to give any further information that might be desired, by moving

"*That the report and accounts submitted to the meeting be and they are hereby received and adopted by the Company, and that the Company declare the dividend recommended in such report.*"

The DEPUTY CHAIRMAN (Mr. J. Irving Courtenay), seconded the motion.

A short discussion followed, in the course of which Mr. Lawrence asked two or three questions respecting the accounts, and Mr. A. H. Baker and Mr. FitzGerald, though satisfied with the report, expressed regret at the resignation of Mr. Bateman from the Board, hoping that he might be induced to reconsider his decision.

The CHAIRMAN, in reply to Mr. Lawrence's question, explained that with regard to sundry creditors the accounts in the balance-sheet represented entries for wages, rent, and other expenses belonging to March, but which were only paid in April. That was a technical point, but it explained a great deal. It also included some subscriptions paid in advance, which also meant a great deal. Subscriptions were very irregularly paid at the River Plate, sometimes being in advance, at other times in arrear. With regard to the sundry debtors, that item represented accounts due to the Company for goods sold, and also outstanding subscriptions ; but the latter, he was happy to say, were much smaller now than they were a few months ago, —speaking roughly, about a half. The cheques would be posted that evening if the dividend was approved. With regard to the remarks of Mr. Baker and Mr. Fitzgerald, he said that the Directors' fees under the Articles of Association were fixed at £1,700 a year. He had fully expressed his views regarding the resignation of Mr. Bateman, whose services he had also expressed his appreciation of, and that some day they would see that gentleman back again on the Board. Nine directors might probably be too many at all times, and therefore he looked upon the increase in the number to which he had alluded as merely temporary. He then put the motion and declared it carried unanimously. Continuing, he proposed the election as Directors of Mr. J. Irving Courtenay and Mr. John Coghlan. Mr. Courtenay had rendered valuable services to the Board, and personally he had derived great assistance from that gentleman being their deputy-chairman, while Mr. Coghlan was well known.

Mr. FITZGERALD seconded the motion, which was carried unanimously.

The auditors, Messrs. Cooper Brothers and Co., were subsequently re-elected.

A cordial vote of thanks to the Chairman, Directors and Officers was then proposed, seconded, and carried unanimously.

The CHAIRMAN having acknowledged the compliment, the proceedings terminated.

The Newfoundland Land Company (Limited).

The fifteenth ordinary general meeting of the shareholders of the above Company was held at Winchester House, Old Broad-street, on Thursday last, under the presidency of Mr. Henry Weaver.

The SECRETARY (Mr. T. H. Wells) read the notice convening the meeting and the minutes of the last ordinary and extraordinary meetings, held on the 5th December, 1887, which were confirmed and signed by the Chairman as correctly entered.

The Directors' report and statement of accounts were taken as read.

The CHAIRMAN formally moved their adoption without comment.

Sir JAMES ANDERSON seconded the resolution, which was carried unanimously.

The auditor, Mr. John Gane, having been subsequently re-appointed,

The Chairman submitted the following report of the committee of shareholders appointed at the extraordinary general meeting of the Company, held at Winchester House, Old Broad-street, E.C., on the 5th December, 1887 :—

TO THE SHAREHOLDERS : It will be remembered that at the above extraordinary general meeting the undersigned were, with the late Mr. George Heiron, appointed a committee for the purpose of selecting a new Board of Directors to undertake the future conduct of the business of the Company.

The committee at the outset desire to express their regret at the loss the Company has sustained by the death of the late Mr. William Abbott, who moved the appointment of the committee, and of Mr. George Heiron, a member of their body, both of whom were prepared to render the new Board of Directors active assistance in conducting the business of the Company. The proceedings of the committee have been much delayed owing to these circumstances.

It appears to the committee that the difficulties which have up to the present resulted in the inactivity of the Company are now being overcome, and the moment appears to be propitious for initiating an energetic policy with reference to land grants. The railway is almost completed, and is at work between the two principal towns of the island, St. John's and Harbour Grace, and extensions are in course of construction to other main points.

The committee would therefore recommend that the attention of the Company should be directed—firstly, to prospecting the lands already allotted, comprising a total of 39,002 acres ; and, secondly, to selecting the balance, being a further 24,999 acres, making a total of 64,000 acres, or 100 square miles.

The object of the Directors should then, in the opinion of your committee, be directed to selling or leasing the land in lots to suit the capabilities and requirements of the fishing population, who also farm on a small scale, and to dispose of such sites as may be suitable for lumber, saw mills, fish-curing warehouses and general industrial establishments, such as are successfully carried out on the opposite coasts of Cape Breton and Nova Scotia, in the Dominion of Canada, fishing, fish-curing and lumber sawing being the staple enterprises of the country.

Your committee are further of opinion that the attention of the Directors might profitably be directed to the examination and testing of the lands of the Company with a view to ascertaining their mineral contents, and, if the exploration of the lands should be sufficiently encouraging, to undertake the necessary exploratory work. Mr. Wingfield

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Bonnyn, A.M.I.C.E., who has had a long experience and is intimately acquainted with the country, is willing to place his services at the disposal of the Company with a view to the attainment of the foregoing objects, and the committee strongly recommend his appointment.

A small amount of capital will be necessary and sufficient to carry out the foregoing suggestions, and your committee recommend to the Directors the raising of the necessary funds by the issue of debentures not exceeding £10,000, to be issued at a discount of 25 per cent. and carrying interest at the rate of 7½ per cent. per annum.

Your committee have had considerable difficulty in obtaining the consent of gentlemen fitted for the post to undertake the duties of Directors; but they are pleased to be able to report that Mr. Arthur H. Baker, a member of the committee; Mr. Charles Clark, of Messrs. Charles Clark and Co., 20, Great St. Helens, E.C.; and Mr. Henry Wilson, of Maida Vale, N.W., have consented to undertake the position of Directors, at all events for the present. Your committee strongly urge that the Hon. A. M. Mackay, of St. John's, Newfoundland, should be urged to retain his seat at the Board, as, in their opinion, it is essential to the interests of the Company that one or more Directors should be gentlemen resident in Newfoundland.—We are, Gentlemen, yours faithfully,

23rd June, 1888. (Signed) { A. H. Baker. W. Mason Greenip.

The report having been taken as read, Mr. GREENIP formally proposed and Mr. BAKER seconded its adoption.

The CHAIRMAN, in answer to a shareholder, said that the whole of the old Board had resigned in favour of those now proposed, including the Hon. Alexander M. Mackay, of St. John's, Newfoundland.

Mr. DENNY submitted that, though there might be a great future—say 25 years hence—for their property, in view of the present backward state of industries in the district, this was not the time for embarking any more money on it.

Mr. GREENIP could not share Mr. Denny's opinion; what they had to deal with was the present. Either their land was of value or it was not, and if it was of value they could not afford to sit on their stools and wait for its development. They had no option but to take the proceedings suggested to attain the end desired.

In answer to Mr. DENNY the Secretary said that the principal condition on which the land was held was that within five years there should be placed on every 500 acres one settler.

The CHAIRMAN pointed out that the Directors were not at all responsible for the proposed course of action. They were, in fact, of opinion at the time of the last meeting that the Company should be wound up; but the majority of the shareholders did not entertain the same view, and suggested that a more active policy should adopted, so as to make the most they could out of the land. Hence the appointment of the committee and the report now submitted. They could only put the recommendations to the meeting, and abide by the result.

The resolution was unanimously adopted.

It having been previously agreed, on the motion of Mr. GREENIP, seconded by Mr. BAKER, that the Hon. Alexander M. Mackay be requested by the Board to continue as a Director, in view of his local experience and knowledge,

The CHAIRMAN moved and Sir JAMES ANDERSON seconded

"*That Mr. Arthur H. Baker, Mr. Charles Clark, and Mr. Henry Wilson be appointed Directors of the Company, in place of Sir James Anderson, Mr. Henry Weaver, and Mr. William Barber.*"

The resolution having been adopted,

Mr. Cyrus Field's resignation was formally accepted.

Mr. BAKER proposed a vote of thanks to the retiring Directors, paying a warm tribute to their zealous endeavours to make the best of the Company's property in the past.

The CHAIRMAN having briefly returned thanks,

Sir JAMES ANDERSON strongly recommended the shareholders before spending any more money to make themselves acquainted with the facts contained in a number of papers in their hands—the results of some years' experience on the part of the Company's officers of the nature and value of the land and minerals.

The proceedings then terminated.

West African Telegraph Company (Limited).

Directors' report for the year ended December 31, 1887, to be presented at the third ordinary general meeting of the shareholders, to be held at the offices of the Company, 98, Cannon-street, London, E.C., this day (Friday), at 12 o'clock:—

From the balance-sheet and accounts it will be seen that the gross receipts, including the balance brought down from last account (£128. 6s 10d.), amount to £55,268. 4s. 11d., the general expenditure being £21,586. 8s. There remains a balance of £33,681. 16s. 11d., which has been applied by the Directors in the following manner:—After providing for debenture interest paid and accrued, £10,000 has been carried to repairs and renewal account, and it has also been considered advisable to write down the preliminary expenses by £500. These deductions leave an available balance £8,181. 16s. 11d., from which the Directors propose to carry £3,500 to a debenture redemption account, and leave a sum of £4,681. 16s. 11d. to be dealt with, out of which they recommend the payment of a dividend of 3s. per share, free of income-tax, absorbing £3,466. 7s., and leaving £1,215. 9s. 11d. to be carried forward to the current year's account.

The capital account has been increased by the sum of £2,651. 13s. 6d., owing to necessary expenditure in providing proper accommodation for the Company's staff.

The cost of repairing the São Thomé-Loanda section has been taken from the renewal fund, the balance of which is now £1,021. 9s. 6d.

With the exception of the interruption in the São Thomé-Loanda section mentioned in last report, the cables of the Company continued in good working order throughout the year. The Directors are glad to report that since the repair, the Sao-Thomé-Loanda section has given no cause for anxiety, and as the crucial period is passed they venture to hope that repairs off the mouth of the Congo will not be necessary for a considerable time.

The condition of the cables is now perfectly satisfactory, with the exception of the short branch cable from Bulama to Bissao, some 40 miles in length, which was interrupted in April last. As the fault is in shallow water, and the locality well known, it is expected that the defect will be repaired very shortly, and at a comparatively trifling cost.

The Directors have much pleasure in reporting favourably on the manner in which the Company's staff have maintained the service during the past year.

Mr. E. March Webb having been appointed a Director by the Board, the shareholders are asked to confirm the appointment.

Mr. Gray, the retiring Director, being eligible, offers himself for re-election.

The auditors, Messrs. C. F. Kemp, Ford and Co., retire, and offer themselves for re-election.

Notice is given by the Directors that after the completion of the business of the ordinary general meeting an extraordinary general meeting of the Company will be held at the same place for the purpose of considering and, if thought fit, passing, by the requisite majority under the Companies Act, 1862, the following special resolutions, to be confirmed at a subsequent general meeting, of which notice will be given:—

"That the Articles of Association be amended in manner following, that is to say:—

(*a*) Article 81 (as altered by the special resolution passed on the 20th of July, 1887, and confirmed on the 8th of August, 1887) shall be rescinded, and the following Article shall be substituted for it, namely:—

"81. The number and qualification of the Directors may from time to time be altered and fixed by a resolution of a general meeting in accordance with the Company's regulations, but, until otherwise fixed, the minimum number of the Directors shall not be less than three, and the maximum number shall not be more than nine, and no one but a member of the Company who shall hold in his sole name registered shares or stock of the Company of the nominal value of not less than five hundred pounds shall be eligible as a Director."

(*b*) Article 84 shall as from the date of the said special resolution, passed on the 20th of July, 1887, and confirmed on the 8th of August, 1887, be deemed to have been and shall henceforth be rescinded, and the following Article shall as from the date of the said special resolution be deemed to have been and shall henceforth be substituted for it, namely:—

"84. The continuing Directors at any time may act notwithstanding any vacancy in their body, provided always that in case the Directors shall at any time be reduced in number to less than the minimum number for the time being fixed by the Company's regulations or a resolution of a general meeting, it shall be lawful for them to act as Directors for the purpose of filling up vacancies in their body, but not for any other purpose."

Eastern Telegraph Company (Limited).

Report and accounts of the Directors for the half year ended March 31, 1888, to be presented to the thirty-second half-yearly ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, E.C., on Thursday, the 19th inst., at 1 o'clock:—

2. The revenue for the period amounted to £359,706. 0s. 8d., from which are deducted £87,134. 10s. 8d. for the ordinary expenses and £38,412. 5s. 6d. for expenditure relating to repairs, renewals and laying of cables, &c., during the half year. After providing £4,452. 4s. 7d. for income-tax, there remains a balance of £229,706. 19s. 11d., to which is added £29,397. 16s. 5d. brought from the preceding half year, making a total available balance of £259,104. 16s. 4d.

3. From this balance there has been paid:—Interest on Debentures and Debenture stock, £29,835. 14s. 7d.; dividend on Preference shares, £20,384. 13s.; an interim dividend of 1¼ per cent. on the Ordinary shares, £47,500—total, £97,720. 7s. 7d., leaving a balance of £161,384. 8s. 9d., from which £75,000 has been carried to general reserve.

4. The directors now recommend the declaration of a final dividend for the year ended 31st March, 1888, of 2s. 6d. per share and a bonus of 2s. per share, amounting to £85,500, both payable on the 19th inst., making, with the three previous payments on account, a total distribution of 12s. per share, or 6 per cent. for the year on the Ordinary shares. The balance of £884. 8s. 9d. shown at the foot of the revenue account is proposed to be carried forward to the next half year.

5. The revenue includes £34,981. 14s., dividend and interest for the half year upon the Company's investments in the Eastern and South African, the Black Sea, and the Direct Spanish Telegraph Companies. The cables of all these companies are in good working order.

6. The several sections of this Company's cables are in good working order, with the exception of the Aden Bombay duplicate cable, which is interrupted in shallow water about eighteen miles from shore, and will be repaired without delay.

7. With the object of providing a duplicate and alternative telegraphic service to the Cape, the Eastern and South African Telegraph Company (nearly all the shares of which belong to this Company) are making arrangements with the West African Telegraph Company under which the existing line of cables along the West Coast of Africa (now terminating at Loanda) will be continued to Port Nolloth and the Cape of Good Hope.

The new cables will be worked by this Company as part of the Eastern and South African Company's undertaking.

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The laying of these cables will secure the very important Cape service from the danger of interruption of the existing cables, and provide an alternative line to Aden and India, thus greatly strengthening this Company's position both on the East and West Coast of Africa.

Direct United States Cable Company.

Report of the Directors for the six months ended 30th June, 1888, to be presented at the twenty-second ordinary general meeting of the Company, to be held at Winchester House, 50, Old Broad-street, E.C., on Friday, the 20th inst., at 2 p.m. :—

1. The Directors submit the usual statements of account for the half year ended 30th June, 1888, which, with the half-year's accounts to 31st December last, presented at the ordinary general meeting on the 20th January last, show the financial result of the eleventh year's working of the Company.

2. The half-year's revenue (still subject to revision) including income-tax refunded, and after deducting out-payments, amounted to £17,507. 17s. 2d., against £23,671. 15s. 4d. (after similar deductions) for the corresponding period of 1887, being a difference of £6,063. 18s. 2d. against the half year under review, resulting from the low rates current.

3. The working and other expenses for the same period, including income-tax, but exclusive of cost of repairs of cable, amounted to £15,276. 11s. 10d., leaving a balance of £2,231. 5s. 4d. as the net profit of the half year, making, with £9,910. 14s. 8d. transferred from the reserve fund account, a total of £12,142. For the corresponding half year of 1887 the working expenses and other payments amounted to £15,905 3s. 2d.

4. Three quarterly interim dividends of 2s. each per share, amounting to £18,213, have been declared and paid during the financial year, and a final payment of 2s. per share is now proposed, making, with the three interim dividends, 2 per cent. for the year, being a total distribution of £24.284.

5. Faults having developed in the deep sea portion of the main cable to such an extent as to interfere with efficient working, the Directors, after mature consideration and consultation with eminent telegraph engineers, arrived at the unanimous opinion that the cable should be repaired. They accordingly entered into a contract with the Telegraph Construction and Maintenance Company for the repairs, which have been partially effected, and it is expected that the cable will in a short time be in good working order throughout. The cost of these operations will be dealt with in subsequent accounts.

6. The action brought by the Anglo-American Company against the French Company is still unsettled, the French Company having appealed against the judgment delivered in January last by the Paris Tribunal of Commerce.

7. The 6d. tariff continues. The traffic of the Associated Companies shows a diminution as compared with the last half year.

8. Pursuant to the provisions of the Articles of Association, two of the Directors, viz. :—William Ford, Esq., and C. J. Gunther, Esq., retire by rotation, and being eligible offer themselves for re-election.

9. Mr. John G. Griffiths and Mr. John Sawyer, the auditors, retire pursuant to the Articles of Association, and offer themselves for re-election.

NEW COMPANIES REGISTERED.

WESTMINSTER ELECTRIC LIGHT SUPPLY CORPORATION (LIMITED).—This corporation was registered on the 30th ult., with a capital of £100,000, divided into 19,900 ordinary and 100 founders' shares of £5 each, to carry on in the city of Westminster, or elsewhere, the business of an electric lighting company. The subscribers are :—

	Founders' Shares.
*Joseph Browne Martin, 2, Victoria-mansions	1
*Henry Kimber, M.P., York-street, Westminster	1
Sir J. R. Heron Maxwell, Bart., Carlton Club	1
*R. W. Wallace, 2, Harcourt-buildings, Temple, barrister	1
J. W. Hiscox, 3, Victoria-street, Westminster, contractor	1
W. H. Baker, 74, Vincent-square, Westminster, head master Baroness Burdett-Coutts School	1
H. A. Hunt, jun., 45, Parliament-street, surveyor	1

The number of directors is not to be less than 3, nor more than 7; qualification, 50 shares or £250 stock; remuneration, £200 per annum to the chairman, and £100 per annum to each director.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended July 6th, 1888, amounted to £4,740.

CADOGAN ELECTRIC LIGHT COMPANY (LIMITED).—This company announce their first issue of shares to the public in the form of 4,000 A (Preference) shares of £5 each, for additional capital, "to execute the increasing demands for the electric light in their district."

DIRECT UNITED STATES CABLE COMPANY.—At a meeting of the Board of this company it was resolved to recommend a final dividend of 2s. per share, free of income-tax, such dividend to be payable on and after July 21st inst., making, with the interim dividend already paid, 2 per cent. for the year ended June 30 last. Recourse will be had to the reserve fund account to make up the required amount for such dividend.

GREAT NORTHERN TELEGRAPH COMPANY.—Traffic returns :—Receipts in June, 1888, £23,600; January 1 to June 30, 1888, £132,000. Corresponding months 1887, £127,120; corresponding month 1886, £124,560.

THE INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY (LIMITED).—Notice is given that a half-yearly general meeting of this company will be held at the Cannon-street Hotel, London, on Thursday, the 19th inst., at 12 o'clock noon, for the purpose of obtaining the sanction of the shareholders to the payment of an interim dividend of 5 per cent., or 10s. per share, free of income-tax. The company's share register will be closed from the 12th to the 19th inst., both days included.

RAILWAY AND DOMESTIC ELECTRIC LIGHTING COMPANY.—A petition for the winding-up of this company has been presented to the High Court of Justice, and will be heard on the 14th inst.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—The transfer books of this company are closed from the 9th to the 17th, preparatory to the payment of an ad interim dividend of 12s. per share to all shareholders on the register.

THE WEST AFRICAN TELEGRAPH COMPANY.—With the sum brought down, the gross receipts of this company for the year ended December were £55.268, and the general expenditure was £21,586, leaving a balance of £33,681, from which has to be deducted debenture interest, £10,000 for repairs and renewal account, £500 for preliminary expenses, and £3,500 carried to a debenture redemption account. The directors now recommend a dividend of 3s. per share, leaving £1,215 to be carried forward.

THE WEST COAST OF AMERICA TELEGRAPH COMPANY.—The directors of this company have declared an interim dividend of 4s. per share, free of income-tax, in respect of the first half of 1888, payable the 23rd inst.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended July 6th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £3,958.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, July 11, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending July 11, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	39½ 40½	3 7 11	Jan., Apr., July, Oct.	40	39⅞
2,614,820	Stock	10/0	Do. Preferred	64 65	4 4 7	,, ,,	64⅞	59
2,614,820	Stock	nil.	Do. Deferred	13¼ 13⅜	...	February	14	13¼
130,000	£10	3/0	Brazilian Submarine	12⅜ 12⅝	4 15 0	Mar., June, Oct., Dec.	12⅝	12⅜
16,000	10	8/0	Cuba Submarine	13¼ 13⅜	5 16 6	February and August	13½	...
6,000	10	10/0	Do. Preference	19 19½	5 2 7	,, ,,	...	...
12,931	5	4%'87	Direct Spanish (£4 paid)	3½ 4	4 0 0	March & September	4	...
6,000	5	5/0	Do. Preference	8½ 9½	5 5 3	April and October	...	...
60,710	20	2/0	Direct United States	8½ 9	4 8 11	Jan., Apr., July, Oct.	9	8½
380,000	10	2/6	Eastern	11¼ 12⅛	4 10 9	,, ,,	12⅛	11⅛
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜ 15¼	3 19 0	,, ,,	15	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅜ 13	5 0 0	Jan., Apr., July, Oct.	13	12⅛
22,050	10	8/3	German Union Telegraph and Trust	9 9⅜	7 7 4	January and March	...	...
179,177	10	2/0	Globe Telegraph and Trust	5⅜ 6	5 4 2	Jan., Apr., July, Oct.	5 15/16	5 9/16
178,992	10	3/0	Do. 6 per Cent. Preference	13¾ 14⅛	4 4 11	,, ,,	14 1/16	13⅝
150,000	10	7½% '87	Great Northern	13½ 14	5 7 2	Jan., July, and April	14	13⅝
17,000	25	37/6	Indo-European	36 38	6 11 9	April and October	...	...
38,348	10	3%	London Platino Brazilian	5⅞ 6½	...	May and November	...	...
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	7⅝	7 11/16
338,225	Stock	15½%	Submarine	140 150	9 3 4	February & August	145	143
30,000	10	6/0	West Coast of America	6⅜ 7½	7 8 2	January and July	7	...
150,000	100	8%	Do. Debentures	110 115	6 19 2	June and December	114¼	113¼
88,321	10	nil.	West India and Panama	7/8 1⅛	...	...	15/16	...
34,563	10	10/0	Do. 1st Preference	10⅛ 11	8 12 8	April and October	11 1/16	10⅜
45,181	15	9/0	Western Brazilian	9⅜ 10	6 7 6	March & September	9 15/16	9⅜
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	102 104	...	March & September	...	...
			TELEPHONES.					
224,850	14/0	£5 7/ '87	Consolidated Telephone and Maintenance	5/8 3/4	5 0 0	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	¼ ⅜	3 13 6	...	...	...
80,000	5	10/0	United	13¼ 14	5 7 2	June and December	14	13 1/16
50,000	5	2/6	United River Plate	5⅜ 6¼	...	April and October	6	...
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb.'86	Anglo-American Brush (£4 paid)	2¼ 2⅜	...	...	2⅝	...
23,692	5	nil.	Do. (fully paid)	3 3⅛	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2⅜	...	...	2⅜	2 5/16
312,000	¼	0/1¼d '86	Maxim-Weston	1/16 1/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39½ 40½	5 18 4	March and July	40	39½
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16⅜ 17½	5 14 3	February & August	16¾	...

* On account of arrears of dividends.

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

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3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 531.—Vol. XXI. FRIDAY, JULY 20, 1888. Price 4d.

NOTES.

Mr. Justice Kay delivered judgment in the case of the Edison-Swan Electric Lighting Company *versus* Holland and others on Monday last. The full text of the judgment will be found in our columns this week. Probably most of our readers are already aware that the Edison patent has been upset, while the Cheesborough patent is maintained. We understand that the counter action brought by the Anglo-American Brush Corporation against the Edison-Swan Company for alleged infringement of the Lane-Fox patents for the manufacture of incandescent lamps, and also for the working of dynamo lamps and accumulators all in parallel, will not come before the Courts until after the Long Vacation.

The litigation which has just resulted in the loss of two important monopolies is the first break in the long series of triumphs which have been won by the holders of electrical patents in this country in maintaining the legal rights conferred upon them by the Patent Office. Possession is proverbially nine points of the law, and it is hardly to be wondered at that a feeling existed in electrical circles that in actions for infringement the odds were largely in favour of the patentees. From an abstract point of view this feeling is by no means to be regretted, for every invalidation of a patent is a tacit reproof to the Patent Office—or, rather, to the patent law—which leaves the patentee to discover whether the protection it professes to confer is worth the paper on which it is written. Under the existing *régime* the English patent law is as much a lottery as the Government lotteries of France or Italy. For our own part we are inclined to think that a deplorable mistake was made when "the poor inventor" was encouraged to seek a delusive protection by diminishing the cost. Far better would it have been to have raised the charges still higher, and by inaugurating a rigorous search for anticipations to have placed an English patent upon a level with those of the United States or of Germany. Had this been the case it is in the highest degree improbable that either "Gaulard and Gibbs *v.* Ferranti" or "Edison-Swan *v.* Holland and Others" would ever have found its way into the courts.

In this connection it is curious to note that, notwithstanding the admitted superiority of the American patent law—to some extent, in fact, by virtue of that superiority—electric lighting patents have not, upon the whole, experienced good fortune in the United States. Attempts were made both on the part of Siemens and of Gramme to obtain patents which would have virtually controlled the manufacture of the modern type of dynamo machines, but in each case the application was frustrated by being delayed beyond the period allowed by the law. The Brush Company failed to sustain its patent on the arc lamp owing to proof of a prior public use, although on a very small scale; and still more recently some of the Edison incandescent lamp patents have come to grief in the States. By-the-bye, we hear nothing further about the alleged intention of the Edison Company to enforce their patent for parallel working in America. This is a patent well worth possessing if it can be made good.

We have often thought Mr. Edison a great inventor in more ways than one, but we have always been sure that his business agents were equal if not superior to him in ingenuity. Of this latter one piece of evidence lies before us in the shape of a circular signed on behalf of the American Edison Electric Light Company by Mr. E. H. Johnson, its president. A rival company, the Westinghouse, having submitted its system to exhaustive tests which were not made public, the method adopted by the Edison man of business to improve the occasion is to inform all the Edison agents that the tests had been made at the instance of the United Gas Improvement Company, who had rejected the Westinghouse system because those tests had proved its inferiority to the Edison system. All this is clearly implied in the Edison circular, and the agents are advised to go in and win on the strength of it; but, at the same time, so carefully guarded is the wording of the document that a court of law would find it hard to convict the writer of a worse offence than that of printing rash and impudent conjectures which had no foundation in fact. The Westinghouse Company reply by publishing flat denials, both from the gas company referred to and from Prof. Morton, who instituted the tests. Business is one of the sciences in the States, and it is impossible to deny the very exalted position to which the Edison scientists have already attained.

As a pendant to this passage of arms we are tempted to quote an advertisement which has recently been issued by the United States Electric Lighting Company. It will be remembered that this company recently succeeded in defending an action brought by the Edison Electric Lighting Company for infringement of patents, the alleged infringement being justified on the purely technical ground that the patent had expired

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owing to the non-renewal of a certain foreign patent embodying the same claim. This plea was, no doubt, good enough for the lawyers, but the victory scarcely seems one to be proud of. Under these circumstances, we are unable to feel much sympathy with the remonstrances contained in the advertisement alluded to, which *verbatim et literatim* reads as follows :—

"EDISON *vs.* THE UNITED STATES ELECTRIC LIGHTING CO.

"'Whom the Gods would destroy
They first make mad.'

"The anger of the Edison Company [*of New York*], since being beaten at law, is forcibly manifested by a 'Confidential Circular to Edison Agents' containing alleged explanations as to why Edison was beaten at law, in which the dignified (!) president delivers himself of his wrath in a tirade of abuse, libelous and personal, against a most humble and unimportant individual, and produces the first 'patch' for the 'collapsed airship' as predicted in 'The Edison Boomerang' Circular.

"As the general public may desire to see this confidential circular, a large edition has been provided, and will be furnished in unlimited quantities, postage prepaid, upon application to

"THE UNITED STATES ELECTRIC LIGHTING CO."

In this case it appears to us that the Edison Company is more sinned against than sinning.

On a careful review of the financial results which have attended the working of the Post Office Telegraphs our contemporary *Engineering* arrived last week at three conclusions: First, that the management by Government officials compares unfavourably with that of private individuals; secondly, that the *employés* are inadequately paid; and, lastly, that Parliament must take the whole matter in hand so as to place British Government telegraphy upon a sounder basis. Now, as it is the habit of private firms to starve their servants when profits are low, and that this is admittedly what the Government is doing in respect to the telegraph service, it is hard to understand where the unfavourable comparison comes in; and when it is remembered that the present unsatisfactory state of the Post Office Telegraph's finances is chiefly due to the interference of Parliament, the prospect of improving them by further interference from the same quarter seems very remote indeed.

These three conclusions are, in fact, mutually destructive, and our contemporary has arrived at them by laying on the shoulders of the permanent officials the responsibility which rests entirely with Parliament. It was Parliament, and not the Post Office, that demanded extensions which could never be remunerative; it was the Treasury which insisted on the cost of these extensions and the consequent increased cost of working being charged to revenue instead of to capital. Finally, it was not the Post Office officials, but their Parliamentary chiefs, backed by Parliament itself, that prematurely forced the unprofitable experiment of sixpenny telegrams—an experiment which, roughly speaking, has caused the expenditure to increase about twice as fast as the receipts. On the other hand, we owe it to the Post Office that the sixpenny tariff has not proved so disastrous as Parliament would have made it. Sixpenny telegrams were yielded to Parliamentary clamour; but that the number of words was reduced, and, above all, the free addresses abolished, was entirely due to the firm stand made by the permanent officials. It is true, as our contemporary remarks, that the so-called sixpenny telegram often costs eightpence or tenpence; but this circumstance only shows how very much worse its financial condition would have been had the Post Office allowed Parliamentary pedants and faddists to have had their way.

According to a pamphlet just issued by the *Financial News* the prospects of copper are more hopeful than one would imagine, the price being kept up artificially by an expenditure which must soon exhaust the resources of the syndicate. The present demand by consumers is being largely supplied by the free smelters, while the stock of the Copper Ring is being enormously augmented without the least possibility of their selling it for what it has cost them to buy.

In an early issue we shall give some account of the electric lighting station at Leamington, which we have recently visited. Meanwhile we take the earliest opportunity of confirming the statements made by Messrs. Chamberlain and Hookham, in a letter which we published on the 1st ult., to the effect that the unmitigated abuse which has been showered upon them at the meetings of the Town Council has largely proceeded from "political" motives. From the enquiries which we have made upon the spot it is sufficiently clear that a certain section of the local "politicians" (save the mark!) were from the outset determined to stigmatise the electric lighting as a failure. Unfortunately, whether by accident or otherwise—and really the latter alternative seems to be more than probable—a series of insulation faults occurred during the first few months of the enterprise, the origin of which has never been satisfactorily explained. The opponents of the scheme were in this way furnished with plausible ground for their complaints. But it is a fact, for which Messrs. Chamberlain and Hookham should receive the fullest credit, that no hitch of any kind has occurred during the last eight months. We still think it unfortunate that Messrs. Chamberlain and Hookham permitted the allegations made against them in the Town Council, and also in some of the local papers, to remain so long without an answer. For although they were no doubt entitled to ignore these attacks so far as concerned themselves personally, yet it would have been well to have realised earlier that the interests of the electric lighting industry were being injuriously affected elsewhere. With regard to the street lighting, we can only say that we saw nothing at Leamington which has induced us to modify our opinion that—taking into consideration the public expectations—it is a mistaken policy to employ low candle-power incandescents for street-lighting.

So the Pilsen-Joel Company's business—patents and all—is put up for sale in the open market. In our issue of June 29th we reported that a joint committee of directors and shareholders had been entrusted with full powers to take this step if, after due examination, it was deemed advisable. We cannot regret the conclusion at which the committee has arrived, for it

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has long been evident that under the present *régime* the company would scarcely achieve any great success. At the same time there is no doubt that the nucleus of a genuine business has been secured, and one which, under good management, might become an extensive and a profitable concern.

At the extraordinary general meeting of the shareholders of the MAXIM-WESTON COMPANY, held yesterday afternoon, five directors were added to the existing Board. This part of the business was settled amicably enough; but on the proposal to remunerate the Committee of Investigation, and the still more serious question of inviting Mr. HUGH WATT to retire from the Board, the meeting became a scene of admired disorder. A recommendation to divide £100 among the members of the committee was at length adopted; but the meeting broke up without any decision in respect to Mr. WATT.

The Electric Lighting Order Confirmation Bill.—This Bill was read a second time in the House of Lords on Monday, July 16th.

Exeter.—The Town Council of Exeter are advertising for tenders for lighting a portion of the city with arc lights. Further particulars may be found in our advertisement columns.

Proposed Central Station at Stamford Hill.—We understand that Mr. E. Fahrig has a scheme in hand for starting a central lighting station in the neighbourhood of Stamford Hill, and that there is a good prospect of success.

The South London Polytechnic Institutes.—Among the donations that have recently been promised towards the funds of the South London Institutes is one of £1,000 from the firm of Messrs. Rothschild, and a similar sum from Messrs. Baring.

Chelsea.—At the meeting of the Chelsea Vestry, on Tuesday week, a letter was read from the Chelsea Electricity Supply Company for the vestry's sanction to their proposed capital under Schedule A. The sum of £32,000 was mentioned, which the vestry considered sufficient.

An Electrical Politician.—From a Cape newspaper we learn that East Griqualand has done itself the distinguished honour of electing Mr. Sivewright (the joint author with Mr. W. H. Preece of the well-known text-book of telegraphy) as its representative in the Cape Parliament.

Halifax.—The Mayor of Halifax, on the application of the Schmidt-Douglas Electric Lighting Company, of Bradford, has promised to call a committee meeting of the Council on an early date to consider whether or not the principal streets of the town should be lighted by the electric light.

Madrid.—From references in the local papers it would appear that the native firms are showing considerable activity in introducing the electric light. It is stated that the Arenal, Preciados and other principal streets of Madrid, as well as the Senate House and offices of the Provisional Government, are to be lighted by the Sociedad Electrecista.

Freemasonry.—At the Provincial Grand Lodge of Middlesex, held at the Memorial Hall, Great Stanmore, on the 7th inst., the Provincial Grand Master, Colonel Sir Francis Burdett, Bart., was pleased to appoint and invest as his Junior Grand Warden for the ensuing twelvemonth W. Bro. Geo. Gregory, P.M. and Secretary of the Electric Lodge, No. 2,087.

The Proposed Polytechnic Institution for Chelsea.—A meeting in support of the movement to raise £50,000 for the establishment and endowment of a Polytechnic Institution for South-West London was held, under the presidency of Lord Cadogan, at Chelsea House, on Wednesday. The proposal met with hearty approval, and a resolution pledging the meeting to carry it into execution was agreed to.

Personal.—We learn that Mr. Antony Reckenzaun has been appointed as managing engineer to a department that Messrs. Woodhouse and Rawson (Limited) have formed for the application of electricity to the transmission of power and similar purposes. He has also been appointed as manager to the Woodhouse and Rawson Electric Manufacturing Company (Limited), in place of Mr. R. Archbould, who has unfortunately had to resign on account of ill-health.

Paris Exhibition, 1889.—We are glad to learn that there is every probability of the Industrial and Machinery Departments of the English Section being extremely well represented. The whole of the space has been applied for, and is now being allotted. But the Arts Section and the Agricultural Machinery Sections have received only scanty support. The Association of Agricultural Engineers have vetoed the Exhibition, and have left the trade of the Continent to their American and German rivals.

The Saunders Lightning Guard.—We have on several occasions recorded cases of cables which have been protected from damage by lightning owing to the efficiency of the Saunders lightning guard. The following are recent instances of its value:—On May 20th and again on June 28th, during severe storms at Marseilles, accompanied by lightning, the Eastern Telegraph Company's Bona cable was automatically put to earth at the cable house by the fusing of the platinum wire of the Saunders lightning guard.

Repairs to the Interrupted Telegraph Cables.—We are glad to announce that one of the Australian cables has been repaired, and the ship is now busy on the second. The company had chartered a third steamer to bridge over the break, but fortunately the line was put through in time to cancel the charter a few hours before the vessel was to sail. Two faults have been removed from the Anglo-American Brest cable, one in deep water, where the cable was in good condition, and the other near St. Pierre. The ship is now at work on the third and last fault.

Application for Provisional Orders for Lighting the Strand District.—At the last meeting of the Strand District Board of Works the Clerk reported having received the following notices of intended application for provisional orders to supply electricity for lighting, &c., in the area of this district, viz., the South Metropolitan Electric Supply Company, the Electrical Power Storage Company, London Electric Supply Corporation, the Westminster Electric Supply Corporation, and Messrs. Walter F. Glover and Co.; these were referred to the Lighting Committee for consideration and report.

Exeter.—At the last meeting of the Committee of the Exeter Town Council, the Town Clerk reported that notice had been given both to the owners of Trew's Weir Mills and to the Electric Lighting Company, and he had prepared the draft case, which he produced. He further reported that at the last meeting of the Council a letter was received from the Electric Lighting Company suggesting a conference, and that the Council had resolved that on the Company putting their proposals in writing the Committee be authorised to enter into the desired conference. Up to the present he had not received the company's reply. The further consideration of the matter was deferred.

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Remarkable Items from the Daily Press.—A financial paper this week informs its readers that "the Grosvenor Gallery is to have the electric light, which will be supplied from a distant centre at Deptford, and will need a very powerful current, so strong that electricians doubt if it will be safe to handle the lines, the leakage from which might be sufficient to cause serious injury." In another paper we find that Mrs. Swan's garden party at Bromley is said to have been "given by Mr. Schwann, at his suburban residence in Balham." The effort of a Dublin journal to grapple with the meaning of electrolysis is, however, still better. We read "Electrolysis is chemical decomposition by means of electricity. When practised on the skin it is injurious to it. It requires complex electric machinery. Most Dublin physicians could have it done. It would not take long."

The London Chamber of Commerce and the Proposed Electrical Section.—A meeting of the members of the London Chamber of Commerce who are interested in the proposal to establish an electrical section was held at Botolph House, Eastcheap, on Friday afternoon last. About a dozen members were present, including Mr. Crompton (who occupied the chair), Messrs. Garcke, Applegarth, Alabaster, Gatehouse, Snell, Wilding, Price, Harold, Fraser, and Binswanger. The following resolutions were carried:—That the formation of an electrical section is desirable; that the members present form a provisional committee for the purpose of organising an electrical trades section; that meanwhile they use their best influence to induce their friends to join the section; and that a circular in the name of the provisional committee be issued to the trade inviting them to attend a meeting on the 27th of July.

Obituary.—We regret to announce the sudden death of Mr. W. H. Davies, Superintendant of the Eastern and South African Company's station at Zanzibar, after a short attack of fever. Mr. Davies leaves a widow and three children. He commenced his telegraphic career in the Electric and International Telegraph Company, and was some little time on board the steamer "Brisk" with Captain Barrow. He afterwards entered the service of the Falmouth and Gibraltar Telegraph Company (now the Eastern Telegraph Company), at their London office, Old Broad-street. From thence he was transferred to Carcavellos, Portugal, and was next appointed the Eastern and South African Telegraph Company's superintendent at Mozambique, and subsequently at Zanzibar, where he married the youngest daughter of Mr. L. Durand, of Lisbon, Mr. Davies' loss will be deeply regretted by a wide circle of friends. We believe that he held instructions from headquarters to proceed to Cape Town as superintendent, but his death, which took place on the 4th instant, unfortunately occurred on the eve of his departure.

Dublin Corporation and the Electric Light.—At the last meeting of the Dublin Town Council, Mr. Healy asked the Chairman of Committee of the Whole House on Electric Lighting what progress had been made, the date when orders were given to apply for license, if that license had been obtained, and, if not, to explain the cause of the delay. And, as the committee has been sitting from time to time since the 2nd May, 1887, if it would be advisable to throw more energy into the matter.—Mr. Robinson said that on May 2, 1887, a committee was appointed to investigate whether the water-power at Island Bridge was sufficient for electric lighting of thoroughfares, and was empowered to employ an expert. On October 10, 1887, a report of the committee was adopted that an application should be made for a license, and that was confirmed by resolution of Council on 12th December, 1887. On December 28th the committee instructed the borough surveyor to reconsider the specification. On 18th February the application for a memorial was forwarded by the Board of Trade. The week before last a meeting took place in London between representatives of the Gas Company and representatives of the Corporation, at which a practical agreement was come to.

Bradford, Yorks.—The Bradford Corporation, in view of its scheme for erecting a central generating station in Bolton Road, for providing a regular supply of electric light and power for Kirkgate, Market Street, and places in the immediate vicinity, has recently issued a circular to occupiers of business premises in the central portion of the borough, inquiring whether such occupiers would be disposed to take a supply of the current regularly for a stated period, suggested as three years. So far, there has been a fair response to the inquiry, though it is somewhat early to enable the Corporation to say to what extent the experiment is likely to succeed. With respect to price, the Corporation has determined to adopt an alternative system of charge for incandescent lamps, namely:—(1) 5d. per unit, the Corporation to supply meters, if desired, at a rental of 10 per cent. on the cost; (2) by an annual charge of 20s. per lamp of 16 candle-power, irrespective of the actual hours of lighting. The charge for the supply to arc lamps is to vary with the illuminating power of the lamp, as required by the consumer, at the rate of 5d. per unit. The Corporation proposes to carry the supply up to the buildings, the internal fittings being provided by the consumer.

Search Lights on Yachts.—We have received the following letters for publication:—"Sir: On behalf of a client I have made inquiries which have elicited a letter from the Assistant-Secretary of the Board of Trade, and since it is of interest to the profession I enclose a copy for publication in your columns.—Yours, &c., A. P. TROTTER."

"Board of Trade (Marine Department), London,
17th July, 1888.

"SIR: With reference to your letter of the 12th inst., asking under what conditions an electric search light may be used on board a yacht, I am directed by the Board of Trade to state that they are advised that the light in question cannot legally be carried or exhibited in the manner in which mast-head or side lights are carried and exhibited under Articles 2 to 11 of the 'Regulations for Preventing Collisions at Sea.'

"The Board are further advised that although by Article 23 of the said regulations a search light may perhaps be legally used under such special circumstances as may render a departure from the regulations necessary in order to avoid immediate danger, the question whether its use is justified by the special circumstances of any particular case is one that must be decided upon its merits in the event of any legal proceedings arising therefrom.—I am, Sir, your obedient servant,

"THOMAS GRAY."

Telegraphic Communication with Mauritius.—In the House of Commons, on Friday last, Sir E. Watkin asked the Under-Secretary for the Colonies whether the island of Mauritius, which had a naval dockyard, and the fortified harbour of St. Louis, was, like Bermuda, unconnected by submarine telegraphic cable, independent of foreign interference, with any other portion of the Empire; whether the Malagasy Government so long as three months ago expressed their readiness to assist in establishing direct communication through their territory with Great Britain by means of a cable from Mozambique, to be landed at Mojunga, and by the erection of a land line thence to the capital, and onwards to the east coast at Andevoranto or Vatomandry, with the right to connect the same by cable to Mauritius and whether he had come to any decision in the matter.—Sir J. Gorst, for Baron H. De Worms, said:—"There is no direct telegraphic communication with Mauritius, but messages are sent as opportunity offers by steam vessels from Aden

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Natal, and Australia. The particular proposal referred to has not come under the consideration of Her Majesty's Government, but various schemes for laying a cable to Mauritius, *vid* Madagascar, have been, and still are, under consideration. It has not, however, been found possible to make provision for this service, and until arrangements can be made for meeting the cost of a cable, it is not possible to come to a decision as to the particular route."

The Electric Light Scheme at Bath.—The report of the Electric Lighting Committee of the Bath Town Council has been issued, giving particulars of the seven tenders received in answer to the advertisement for the lighting by electricity of the streets in the district approved by the Council. The report states, "All persons tendering concur in recommending the adoption of overhead in preference to underground wires, as being much less expensive and less liable to failure on account of defective insulation. There are three methods of fixing overhead wires—(1) on poles placed on house roofs, (2) on brackets placed on house fronts, (3) on lamp-posts in a line with the kerbstone placed from 100 to 150 feet apart. The last mentioned is the method recommended." The chief particulars of the different tenders are given in the table below. The committee have fully discussed the several tenders, and they are of opinion that the one sent in by Mr. Massingham presents great advantages, and that the small extension of the area to be lighted with electric light which it suggests (a plan of which can be seen at the town clerk's office) is well worthy the consideration of the Council.—At the meeting of the Town Council on Tuesday last, Mr. Sturges moved "That the tender sent in by Mr. Massingham for lighting the streets in the extended area therein mentioned with electric light be accepted for a period of seven years, and that it be referred to the Surveying Committee to enter into and superintend the carrying out of a contract accordingly." He remarked that Mr. Massingham's tender was the best and most advantageous. The recommendations in its favour were three-fold. The first recommendation was that the system he proposed to employ, the Thomson-Houston system, had been acknowledged in all competent trials to be the best. The next point was that Mr. Massingham's tender was the cheapest Thus they got the best system at the cheapest rate. Then there was a third point. The tender had not emanated from Mr. Massingham personally, but it came from a body of gentlemen who were their fellow citizens. These gentlemen came to the resolution that if the Town Council would introduce the electric light, they themselves would undertake the responsibility of starting a company. Circumstances now seemed to favour the early introduction of the electric light, and he urged that longer delay was unnecessary. The expense would not be frightful. He was able to say that they could have the electric light throughout the area indicated for an increase of £203 per annum on the present price paid. For that they would get 18 or 20 times the light, and if that was not a recommendation in favour of the electric light he did not know what was.—Alderman Murch seconded the motion, and Alderman Oliver opposed the adoption of the report. They were asked, he said, to do away in their lighting with an agent which they knew, and to adopt an agent of which they knew little or nothing. To his mind the matter had not yet received that ample discussion which the occasion required. He opposed the introduction of the light on the same grounds he did on a previous occasion, viz., that electricity was as yet in its infancy, and that it would not be safe for them to introduce it here, and that they had better wait a few years and then determine what course to take. He had watched very carefully the progress of the electric light for many years, and he said unhesitatingly its growth had not developed in such a manner as to justify them in saddling the ratepayers with the cost of its introduction. Did anyone suppose that towns like Birmingham, Manchester, and Liverpool, where there were experienced, far-seeing, intelligent, and go-a-head men in their councils, would not have adopted the light if it was so desirable as it was stated to be. At Leamington it was an admitted failure. As to the report presented that day, it was unsatisfactory, inasmuch as it gave no information with regard to cost or as to the number of lamps which were to be displaced. Seventy lights were to be furnished for fifty streets. That seemed a rather small number, and his own feeling was that it was not anything like sufficient, and they would find eventually that it was not sufficient. Then they were told the lamps were to be from 100ft. to 150ft. apart. He had not measured the distance, but was of the impression that seventy lamps would not cover the area, and that they would be called upon again. He hoped the Council would never sanction overhead wires owing to the great danger arising therefrom. People would wonder how it was that if the electric light at Eastbourne cost double the amount of gas it became cheaper in Bath. By extinguishing 273 lamps and replacing them by 70 electric lights they were only giving one and a-quarter lights to every four gas lamps. In other towns they gave one electric light to every three lamps. According to Mr. Sturges' figures the cost would be £368, but in the report it was £203. How the difference arose he had yet to learn. The introduction of the electric light would increase the rates in a way which he did not think would be advantageous. Do not let them be in a hurry.—Alderman Gibbs urged that the matter could be very well put off for a long time to come.—Ultimately, on the motion of Mr. Radway, the question was adjourned until Tuesday next.

NAMES OF PERSONS TENDERING.

—	Laing, Wharton, and Down, London.	Newall and Co., Bristol.		Nicholson and Jennings, London.	C. Allen and Sons, Taunton.		J. Ravennes, London.	Anglo-American Brush Electric Light Corp'ration (Limited).	H. G. Massingham, Bath.
System of lighting	Thomson-Houston.	Thomson-Houston.	Brush.	Brush.	Thomson-Houston.	Brockie Pell or Pilsen Joel.	Brush.	Brush.	Thomson-Houston.
Candle-power of each lamp	1,200	1,200	2,000	2,000	1,200	1,000	1,250	2,000	1,200
Number of lamps	75	68	68	43	66	66	40	67	70
Price per lamp overhead wires 3 years' contract.....	£ s. d. 24 0 0	£ s. d. 25 0 0	£ s. d. 27 0 0	£ s. d. 30 8 4	£ s. d. 25 0 0	£ s. d. 21 0 0	£ s. d. 26 0 0	...	£ s. d. 19 17 6
Price per lamp underground wires 3 years' contract	28 0 0	29 0 0	31 0 0	...	29 10 0	25 10 0	30 0 0	...	25 17 6

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SOME ENGLISH CENTRAL LIGHTING STATIONS.*

IV.—THE CADOGAN STATION AT CHELSEA.

The central lighting station of the Cadogan Electric Lighting Company at Chelsea is at 91, Manor-street, not far from the river bank, and near the Albert Bridge. The situation is convenient for the transfer of coal and ashes, and for a high-tension system of distribution it is sufficiently near the district which it is contemplated to serve. This district includes Chelsea, South Kensington, Brompton, and Knightsbridge, and as it comprises buildings of almost every class, from an electric lighting point of view it ought eventually to give a favourable curve of output. In commencing operations the company very wisely decided to start upon a modest scale, but to lay out their plans in such a way as to permit of subsequent extension without interference with the plant already at work. To this end it was deemed indispensable at the outset to erect a station capable of containing plant for supplying at least 50,000 lamps. The consequence is that we have now at Chelsea one of the best designed and most spacious buildings which has yet been erected in this country for the purpose of central station electric lighting. Below we give some of the dimensions in detail. The whole of the plant has been laid down and the circuits have been built under the sole superintendence of Mr. J. S. Sayer, the managing director of the company.

As we have already intimated, the system of distribution is that of high tension in the mains. It is, in fact, what Mr. Crompton calls a B.T. system, but is carried out in a much more thorough manner than has yet been done elsewhere, even by Mr. Crompton himself. Unlike Kensington Court, where the batteries are, for the present at any rate, confined to the station itself, every consumer at Chelsea has his own secondary battery, which is charged from the main conductor in series with the rest. The system adopted has therefore all the merits and all the defects of distribution by batteries, and by the behaviour of the cells its success will be chiefly determined. Some important modifications in the method of working have, however, been introduced by Mr. Edmunds, as described below, and which we should be disposed to value more highly if the employment of automatic switches in each installation were not involved. However, we shall be glad to see Mr. Edmund's device receive a fair trial, and shall then be prepared to judge it on its own merits.

Both engines and dynamos have been supplied by Greenwood and Batley, of Leeds. The engines are of the well-known Armington-Sims type, which are so largely used for electric lighting in America, and for which Greenwood and Batley are the sole agents in this country. With these preliminary remarks we proceed to give the following details :—

Station.—The area of the engine room is 90ft. by 90ft., and the space available is sufficient for a 50,000-light plant; it is provided with a 10,000-gallon water tank and a coal house of 40 tons capacity. There are also spacious offices and store rooms, all situated upon the ground floor. The building was designed by Mr. Sayer and erected by Messrs. Trollope and Sons, of Pimlico.

Engines and Boilers.—The plant at present consists of three 50 horse-power Armington-Sims engines, with 12in. stroke, cylinders 9½in. by 12in., running at 300 revolutions per minute, made by Messrs. Greenwood and Batley, of Leeds. The boilers are two in number and are of the Babcock and Wilcox water tubular pattern, each working up to 104 horse-power. The boilers are supplied with water from a pair of Worthington pumps. The steam exhaust from the engines is passed through a water heater, whence water is pumped into the boilers. The products of combustion are carried up an iron smoke stack 70ft. high and 4ft. 6in. in diameter. It is intended later on to fit the engines with electrical governors.

Dynamos.—The dynamos are three in number, made by Messrs. Greenwood and Batley and designed by Mr. Jones. These machines are of the single horseshoe type, and are series wound; running at 800 revolutions per minute, they have an output of 35 units (70 amperes and 500 volts). The field-magnets are separately excited by a battery of accumulators. This arrangement is alleged to be more economical than using a small dynamo exciter, and the separate excitation permits the three machines to be run in series, and obviates all danger of reversal. For our own part we should have preferred the use of shunt-wound machines, which, although costing somewhat more for the field winding, would have given nearly automatic regulation for constant current. Owing, however, to the fact that the machines do not deliver current to the lamps, the regulation is a matter of secondary importance, and is easily effected by means of resistance coils in the field-magnet circuit, which are adjusted by hand.

Batteries.—Each consumer has a set of accumulators, which are charged in series, and which by an ingenious device, referred to below, can, if required, be used by the consumer whilst the charging current is on. The cells are of the new pattern E.P.S., 31L type, of 700 ampere-hour capacity. The number of cells in each installation varies from 8 to 64, according to the number of lamps. The circuit is worked upon the "Edmunds's distributing system," now introduced for the first time. The accumulators at each house are arranged in four sets, three of which are always in series on the lamps, and the fourth is on the charging mains. A small electric motor actuates a switch, which at intervals of one, two, or three minutes, as may be required, switches one set of cells off the lamps and on to the mains; each of the four sets is thus charged at equal intervals for equal periods. During the brief space of time when all four sets are on to the lamps, a resistance is simultaneously placed in series with them. By this device the total E.M.F. on the charging mains is diminished to one-third of the amount which would otherwise be necessary; but the total duration of charging is, of course, spread over a correspondingly longer period. Combined with this distributor is a new coulomb-meter, which, together with the distribution itself, we shall describe more fully as soon as the patents have been completed.

Cables.—The main circuit is a simple series one, seven miles long out and home. The furthest point supplied is Belgrave-square. The circuit is at present entirely overhead, though before long some portion will be placed underground along the Chelsea Embankment. The cable, a 19/14 strand, made by Messrs. Glover and Co., is suspended from a 7-strand steel wire, with standards at intervals of about 70 yards.

Lamps.—The total number of lamps at present in work is 965, though in a short space of time it is expected that there will be a total of 2,500 connected. The lamps used are Edison-Swan 16 candle-power, their voltage varying from 12 to 96 volts, according to the size of the installation. The largest private installation on the mains is that in the house of Mr. Reuben Sassoon, where 350 lights are wired.

* For previous articles see the following numbers of *The Electrician*:—Brighton, Dec. 9, 1887, p. 100; Dec. 16, 1887, p. 127; Dec. 23, 1887, p. 152; Dec. 30, 1887, p. 178. Bradford, Jan. 6, 1888, p. 204. Sheffield, Jan. 13, 1888, p. 233. And also Taunton, Dec. 17, 1886, p. 126; Paddington, May 28, 1886, p. 51.

NOTES ON ALTERNATE CURRENTS.

BY J. A. FLEMING, M.A. D.SC.

(Continued from page 143.)

Mutual Induction of Two Circuits of Constant Inductance.—We will conclude this chapter on the theory of simple periodic currents moving in circuits of constant inductance by examining the mutual induction between two circuits in one of which a simple periodic electromotive force operates. We suppose two circuits to be so placed relatively to each other that when a change of current occurs in one, which is called the Primary (Pr.), a change of magnetic induction takes place through the other, called the Secondary (Sec.). We have then to regard the primary and secondary as linked together by loops of induction and the closed lines of induction, together with the two circuits must be considered as forming three links of a chain. We shall suppose the self and mutual inductance to be known, as also the resist-

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ance of each circuit. The primary inductance and resistance will be denoted by L and R, and those of the secondary by N and S, and the mutual inductance by M. The primary is to be subjected to a simple periodic electromotive force of which the maximum value is E, and the result is to generate in the primary circuit a primary current, which, as we have seen, is also a simple periodic quantity, and is to be denoted by its maximum value, I_1. The change of induction through the secondary follows the change of current, and gives rise to an impressed electromotive force in the secondary circuit, which, being represented by the rate of change of the simple periodic induction, is also a simple periodic quantity, and gives rise to a simple periodic current in the secondary, to be denoted by its maximum value I_2.

The general description of the phenomena produced in such a system of primary and secondary circuits connected by an air magnetic circuit is as follows:—

1. The application of a simple periodic impressed electromotive force, E, produces a simple periodic current, I_1, moving under an effective electromotive force, $R I_1$, and brings into existence a counter electromotive force of self-induction, which causes the primary current I_1 to lag behind E by an angle called the primary lag θ_1. If n is the frequency of the vibrations and $2\pi n = p$, as before, then, as we have before seen, $\tan \theta_1 = \frac{Lp}{R}$, and this counter electromotive force of self-induction is a periodic quantity of which the maximum is $Lp I_1$, and of which the phase is 90° behind that of the effective electromotive force or current, or is in quadrature with it.*

2. The field round the primary, and therefore the induction through the secondary, is in consonance with the primary current I_1; but since it is also a simple periodic quantity its time-rate of change, and therefore the impressed electromotive force in the secondary, is in quadrature with the primary current. Since the induction through the secondary, due to a current, I_1, in the primary, is $M I_1$, by the definition of M the maximum value of the rate of change of this induction for a pulsation p is $Mp I_1$.

It is useful to note that in all dealings with simple periodic quantities, if X is the maximum value of a simple periodic quantity which runs through its cycle n times in a second, the maximum value of its time rate of change is denoted by pX where $p = 2\pi n$.

If, then, as usual, simple periodic quantities are denoted by the letter signifying their maximum values, prefixing p to any one gives us the value of its first differential with regard to time, or p is equivalent in notation to $\frac{d}{dt}$.

3. This secondary impressed electromotive force gives rise to a secondary current, I_2, moving under an effective secondary electromotive force, $S I_2$, and creating a counter electromotive force of self-induction in the secondary, represented by $Np I_2$.

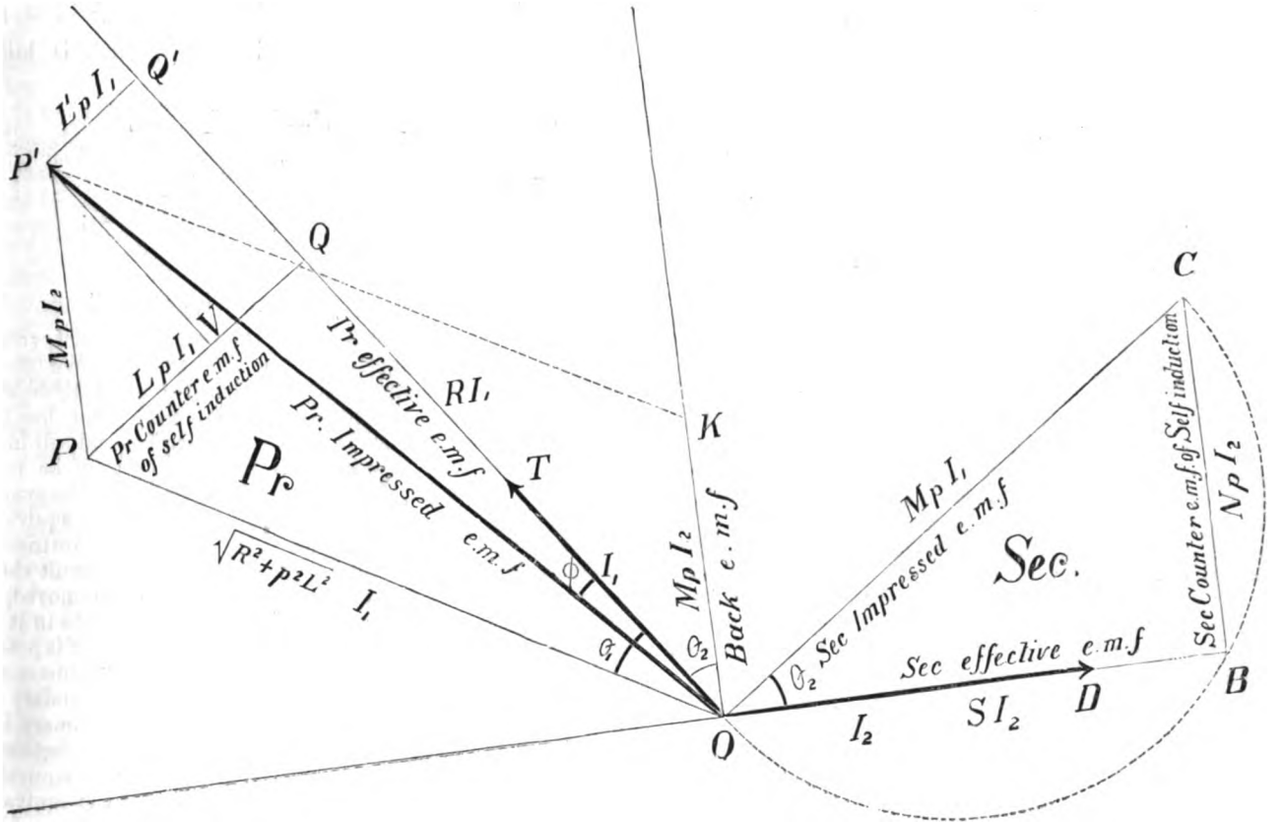

FIG. 40.—Electromotive Force Diagram for a Pair of Mutually Inductive Circuits.

The secondary current lags behind the secondary impressed electromotive force by an angle, θ_2, such that

$$\tan \theta_2 = \frac{Np}{S}.$$

4. This secondary current, I_2, reacts in its turn on the primary, and it creates what is called a back electromotive force, or reacting inductive electromotive force on the primary circuit. The phase of this must be in consonance with that of the electromotive force of self-induction in the secondary, and it is represented by the quantity $M I_2 p$. This is obviously in quadrature with the phase of the secondary current or secondary effective electromotive force.

5. There is, then, a phase difference between the primary and secondary currents, and also between the primary impressed electromotive force and the primary current.

The general problem is, then; given the value of the inductances L, M, N, and the resistances R, S, and that of the impressed electromotive force E and the frequency n, find from these seven quantities other four, viz., the primary current I_1,

* Mr. T. H. Blakesley has employed the term *in quadrature* to express the fact that one simple periodic quantity lags 90° behind another; hence the electromotive force of self-induction is said to be *in quadrature* with the effective electromotive force or current.—*See* T. H. Blakesley, "On Magnetic Lag," *Phil. Mag.*, July, 1888.

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the secondary I_2, and the difference of phase between E, I_1 and I_2.

We shall attack the problem geometrically, as this method exhibits far better than the algebraic method the relation between the various quantities involved. The method adopted is to construct an electromotive force diagram, in which all lines represent on any scale volts; and moreover as each of the quantities considered is a periodic quantity, the lines all represent the maximum value of each quantity, and the value at any instant can be obtained by taking the projections of all lines on any straight line through the centre of the diagram suitably placed.

Let O (Fig. 40) be taken as a centre; draw any line O Q', and on it set off any length, O T, which we *assume* as the magnitude of the maximum of the primary current. All other lines will be in proper proportion to this. Produce O T to O Q so that $O Q = R I_1$. O Q is then the effective electromotive in the primary circuit. From Q draw Q P at right angles to O Q, and set off Q P equal to $L p$ times O T or to $L p I_1$; Q P represents the electromotive force of self-induction in the primary circuit. Join O P.

From O draw O C at right angles to O Q, and set off O C equal to $M p$ times O T. O C is then equal to $M p I_1$, and O C represents the impressed electromotive force in the secondary circuit. On O C describe a semi-circle, and set off O B, making an angle C O B with O C such that $\tan C O B = \frac{N p}{S}$, or tan C O B = the ratio of the inductive to the ohmic resistance for the secondary circuit. Join B C. On the same scale on which O C represents the impressed electromotive force in the secondary circuit, viz., $M p I_2$, O B will then represent the effective electromotive force in the secondary, or will represent $S I_2$, and hence if O D is taken equal to one S^{th} part of O B, O D will represent I_2, or the secondary current. Next draw a line O K perpendicular to O B, and therefore parallel to B C, and on it set off a length, O K, equal to $M p$ times O D or to $M p I_2$. O K represents then the back inductive electromotive force of the secondary on the primary.

The impressed electromotive force which has to be applied to the primary to produce in it the primary current O T and induce in the secondary the secondary current O D has therefore to be equal and opposite to the resultant of three electromotive forces, or to equilibrate three electromotive forces, viz., the effective electromotive force of the primary O Q, the electromotive force of self-induction in the primary P Q, and the back electromotive force in the primary due to the inductive effect of the secondary on the primary, viz., O K.

The resultant of O Q and Q P is O P. If, then, we draw P P' from P, and make it equal and parallel to O K, and join O P', O P' will be the resultant of O Q, Q P, and O K; and hence O P' will represent E, or the impressed electromotive force required to be applied to the primary to maintain the currents I_1 and I_2.

It is to be understood that in this diagram a unit of length stands for a volt, an ampere, an ohm, and a secohm; and hence, on that assumption, E represents in volts the impressed E.M.F.—that is, the maximum of the simple periodic E.M.F. required to maintain the currents I_1 I_2, of which O T, O D represent the maximum values. The relative phases are indicated by the positions of these lines. To obtain the actual values of the E.M.F. and currents at any instant we have only to take the projections of O P', O T, and O D on any line drawn through O suitably placed, and the magnitudes of these projections will give the required quantities. We may consider the two right-angled triangles O Q P, O B C as pivoted together at O, and revolving round O; the fluctuations of the projections of O P', O T, O D on any line will give us the cyclic values of E, I_1, and I_2. We can next obtain some useful relations between these quantities from the geometry of the figure. In the triangle O B C,

$$O C^2 = O B^2 + B C^2.$$

Hence,
$$I_1^2 M^2 p^2 = S^2 I_2^2 + N^2 p^2 I_2^2;$$

or
$$\frac{I_1}{I_2} = \frac{\sqrt{S^2 + p^2 N^2}}{M p};$$

or
$$\frac{\text{primary current}}{\text{secondary current}} = \frac{\text{impedance of secondary}}{M p}.$$

$M p$ might by analogy be called the mutual inductive resistance.

To obtain the value of I_1 in terms of E, and the inductances and resistances, we project the lines O P' and O P on the vertical line O K, and express the fact that O P' or E is in all cases the resultant of O K and O P. Let the angle P' O Q' be called ϕ. ϕ is the angle by which the primary current lags behind the total impressed electromotive force. Then C O B is θ_2, and T O K = C O B = θ_2, since Q O C and K O B are both right angles.

Hence we have by resolution on O K

$$E \cos(\phi + \theta_2) = M p I_2 + \sqrt{R^2 + p^2 L^2}\, I_1 \cos(\theta_1 + \theta_2);$$

but since
$$I_2 = I_1 \frac{M p}{\sqrt{S^2 + p^2 N^2}}$$

we have by substitution

$$E \cos(\phi + \theta_2) = \left\{ \frac{M^2 p^2}{\sqrt{S^2 + p^2 N^2}} + \sqrt{R^2 + p^2 L^2} \cos(\theta_1 + \theta_2 \right\} I_1,$$

a relation established between E and I_1, which is known when ϕ is known.

Since
$$\tan \theta_1 = \frac{p L}{R}, \text{ and } \tan \theta_2 = \frac{p N}{S},$$

it follows by an easy transformation that

$$\cos(\theta_1 + \theta_2) = \frac{R S - p^2 L N}{\sqrt{R^2 + p^2 L^2}\sqrt{S^2 + p^2 N^2}};$$

hence
$$E = \frac{M^2 p^2 + R^2 - p^2 L N}{\sqrt{S^2 + p^2 N^2}} \frac{I_1}{\cos(\phi + \theta_2)}.$$

To find the value of ϕ, suppose that whilst E and I_1 remain the same the secondary circuit is suppressed. We should then only have an impressed electromotive force, E, creating a current, I_1, and from the diagram and from what has been before explained it is obvious that the effective and self-inductive electromotive forces in the circuit would then be represented by O Q' and Q' P'. If we denote these by the symbols $R' I_1$ and $L' p I_1$ we may properly call R' and L' the equivalent resistance and inductance; that is to say, these quantities are the resistance and inductance which the primary circuit should have in order that, when the secondary circuit is removed, the primary impressed electromotive force may generate in it the same current which it does when the secondary circuit is present and the primary has its natural resistance R, and inductance L. We see, then, that the effect of bringing up the secondary and allowing it to be acted upon and react upon the primary is to increase the effective resistance and diminish the effective inductance of the primary; in other words, the equivalent resistance of the primary circuit is greater and the equivalent inductance is less by reason of the presence of the secondary circuit.

We have then to find the value of $\cos(\phi + \theta_2)$.

$$\cos(\phi + \theta_2) = \cos\phi \cos\theta_2 - \sin\phi \sin\theta_2;$$

but
$$\cos\phi = \frac{R'}{\sqrt{R'^2 + p^2 L'^2}}, \qquad \sin\phi = \frac{L' p}{\sqrt{R'^2 + p^2 L'^2}},$$

and
$$\cos\theta_2 = \frac{S}{\sqrt{S^2 + p^2 N^2}}, \qquad \sin\theta_2 = \frac{N p}{\sqrt{S^2 + p^2 N^2}};$$

hence
$$\cos(\phi + \theta_2) = \frac{R' S - L' N p^2}{\sqrt{S^2 + p^2 N^2}\ \sqrt{R'^2 + p^2 L'^2}}.$$

Substituting this in the equation connecting E and I_1 we arrive at

$$E = I_1 \frac{(M^2 p^2 + R S - p^2 L N)\ \sqrt{R'^2 + p^2 L'^2}}{R' S - L' N p^2}.$$

Returning to Fig. 40, we see from it that P' Q' is parallel to P Q, and hence, if we draw P' V parallel to Q' Q, we have

$$P' Q' = P Q - P V$$
$$= P Q - P P' \cos P' P V$$
$$= P Q - P P' \sin \theta_2,$$

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or $$L' p I_1 = L p I - M p I_2 \frac{N p I_2}{M p I_1};$$

or, since $$\frac{I_2^2}{I_1^2} = \frac{M^2 p^2}{S^2 + p^2 N^2},$$

we have $$L' = L - \frac{N M^2 p^2}{S^2 + p^2 N^2} \quad \ldots\ldots \quad (A)$$

Also, again, O Q represents $R I_1$ and O Q′ on the same scale $R' I_1$, and

$$\begin{aligned} O Q' &= O Q + Q Q' \\ &= O Q + P' V \\ &= O Q + P P' \sin P' P V \\ &= O Q + P P' \cos \theta_2; \end{aligned}$$

hence $$R' I_1 = R I_1 + M p I_2 \frac{S I_2}{M p I_1};$$

and therefore $$R' = R + \frac{M^2 p^2 S}{S^2 + p^2 N^2} \quad \ldots\ldots \quad (B)$$

These formulæ (A) and (B) give us the effective inductance and resistance of the primary circuit as affected by the secondary. They were given by Clerk Maxwell in a Paper in the *Transactions* of the Royal Society in 1865.

If we form from (A) and (B) the function $R' S - L' N p$, we find it to be $M^2 p^2 + R S - p^2 L N$; and hence, by substitution in the expression already given, connecting E and I_1, we arrive finally at the result

$$E = I_1 \sqrt{R'^2 + p^2 L'^2},$$

or $$I = \frac{E}{\sqrt{R'^2 + p^2 L'^2}}.$$

Following the usual nomenclature, we may call the expression $\sqrt{R'^2 + p^2 L'^2}$ the *equivalent impedance* of the primary circuit, and we have as the final result for the induction coil of constant inductance

$$\text{Primary current strength} = \frac{\text{impressed electromotive force}}{\text{equivalent impedance of primary circuit}},$$

$$\text{Secondary current strength} = M p \times \frac{\text{primary current}}{\text{impedance of secondary circuit}},$$

The angle of lag of primary current behind impressed E.M.F $= \phi$ tan $\phi = \frac{p L'}{R'}$, and the angle of lag of the secondary current behind the primary is seen to be $90° + \theta_2$ and tan $\theta_2 = \frac{N p}{S}$; hence we have the values and relative phases of the currents and the impressed electromotive force.

In the above equations we are to understand current strengths and electromotive forces to be either the maximum values or the average values during the period. If i_1 and i_2 be the actual values at any time t, reckoned from the instant of the maximum value of the electromotive force, then, from the principles previously explained in this chapter, it is obvious that

$$i_1 = I_1 \sin (p t - \phi),$$

or $$i_1 = \frac{E}{\sqrt{R'^2 + p^2 L'^2}} \sin (p t - \phi),$$

and $$i_2 = \frac{M p i_1}{\sqrt{S^2 + p^2 N^2}};$$

or, $$i_2 = \frac{M p}{\sqrt{S^2 + p^2 N^2}} \frac{E}{\sqrt{R'^2 + p^2 L'^2}} \sin (p t + \phi + \theta_2 + 90).$$

This series of articles on "Alternate Currents" will be continued in the autumn, when the practical measurements of self and mutual induction and the practical cases of mutual induction of circuits embracing iron or magnetisable cores will form the subjects to be treated.

The London Telephone Service.—The United Telephone Company have now made arrangements to keep their exchange service open day and night, including Sundays.

THE VOLTAIC BALANCE.

BY DR. G. GORE, F.R.S.

A new and simple lecture experiment. Take two small clean glass cups containing distilled water; simultaneously immerse in each a small voltaic couple, composed of either unamalgamated zinc or magnesium with platinum, taking care that the two pieces of each metal are cut from the same piece and are perfectly clean and alike. Oppose the currents of the two couples to each other through a sufficiently sensitive galvanometer, so that they balance each other and the needle does not move. Now dip the end of a slender glass rod into a very weak aqueous solution of chlorine, bromine, iodine, or hydrochloric acid, and then into the water of one of the cups. The voltaic balance is at once upset, as indicated by the movement of the needle, and may be shown to a large audience by means of the usual contrivances.

The chief circumstance to be noticed is the extremely great degree of sensitiveness of the arrangement in certain cases—this is shown by the following instances of the minimum proportions of substance required to upset the balance with an ordinary astatic galvanometer of 100 ohms resistance, and with a Thomson's reflecting one of 3,040 ohms resistance.

1. *Zinc and Platinum with Iodine.*—With the astatic galvanometer, between 1 part of iodine in 3,100,000 and 3,520,970 parts of water.

2. *Zinc and Platinum with Hydrochloric Ac'd.*—With the astatic galvanometer between 1 in 9,300,000 and 9,388,185 parts; and with the reflecting one between 1 in 15,500,000 and 23,250,000 parts.

3. *Magnesium and Platinum with Bromine.*—With the astatic galvanometer between 1 in 310,000,000 and 344,444,444 parts.

4. *Zinc and Platinum with Chlorine.*—With the astatic galvanometer between 1 in 1,264,000,000 and 1,300,000,000 parts.

5. *Magnesium and Platinum with Chlorine.*—With the astatic galvanometer between 1 in 17,000,000,000 and 17,612,000,000 parts; and with the reflecting one between 1 in 27,062,000,000 and 32,291,000,000 parts of water.

Every different soluble substance requires a different proportion, and with unlike substances the difference of proportion is extremely great. With solutions of neutral salts the proportion of substance required to upset the balance is large; for instance, with chlorate of potash, a zinc platinum couple and the astatic galvanometer, it lay between 1 part in 221 and 258 parts of water.

By first bringing the balance with a magnesium-platinum couple and the astatic galvanometer nearly to the upsetting point, by adding 1 part of chlorine to 17,612 million parts of water, and then increasing the proportion to 1 in 17,000 millions, the influence of the difference, or of 1 part in 500,000 millions, was distinctly detected.

HIGH AND SLOW SPEED ENGINES.*

BY J. A. POWERS, C.E.

The able Paper read at the late Convention of the National Electric Light Association, at Pittsburg, by Mr. Wm. Lee Church (see *The Electrician*, 16th March, 1888), suggests some points in the relative coal economy of high and slow speed engines which it is believed are not fully nor fairly treated in that Paper. That the experience of Mr. Church in the making, testing and using of high-speed engines leads him to the conclusion that the independent high-speed engine is the best in average coal economy in incandescent light stations, because the stations which he cites as users of large engines are less economical of coal than other well-designed stations using high-speed engines, is no proof that high speed is a better economist than slow speed, even for the variable loads of incandescent light stations. The great variety of boilers, settings, and draft appliances, and in the quality of fuel in use render any comparisons of coal consumption valueless except as a general index of possible results. The only fair way to state the general problem is to make a distribution of the steam consumption, which would be about as follows :—

* From the *New York Electrical Engineer* of July, 1888.

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First.—Steam loss by radiation, and used for boiler feed and in providing water supply, &c. This will constitute a certain nearly uniform amount per day for any given plant when under steam.

Second.—Steam consumed in engines, as shown by indicator cards. It is this second item with which we are concerned, as the first will be an individual factor for each station.

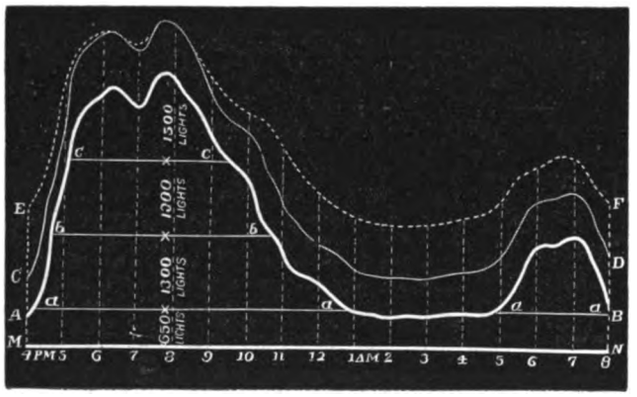
We should then consider the nature of the loads imposed on the power plant in every electric light station, and then deal fairly with the problem. These loads are :—

1st. Friction.—*a*, consists of friction of engines in use ; *b*, friction of shafting in use ; *c*, friction of dynamos and belting in use.

2nd. Effective load ; power required for conversion from mechanical to electrical energy, including the losses in conversion out-put.

It will be evident that the "friction" load in the case of independent engines will be a nearly uniform percentage of the electrical out-put at any time, providing each engine is loaded to about its fair capacity, while in the case of slow-speed engines there will be a certain constant quantity introduced, viz., the friction of the engine shafting and dynamos necessary to be run whether without load or not when dynamos are in operation. This is a consequence of the inflexibility of the shafting system, and we must, therefore, under light loads pay a penalty of a larger percentage of friction to load, than with independent engines, and this will entail an extra coal expense. The question of the coal economy of the two systems therefore depends on whether the slow speed can save enough coal when under heavy load to more than counterbalance the losses by friction under light load.

It is not to be presumed that any sane man will design a station for such a loading as Mr. Church shows in his diagram, which is reproduced below, to be run by a single engine large enough



Mr. Church's Diagram.

(See *Electrician*, March 16, p. 513.)

to handle the entire load. No steam engineer would consider the idea of handling the lightest loads—say from 60 to 75 horse-power—with an engine of 400-horse capacity. The necessities of any but the smallest station call for a divided engine plant. If the question of reserve power be left out, a station of 400 horse might be properly provided with one engine of 100 horse and one of perhaps 300 horse, both slow speed if desired. If the smaller engine be a high-speed the station will be on the same terms as a station with exclusively high-speed engines during the hours of light loading, which would limit the question of relative coal economy to the hours of heavy loading, say from 4 till 11 p.m. and 5 to 8 p.m. The arrangement for such a plant should be to drive each engine to a section of shafting conveniently arranged to give each engine its separate shaft and dynamos. These sections may be coupled by a friction clutch when desired, and friction clutch pulleys should be used for the driven pulleys from the engines. The dynamos may be provided with loose pulleys on the shaft or with some kind of belt holder to enable the dynamo to be stopped without interfering with the line shaft. The dynamos may be belted in opposite directions in pairs when space will permit, so as to reduce friction to a minimum.

Now, in comparing the relative friction of the two systems the friction of dynamos may be neglected, since any dynamo may be stopped as soon as its load is taken off, in either system ; in one case by stopping an engine, in the other by shifting a belt. This brings the question of friction down to whether the friction of large engines and shafting exceeds that of small engines alone.

The friction of high-speed engines is variously stated by engine builders at from five to eight or 10 per cent of full load. Probably the latter figure is not far from the truth, and if it were too large a percentage for full loading it must be remembered that a minute subdivision of power would be required to bring this about, and that this is neither practical in cost of investment nor of operation, and that a reasonably divided power plant will not ensure high-speed engines always working on full loads. The percentage of friction will be greater under less than full loading, since engine friction seems to be nearly constant for all loading in well-designed engines.

Mr. Church states that shafting and engine friction ranges from 12 to 20 per cent. upward, and not infrequently rises to 30 per cent. This may be possible, but it certainly is not so in all cases, and if we allow the same skill in designing a slow-speed station, which some of Mr. Church's show, it is entirely unnecessary. Indicator diagrams from a 20 by 48 Corliss engine, driving 16ft. of $3\frac{7}{8}$ shafting at 320 revolutions, one 50-light Thomson-Houston 1,200 candle-power and one United States 20 arc light dynamo, out of circuit, showed a total of $14\frac{6}{10}$ horse-power, and deducting 3 horse-power for the dynamos this leaves $11\frac{6}{10}$ horse-power for friction of engine and line shaft, or $5\frac{8}{10}$ per cent. if the engine be rated at 200 horse-power. This would indicate the engine friction to be as low as three per cent. The same engine driving 17ft. of $4\frac{7}{8}$, and 33ft. of $3\frac{7}{8}$ shafting with pulleys, but without belts, showed $22\frac{1}{2}$ horse-power, or 9 per cent., for engine and shafting. If the dynamos are belted in pairs with belts pulling against each other there will be no increase of their friction under load. A slight increase under load may be expected from the extra strain of the main engine belts under load, but a fair outside limit of 10 per cent. for engine and shafting friction may be taken from these data.

Now, in the diagram shown of the load of an incandescent station (reproduced above) Mr. Church says that the heavy lines A B represent the fluctuation of the *actual load*, such as would be determined by indicating a series of independent engines, and the area enclosed between it and the base line M N may be denominated the net power required. This presumably includes the engine, belting, and dynamo friction of the high-

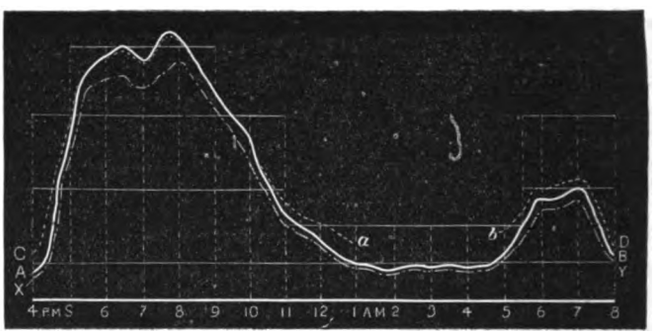


Diagram A.

speed engine. Then Mr. Church proceeds to saddle all the sins of the high-speed system on the slow-speed system by saying :—"The fine irregular line C D encloses the gross load when driven by a single large engine, being equivalent to the *net load* plus the friction of the shafting and pulleys required in transmission," thus assuming that the net load is the *indicated horse-power* of the high-speed engines, entirely ignoring the frictions which are chargeable to that system.

Now let us take some liberties with Mr. Church's diagram (*see* diagram A). We have reproduced his heavy line, A B, of gross loading, as shown by the indicator on the high-speed engine plant. From this line is constructed a new curve, shown in broken and dotted line, which is obtained by deducting from the ordinates to the curve, A B, the 10 per cent. of friction chargeable to the high-speed system. This new line, X Y, is the true line of net power, and it is from this line that we must construct our friction curve for the slow-speed system. This curve, C D, will be found by laying off a line above the curve X Y, and distant from it 10 per cent. of the maximum power in use. The diagram now shows simply the power used in driving the entire station, and does not consider the coal economy of the engines, which in Mr. Church's diagram is charged up against the slow-speed system in the curve E F, and is not considered in the high-speed curves at all. It will be noticed that this slow-speed power curve, C D, nearly coincides with the gross power curve A B of the high-speed system during the times of heavy loads, and that it rises above it as the load becomes less. The station is supposed to be operated by starting the 300 horse-power engine at 4 p.m., and supplementing it with the 100 horse-power at 5 p.m., then dropping off the 100 horse-power at 9 p.m., and starting it again at 11 p.m., shutting down the large engine at the same time. At 5:30 a.m. the 300 horse-power would be started and run till 8 p.m., the 100 horse-power going out of service at 5:30 a.m.

We have now to consider the steam economy of the various types of engines in order that we may discuss intelligently the

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relative economy of the two systems. The following is a summary of the statement of engine builders on the point :—

	lbs. steam per horse-power-hour.
High-speed engines of 50 to 100 horse-power	28 to 32lbs.
Corliss engines of 200 to 400 horse-power—	
Single cylinder, high pressure.....	24 to 26lbs.
,, ,, condensing	20 to 21lbs.
Compound condensing	15 to 16lbs.

These results would give with an evaporation of eight pounds of water per pound of coal :—

	Coal per horse-power-hour.
High speed	3·50 to 4·00lbs.
Corliss single cylinder, high pressure	3·00 to 3·25lbs.
,, ,, ,, condensing	2·50 to 2·62lbs.
,, Compound condensing	1·87 to 2·00lbs.

These results do not vary much from good practice for the Corliss engines, but the departure is very wide from the ordinary results in the case of the high-speed type. A central station operator of great experience informed the writer not long since that he allowed six pounds of coal per arc lamp per hour as an average result. This would not be less than six to seven pounds of coal per horse-power hour for engines of 50 horse-power. The experience of the writer goes to prove that this result is about correct for engines of that size. For 100 horse-power engines a result, perhaps, one pound better can be had. The results recently shown in changing some stations from high to slow speed seem to indicate the correctness of these results, one such reporting a saving of 50 per cent. in fuel. Another case where a 20 by 48 Corliss was substituted for three 50 horse-power high-speed the results were fully as good, though the Corliss engine was a part of the time under a very light load. The most curious result is that this engine is sometimes run under a load of 125 horse-power during a dark day in place of the 50 horse-power engine which ordinarily carries a day-load of 60 horse-power, and actually carries the heavier load with the same coal, though the Corliss engine works at only half-load, while the 50 horse-power was but slightly overloaded, and at a comparatively economical point of cut-off. This is a comparison of much value in considering the relative merits of the two systems, since the indications are that the Corliss engine is more economical even when under half-loading than the 50 horse-power high-speed engine is at a fair load.

Now let us consider the comparative coal consumption of the two systems on the power curves we have laid out in diagram A. The planimeter shows between the base line and the power lines—

A B	horse-power-hours 3,300
C D	
4 to 11 p.m.....	
11 p.m to 5 a.m.....	
5 a.m. to 8 a.m.	3,580

If these quantities are multiplied by the proper coal rates we have :—

High speed A B, 3,300 × 5lb.	=16,500
Slow speed C D.	
High pressure	3,300 × 3·25 = 10,750
Condensing	3,300 × 2·62 = 8,646
Compound condensing.....	3,300 × 2·00 = 6,600

These results show savings as follows :—

	Saving.
High-pressure Corliss.....	5,750lb.
Condensing	7,854 ,,
Compound condensing	9,900 ,,

over the high-speed engines at 5lb. coal per horse-power per hour.

Now the Corliss engine will not, of course, be working on an economical loading during part of the time, but in order to get an extreme comparison let us suppose that the Corliss system is run at full power whenever in use at all, or, other words, that the coal consumption is the same whether the engine is partly or fully loaded. I do not believe that the most ardent advocate of the high-speed system will claim that the Corliss engine will burn more coal under light load than when fully loaded.

The schedule as above indicated would give the following horse-power-hours :—

310 horse-power, 4 to 11 p.m.	2,170
5:30 to 8 a.m.	776
125 horse-power, 5 p.m. to 9 p.m.	500
11 p.m. to 5:30 a.m.	812
	4,257

which would give the coal consumption—

High-speed at 5lb. coal per horse-power-hour	=16,500
Corliss, high pressure	4,257 × 3·25 = 14,835
,, condensing	4,257 × 2·62 = 11,153
,, comp. condensing	4,257 × 2·00 = 8,514

So that the high-pressure Corliss engine is the better on coal consumption, even under the *reductio ad absurdum* that there is no saving in coal as the load becomes less, and giving the high-speed engine the benefit of a coal rating at full load. It will be noticed also that the coal rates taken for Corliss engines, as above, are the largest rates shown by ordinary practice, and make no allowance for expert care which has its effect on all engines in saving of leakage and friction.

This discussion leads us to about the following conclusions as to the coal economy of the various types of engines, taking the high-speed engine as unit :—

	Coal consumption, lbs.	Percentage, saving.
High speed	16,000	0·00
Corliss, high-pressure	11,000	·31$\frac{2}{16}$
,, condensing	9,000	·43$\frac{8}{16}$
,, comp. condensing	7,000	·57$\frac{2}{16}$

This is believed to be as fair a statement as can be shown from the average practice. These results speak for themselves. We must use condensing engines wherever possible, and to do this we must locate near a plentiful supply of water. If no stream or pond is convenient we must try driven or artesian wells. Both have proved effective, and location must determine the choice. The saving by condensing is not less than 25 per cent. under full loads, and one-quarter of our coal bill will pay large interest on any reasonable expenditure to obtain water supply.

First cost of steam plant is a matter of importance in station construction, and may be fairly stated about as follows for the different types of engines :—

One 100 horse-power engine, high-speed	$1,500 to $1,800
,, 200 ,, Corliss ,, ...	4,500 ,, 5,000
,, ,, ,, ,, condensing	5,200 ,, 5,800
,, 350 ,, ,, comp. condensing	13,000 ,, 14,000

If we add shafting to the cost of the last three engines we shall have a cost per horse-power :—

	Cost per horse-power.
100 horse-power high-speed engine.....	$15 to $18
200 ,, Corliss high pressure	30 ,, 32
200 ,, ,, condensing.....	33 ,, 36
350 ,, ,, comp. condensing.....	45 ,, 48

This is as far as the high-speed advocate usually goes, but it is not far enough. If we need less steam we require less boiler capacity, and this reduction will be nearly in proportion to the coal rates of the different types of engines. A well-set boiler of 60in. diameter by 17ft. long, with good draft, will supply steam for three 50 horse-power engines, but will need forcing to do it. The same boiler will supply a 20 by 48 Corliss condensing engine of 250 horse-power much more easily.

We may fairly state the cost of steel boilers well set, as required by the different systems, about as follows :—

100 horse-power high speed.....	$16 to $18 per h.-p.
200 ,, Corliss	12 ,, 14 ,, ,,
200 ,, ,, condensing	10 ,, 12 ,, ,,
350 ,, ,, comp. condensing	7 ,, 9 ,, ,,

So that the total cost of steam plant will be about as follows :—

High-speed.....	$31 to $36 per horse-power.
Corliss.....	42 ,, 46 ,, ,,
,, condensing.....	43 ,, 48 ,, ,,
,, comp. condensing.....	52 ,, 57 ,, ,,

Now let us compare our results of first cost and saving together.

	Cost per cent.	Coal consumption, per cent.
High-speed	$1.00	100
Corliss	1.31	62
,, condensing.....	1.36	56
,, comp. condensing.....	1.62	44

and with coal at $3 per ton on the above schedule and interest at 6 per cent., the results will be for the 400 horse-power station under consideration :—

	Cost of coal per day.	Saving in coal over high speed.	Interest per day on 400 horse-power.	Loss in interest.
High speed.....	$24.75	0·00	2·36	...
Corliss horse-power	18.90	5·85	3 08	·72
,, condensing	15.24	9·51	3·15	·79
,, comp. condensing...	11.64	13·11	3·75	1·39

Or in a 400 horse-power station the high-pressure Corliss engine beats the high-speed system $5.13 per day, Corliss condensing $8·72, Corliss compound condensing $11.72.

It may be said that these figures are theoretical to some extent; but they will be found to agree pretty closely with the results of good practice for both systems.

It is to be noted that a number of stations lately laid out contemplate the use of Corliss engines, in part at least; and some of them from the plans of the best engineers we have.

The writer hopes to supplement this Paper with a statement of some accurate tests on engines of each type at an early date.

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The Electrician.

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INCANDESCENT LAMP LITIGATION.

Now that the prolonged and exhaustive investigation into the merits of EDISON as an inventor of the incandescent lamp has at last come to an end, and judgment has been pronounced invalidating the patent, the strongest impression left upon our minds is one of utter astonishment that a stringent monopoly should have been maintained so long and so successfully upon a patent of so flimsy a character. "Flimsy," we think, is not too strong—or rather too weak—a word to describe a patent which has been declared invalid on points so fundamental and so numerous as the following:—Because it does not describe a lamp which ever became commercially successful; because the directions were so insufficient that no one could make the carbons described without previous experiment; because one of the processes set forth is positively injurious, and the clauses relating to coated and coiled filaments are of no practical utility; and, lastly, because the claim for a monopoly of incandescent lamps having a filament of carbon is far too wide, "considering," as his lordship added, "how little EDISON has actually invented." We believe that no unprejudiced person who has followed the proceedings can fail to admit that the weight of the evidence demanded this decision, and we must now recognise the fact that the claims of EDISON to be regarded as a discoverer of any element of the first importance in incandescent lamp manufacture are thereby finally exploded. And yet this patent had already stood the test of an action which was carried through every legal tribunal up to the House of Lords! And on the strength of that decision the Edison-Swan Company has extinguished all competition in this country save that of the defendants in the recent action, while the glory of the American "inventor" has outshone that of SWAN or LANE-FOX a hundredfold. We do not, of course, attach any vestige of blame to the company for taking every advantage of their success in the action against WOODHOUSE and RAWSON, but at the same time it is evident that a grave injustice has been done, not only to the firm last mentioned and to other manufacturers of lamps, but to the whole electric lighting industry, to say nothing of the consumers themselves, who have undoubtedly paid many thousands of pounds in virtue of this monopoly. How it came to pass that the Woodhouse and Rawson action resulted as it did is less extraordinary when we remember that no evidence was tendered as to the difficulty of carrying out Edison's specification in its literal interpretation, that no question was raised as to the utility of any part of the patent, and that the

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historical evidence was of the most meagre description. Mr. JUSTICE KAY, commenting upon the decision of the Court of Appeal, expressly stated his belief that had the same evidence been brought forward on that occasion the learned Judges would have arrived at the same conclusion as he had now done. It is now, however, possible to assert without fear of contradiction, that EDISON did not invent the incandescent lamp. For ourselves, we have never supposed that he did; but there are many people, mostly untechnical, who imagine that he was the true inventor. Even among the electrical fraternity, EDISON, as an inventor, has been somewhat over-estimated. One reason for this is that he possesses the valuable faculty of covering a great deal of ground. If you ask an electric light engineer what EDISON has actually invented, he says, "Oh, nothing much in our line, but look what he has done in telephones!" The telephonist says, "Of course he has not really done anything to speak of in telephones, but he invented nearly everything in the electric light." Then the American Press treat him as a sort of wizard, and his name has gradually become something to conjure with, even in this sober country.

We do not deny EDISON himself, as well as the organisation of clever assistants of whom he is the figure-head, the credit for a vast deal of ingenuity, but we decline altogether to look up to him as the greatest inventor of the age. From our previous knowledge of the subject, aided by what has come to light in the recent trial, we are compelled to recognise that EDISON took a false position in the matter of the incandescent lamp. He knew that high resistance was needed for parallel distribution at the time that he was working at a platinum lamp. In an American patent suit it has come out that in 1878 lamps with paper carbons were shown publicly. EDISON'S people for certain, and perhaps EDISON himself, though that is more doubtful, saw these lamps. EDISON then tried some rough experiments to see if he could get high enough resistance by using paper carbons, and, finding that the results showed some degree of promise, he lost no time in taking out a vague patent, by which he hoped to cover high-resistance carbon lamps, in case they should ever become practicable. On this he poses as the inventor of the incandescent lamp. As anyone who introduces a foreign manufacture previously unknown in this country is entitled to a patent, this would not legally invalidate EDISON'S patent. Moreover, it is very difficult to bring evidence of this character before the Court.

We will now briefly run through EDISON'S specification with the additional light thrown on it during the trial. The object is not to produce a commercial lamp generally, but to make one with a resistance high enough for parallel distribution. He had already described the notorious platinum lamp as suitable, and now, as shown clearly by the provisional, he proposes to substitute carbon for platinum in this lamp, and that is all. He had no doubt found that Sawyer-Man low-resistance lamps contained carbon, and he thought that substance might still do when cut thin. To avoid undue thinness and resulting fragility, and still to get high enough resistance, he coils his carbon into a close spiral. Instead of wanting a very thin carbon he wanted it as thick as he could get it consistently with small radiating surface and high resistance. It was some time afterwards that EDISON "discovered," to use his own expression, that this coiling was unnecessary, so he took out an additional patent for doing without a coiled fibre. The whole of the 1879 specification, therefore, refers to coiled carbons.

The invention further consists in using a good vacuum. The necessity for this was of course well known long before. The method of mounting with tar-putty is the next part of the invention. There is really nothing especially valuable in this, but it is actually the only trace of originality or novelty in the whole specification. Every other suggestion is either useless or well known. So the Edison-Swan Company has had a monopoly of lamp manufacture on a patent whose only merit is a suggestion to mount with tar-putty, a material which has not come into actual use. EDISON'S description of the state of knowledge is quite erroneous. He seems scarcely to know what other people have done since somewhere about the year 1850.

The patent then goes on to say that he has "discovered" that a properly carbonised cotton thread gives from one to five hundred ohms resistance, and is absolutely stable at very high temperatures. After this astounding statement he says that any fibrous vegetable substance which will leave a carbon residue on heating in a closed chamber will do. No doubt an Edison lamp, made under this specification, of spring rhubarb or asparagus would be as valuable commercially as the other forms described. Though fibrous vegetable material includes a great many things, it does not suggest much to a workman. The famous lampblack putty is next described. The manufacture of lampblack putty is an art in itself. The mixture must be kneaded for some hours, and then, with care, you can very nearly make a filament. It is a curious thing that during the whole trial a lamp made with the filament coiled according to the specification was never put in. Apparently it could not be made, even with modern knowledge and experienced manipulation. Various erratic horseshoes and irregular corkscrews were put in, but these were not according to the specification.

In order to get his carbon massive, EDISON introduces camphor or oxide of zinc to keep up the resistance. It need hardly be said that this process is of no practical value. The tar putty mounting is then described, and its object is to allow of mounting before carbonisation, as the filaments are too fragile afterwards.

The inventor once more speaks of the advantage of having his carbons massive. In spite of this it has generally been held that thinness was his aim. He says he has used "cotton and linen thread, woodsplints and paper coiled, and tar putty." No lamp was put into court made with a filament of a coiled wood splint.

He proposes to insulate his coils with some non-carbonisable non-conductor. The drawback to this is that no suitable substance can be found. Every reader probably knows the second and most important claim by heart now. It is, broadly, a claim for incandescent lamps with carbon filaments, and we have briefly shown on what basis it rests.

Apart from this extraordinary patent we cannot find that EDISON has invented anything of real importance in incandescent lamps. Parallel distribution, high resistance to save leads, carbon conductors, good vacua, and hermetical sealing were all well known before his day; parchmentised cellulose was introduced by LANE-FOX; running on the pumps was invented by SWAN or STEARN, though EDISON had stumbled across something of the sort, but had not adopted it; external heating on the pumps was applied to lamps by STEARN; thickened ends for mounting were invented by LANE-FOX, and flashing was also independently devised by LANE-FOX, although it has been held to be covered by CHEESBOROUGH'S patent. We cannot avoid the conclusion, therefore, that of all the important advances in lamp-making not one is due to EDISON.

ELECTRICAL TRADES AND THE LONDON CHAMBER OF COMMERCE.

We announced last week that the London Chamber of Commerce had convened a meeting of those of its members who are interested in the electrical trades in order to consider a proposal for the formation of an "Electrical Trades Section." This

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proposal, as our readers are aware, emanated from the firm of WHEATLEY KIRK, PRICE AND GOULTY, and the suggestion is one which merits the very fullest consideration. At the meeting on Friday last, which was attended by about a dozen members of the Chamber, a Provisional Committee was formed with the object of arranging for a public meeting of the electrical trades, to be held on July 27th, when resolutions will be moved that the London Chamber of Commerce be requested to establish an Electrical Trades Section. It is earnestly to be hoped that this meeting will be attended by everyone who is interested in the commercial aspects of electrical engineering, and that some definite result may be attained. We are not prepared to say that the scheme referred to will fulfil all the expectations at present entertained by its more ardent supporters; but we do feel confident that the movement will not fail to be distinctly conducive to the business interests of electrical engineers. A glance at its Memorandum of Association will show that the LONDON CHAMBER OF COMMERCE is in a position to afford an admirable basis of operation. Its objects are the promotion of the trade, commerce, shipping, and manufactures of London, and of the home, colonial, and foreign trades of the United Kingdom; the collection and dissemination of statistical and other information relating thereto; the promoting, supporting, or opposing legislative measures affecting those interests; the undertaking by arbitration of the settlement of disputes arising out of trade, commerce or manufacture; and generally to combine for the purpose of promoting the aforesaid objects. The various Chambers of Commerce both in England and throughout the world are in close intercommunion; and there is no restriction as to membership in the London Chamber, provincial firms being eligible equally with those in the metropolitan district.

A few words explanatory of the organisation of the association may be useful to our readers. It is governed by a general council selected from the numerous trades which are upon its roll. Of course, the members include a large number of individuals and firms not directly or specially interested in any one trade; but whenever any considerable body of representatives are desirous of associating themselves for the purpose of more effectually dealing with the welfare of a particular trade, they may, with the approval of the Council, form themselves into a Trade Section; and this, again, may be divided into sub-sections. In the case we are considering there would be an Electrical Trade Section, which would most probably subdivide itself into Electric Lighting, Electric Traction, Telephonic and other Sections. The proceedings of the section and its subsidiaries would be entirely in the hands of the members—with this proviso only, that any resolution arrived at involving action on the part of its members as a body must be submitted to the Council, and if approved would then receive the united support of the whole Chamber. This, it will be perceived, is no small advantage to trades which are not powerful enough to fight their own battles unaided; and the electrical trades are confessedly in that condition at present.

Membership of the Chamber by payment of an entrance fee and annual subscription is, of course, a condition of entry to any of the trade sections. But for those who favour the scheme, or may wish to take part in the preliminary proceedings, in order to decide their course of action, it may be mentioned that membership is not necessary until the final stage has been reached. That is to say, a number of names of persons or firms may be submitted as ready to join in the formation of an electrical trade section, but their entry into the Chamber as members need not be made good unless and until the Council agree to the proposition. This fact will, no doubt, be made known, and will facilitate proceedings at the meeting which is announced for Friday next. It may be hoped, too, that the trade jealousies which were the chief cause of the collapse of the original project last autumn will disappear under the more genial auspices of this new departure. We are not predicting that they will; we only assert that they ought. A Chamber of Commerce is a wide enough platform for all; and the system which prevails there is eminently calculated to assuage personal rivalry and trade feuds. The condition which we have mentioned, that all active measures are subject to the approval of the General Trades Council, admirably serves this end; and although at first sight it may appear irksome, it is a perfect guarantee against the undue influence of mere wealth and the tyranny of numerical majorities. On the whole, we are disposed to look favourably on this proposal; it can do no harm to the SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS, and it can hardly fail, if carried out, to do some good to the electrical trades of this country.

ON THE TESLA ALTERNATING-CURRENT MOTOR.

BY J. SWINBURNE.

The account of Mr. Tesla's invention has received such attention from the technical press, and appears to have satisfied so many people that the problem of alternating-current motors is solved, that a short investigation of the subject may not be amiss.

The problem of alternating-current motors may be divided into two distinct parts—to make a motor that will start, and to make a motor that will work with varying loads, preferably with constant or nearly constant speeds, but certainly with reasonably high efficiency in each case. As those who are accustomed to the usual way of treating dynamo problems will perhaps find a little difficulty in following Mr. Tesla's description, an attempt will be made to describe his apparatus another way.

Suppose an alternating-current dynamo, such, for instance, as the Westinghouse, were taken, the armature has, roughly speaking, only half its periphery covered with wire. If another circuit were wound on, filling up the air spaces, it would also give an alternating current if it had its own collectors, but this alternating current would be a quarter of a period behind the other. The same effect would be got by rigidly coupling two alternate-current machines together so that one is a quarter of a period in advance of the other—that is to say, one has its coils in a maximum field when the others are in their minimum field. The simplest form of such a motor would be an ordinary drum armature wound with two coils at right angles, each coil having its own pair of collector rings. This is the example taken by Mr. Tesla. The magnets, of course, are supposed to embrace a quadrant each, instead of about 150 degrees as is usual in continuous-current machines. For simplicity we will suppose the generator to be made up of two ordinary alternating-current machines, coupled rigidly together as described, with two pairs of conductors, each with its own alternating current, these currents differing by a quarter of a period. If a motor is made up in a similar way by coupling two alternate-current machines together, if once started it will run in exactly the same way as an ordinary alternating-current motor, having all its advantages and disadvantages, with the addition that it needs two sets of leads and a special generator. Its efficiency is the same as an ordinary motor, and it will synchronise in the same way. Of course it will not start.

Suppose now that the alternating motor is varied in construction so that the armatures are stationary, the effect will be just the same. A synchronising motor will be obtained which is not self-starting. Instead of this Mr. Tesla uses what he calls a fixed field-magnet with a rotating field and rotating armature in his motor, but we may perfectly correctly call it a fixed armature and rotating field-magnet. The armature is outside the field-magnet, and may be looked upon as a Gramme ring wound with four coils, the opposite coils being pairs, so that there are two circuits. One is connected to each pair of

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leads. The direction of magnetisation is thus made to revolve just as in any alternate or direct current machines in which the armature is fixed and the field revolves, such, for instance, as the Ayrton and Perry motor or new Siemens dynamo. So far the only result is no better than can be got from machines already known.

As to the exceedingly ingenious method of starting, suppose in an ordinary dynamo an armature is revolved, having some short-circuited coils, the armature resists the motion owing to the currents induced. The armature is revolving, and the direction of magnetisation is fixed; but, as motion is relative, we may say that the direction of the magnetisation and the closed coils are moving relatively to each other. This relative motion is opposed by the currents induced in the coils. Now, if Mr. Tesla winds some closed coils on what he calls his armature, and what is here called his field-magnet, when the direction of magnetisation moves round relatively to the closed coils, currents are induced which tend to make the field-magnet revolve.

This ingenious method of making it start is the only advantage Mr. Tesla's motor possesses. In the synchronising form the closed coils of the field-magnets are used till the proper speed is attained, when the machine falls into step, and the exciting current is switched on, so that they become the field-magnet coils in the ordinary sense. In another form the whole motive power is supplied by these closed coils, so that the machine does not actually synchronise, but goes slower at heavy loads.

Taking the first form, or synchronising motor, we get a self-starting motor, but it needs an exciter, and needs also a special dynamo to drive it, with two circuits, involving three or four leads. In the second form the revolving part cannot be so well described as the field-magnet, because it is excited entirely by the armature. Of course an ordinary direct-current dynamo will work as a motor without any field current if the brushes are put forward, the field being then excited by the armature current; but to make such an arrangement efficient, apart from the question of sparking, which does not now concern us, the armature would have to be designed so as to magnetise the field strongly. In Mr. Tesla's arrangement this is impossible unless the machines are of enormous size. This difficulty would be lessened by making both the fixed and revolving parts on the Pacinotti principle. Instead of using two closed coils on a smooth core, there would also be an advantage in simply encasing the armature in solid copper.

The low efficiency is not at all the chief objection to the scheme. The whole arrangement is unpractical, as it demands special alternate-current generators and leads. There are several ways of starting alternate-current motors. The exciter may have laminated field-magnets, and may be put on the alternate-current circuit to get up the speed, as already proposed by the writer, or a small secondary battery may be used in connection with the exciter, which will start the whole system. It would never be worth while to put down special dynamos and special leads just to use a motor that will start, and that has no other advantages. The two circuits would be useless for other purposes. The transformer proposed by Mr. Tesla must be very inefficient. It has consequent poles revolving, and has thus an open magnetic circuit. It would be better to use the two alternating currents separately, putting some of the transformers on one circuit and some on the other; but if two circuits are to be used it would certainly be cheaper to use a direct current for the motors, and have them self-starting, self-regulating, and efficient. Until Mr. Tesla can produce a motor which will work on alternate-current circuits as they are, and do that efficiently even with varying loads, and without difficulty in starting, he can hardly be said to have solved the problem. With the ingenuity he has already shown no doubt he will do it soon, but he cannot be said to have done it yet.

RE LUTHER HANSON.—Last week a meeting of the creditors of Luther Hanson, electrical engineer, Halifax, was held at the offices of the Official Receiver. The debtor's statement of affairs showed assets £1,724. 17s. 4d., and liabilities £1,518. 3s. 8d., a surplus of £206. 13s. 8d. In this estimate, however, the works had been taken as a going concern. The debtor was made bankrupt, no offer of composition being made.

THE ANGLO-AMERICAN BRUSH CORPORATION AND THE LAMP QUESTION.

The following circular has this day been issued to the shareholders of the Anglo-American Brush Electric Light Corporation (Limited):—

The Directors have reason to congratulate the shareholders upon the result of the litigation with the Edison-Swan United Electric Light Company (Limited), and take this opportunity of putting before them the facts connected with this important case.

It is doubtless within the knowledge of many of the shareholders that the Edison-Swan Company about a year and a-half since obtained a judgment in their favour against the manufacturing firm of Woodhouse and Rawson upon two patents held by them, viz., that which was considered as the fundamental Edison patent for the general principles involved in the manufacture of incandescence lamps, No. 4,576 of 1879, and that of Sawyer and Man (known as the Cheesborough patent), No. 4,879 of 1878, for a process in the manufacture of carbon for electric lamps. These actions were gained by the Edison Company in the court of first instance, before Mr. Justice Butt, and subsequently in the Court of Appeal.

Following these decisions the Edison-Swan Company commenced a system of intimidation against the users of the Victoria incandescent lamps, rendering it necessary for the Corporation to indemnify all purchasers or users against loss or damage, and to call upon the Edison-Swan Company to withdraw such notice, or to take such action as would justify their procedure.

At the same time, not wishing to involve the corporation in the uncertainty of costly litigation in respect of patents which, as has been stated, had been upheld in the Courts, your Directors offered to pay such a recognition royalty as should not be injurious either to the trade or to the interests of the public, provided that the Edison-Swan Company on their part would recognise also, by payment of a non-prohibitive royalty, the valuable patents of Mr. Lane-Fox, the property of the corporation, which the Edison Company use in their manufacture.

These negotiations, which were initiated and conducted by your directors in the most friendly spirit, and which from every possible point of view were honourable and equitable to all concerned, were rejected, and the prolonged and costly litigation which has just been terminated was forced upon your corporation in defence of their rights, and to protect one of the most vital and important branches of their business.

The action was nominally brought by the Edison-Swan Company against Mr. William Holland, of Albert Palace, who was using, and the Jablochkoff Electric Company, who had supplied, a large number of the corporation's lamps, and to whom the corporation had given indemnities.

Upon the application of the defendants that the Anglo-American Brush Electric Light Corporation should take part in defending the action, opposition in the Courts of Law was raised by the Edison-Swan Company, thus endeavouring to preclude the corporation from justly protecting their own interests by defending the attack made on their lamps, but an order of the Court was obtained enabling them to defend as third parties.

In consequence of the procedure of the Edison-Swan Company, your Directors considered that it was necessary to protect your interests by demanding recognition of the Lane-Fox patent, held by the corporation, and they therefore commenced an action against the Edison-Swan Company for an infringement of two of them. This action will come on in due course, and your Directors, having acted upon the best technical and legal advice, await the result with every confidence.

After an exceptionally exhaustive trial, occupying 22 days, the action resulted on Monday last in a judgment in favour of the corporation upon the main issue, viz., the Edison patent, and in favour of the Edison-Swan Company upon the minor issue of the Cheesborough patent.

The effect of this judgment is to invalidate the Edison patent, thus destroying the claim of the Edison-Swan Company to a monopoly for the carbon filament.

The plaintiffs' Cheesborough patent, under which they claim a special method of preparing the "carbon filament" of incandescent lamps, is upheld, and the corporation (who have always contended that they did not employ the process for the object intended and patended by Sawyer-Man) were held to infringe this patent. This latter decision, however, in no way affects the corporation's right to manufacture incandescent lamps, and they will continue without interruption to make Victoria lamps under their own patents, which are quite independent of any process which can be considered as falling within the scope now given to the Cheesborough patent.

With regard to the costs, those incurred in respect of the Edison patent are to be borne by the Edison-Swan Company upon the higher scale; and those incurred in the minor issue of the Chees-

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borough patent, which are relatively small, are to be borne by the corporation.

It is quite possible that the Edison-Swan Company may appeal against Mr. Justice Kay's judgment, but your Directors have not the slightest uneasiness as to the result.

By order of the Board,

E. GARCKE, Manager and Secretary.

MESSRS. CROMPTON AND CO'S WORKS AT CHELMSFORD.

On Thursday last week, at the invitation of Messrs. R. E. Crompton and Co., a party of engineers and journalists visited the important electrical engineering works of that firm at Chelmsford. Of much that was interesting to be seen we have only space this week for the following notes :—

In the heavy tool shop, on the ground floor, were several large dynamos in course of construction ; the winding and similar work is all relegated to the first floor. Here we were sorry to miss seeing the biggest armature ever built, which has lately gone down to Milton for working the Cowles process. At present the largest armature in hand is for a 5,000 lighter for the Liverpool Electric Supply Company. It is to run at 720 revolutions per minute, and is built on Messrs. Crompton and Swinburne's very pretty modification of the drum winding, which allows perfect ventilation and greatly facilitates repairs.

Perhaps the most interesting machine in hand was the new Crompton-Swinburne Alternator. Here the armature consists of a large number of thin iron discs strung on a centre spindle ; these are clamped together, and the coils dropped into transverse slots. When the latter are in place the whole armature is wound round with a single layer of iron wire ; the copper being thus completely enclosed in iron, the interpolar space can be made very small. The field-magnets are formed very much in the same style as the armature, but are, of course, solid. It is expected that the machine will give 2,000 volts and 32 amperes at 400 revolutions, or eight times the output of a Westinghouse machine of the same size ; this, however, it is frankly acknowledged is on the supposition that the iron in the armature will remain sufficiently cool.

The second floor is principally devoted to instruments, switches, fittings, &c. ; there we noticed some very much improved forms of the Crompton-Kapp instruments.

Returning to the ground floor, we next saw the large switch-board intended for the central station close to Whitehall Court. The switch-board will deal with some 10,000 amperes, and allow for joining up four of the largest size dynamos and eight batteries of accumulators. In the centre portion of the board are eight very large double-ring contact switches, similar to those shown by Mr. Crompton at the Society of Telegraph-Engineers. On the ammeter board Mr. Crompton is going to measure the current by a method which, though old in the laboratory, is now being applied for the first time on a commercial scale. In each circuit is introduced a large bar of platinoid about 12in. long ; from points near the end of each such bar are fine wires leading to a central switch, so that the ends of any bar can be joined to the terminals of a Deprez-D'Arsonval reflecting galvanometer, and the resistance of the bars being assumed constant, the current is, of course, proportional (approximately) to the deflection.

Passing to one of the yards we saw a model of an electric training gear, which has been applied by Messrs. Crompton to a 38-ton gun for the British Government. Here the traversing and elevating movements are both obtained by one handle movable in two planes, the speed variations and reversals being obtained by shifting the brushes. This is a method apparently much favoured by Messrs. Crompton, as we saw it applied to various other motors for different purposes, and though of course slightly wasteful, since the power varies nearly inversely as the work done, yet no doubt in many cases the perfect control of speed thus obtained counterbalances the loss. We also saw in the pattern shop patterns for an electrical crane. This is to lift a net load of 15cwt. 80ft. per minute ; it also has a travel of 80ft. per minute, and can be slewed at 140ft. per minute. All these motions will be obtained by clutch gears from one motor running at constant speed. Among minor novelties we noticed a new brush, made of fine-wire gauze, which Mr. Crompton has tried and found to answer extremely well.

We may add, in conclusion, that on the way down Mr. Crompton showed us some very interesting photos of one of the boilers which caused so much trouble at the Vienna Theatre installation, and which finally had to be replaced by English-built ones. The photos were taken from the boiler which he had broken up before the experts and others, and showed bad work and negligence of a most deplorable description.

EDISON AND SWAN ELECTRIC LIGHT COMPANY v. HOLLAND AND OTHERS.

JUDGMENT OF MR. JUSTICE KAY.

Judgment herein was delivered on Monday last at the Royal Courts of Justice, Chancery Division.

Mr. JUSTICE KAY said : The plaintiffs sue the defendants for infringing two letters patent, one Edison's patent, No. 4,576, of November 10th, 1879 ; the other Cheesborough's patent, No. 4,847, of 1878, amended by disclaimer of the 12th November, 1884, both patents relating to electric incandescent lamps. The defence was taken up by a third party, the Anglo-American Brush Electric Light Corporation. The validity of both patents is put in issue.

The first thing necessary is to ascertain as accurately as is possible to anyone who has not had the requisite scientific training what was known on the subject at the date of these patents, say in 1879. There are two commonly known systems of electric lighting, the arc and the incandescent system. These patents relate to the latter. The former, dependent upon an actual break in the conducting material occurring at the point where the conductor is cast in the form of a pretty thick pencil, the current leaped over the break in the arc, gradually destroying the carbon, and this arc light gave a very white light, especially at the positive pole. The incandescent system is different. The conducting material in this is continued without any break, or actual interval, but being in part an imperfect conductor, that part becomes heated by its resistance in what is called the passage of the current, and this heating, raised to an intense degree, gives the light now familiar to us in the incandescent lamp.

The material that is now so heated is some form of carbon. It was well known that this was a good material for the purpose, because it was an imperfect conductor—in other words, had a high specific resistance—and that it was essential to use it in a vacuum or in some gas or vapour which did not contain oxygen, otherwise the carbon consumed quickly. Until 1872 when Sprengel's air pump was improved by Mr. Crookes, it was difficult to obtain a vacuum which was complete enough. The consequence was that it was necessary to employ a pencil of carbon to carry it effectively, because there was enough oxygen in the exhausted glass bulb to occasion some consumption of the enclosed carbon, and also enough air to diminish the bulk of the carbon when it became incandescent by frictional action on its heated surface, which Edison in his specification and some of the witnesses have called air-washing. Another difficulty which prevented the use of very slender carbons was the irregularity of the current taken from the dynamo ; it was subject to variation, which at times produced a current stronger than the carbons could bear. This was remedied by the improvements of Gramme and Brush, which were perfected in the year 1878. Two modes of improving the resistance of the carbon were known—one by increasing its length, and the other by the diminution of its thickness, or, to use the more exact language of the witnesses, of its sectional area. It was known that the carbon for an incandescent lamp must be enclosed in a glass bulb, from which the air must be exhausted. Bulbs made entirely of glass had been used and publicly exhibited for this purpose. It was known that molten glass could be made to adhere closely to platinum wires, because the glass prepared for this purpose expands with heat in the same degree as that metal ; and that for this reason, and also because of its properties as a conductor of electricity, the best mode of connecting the carbon within the glass bulbs with the main wire through which the current passes was to unite each end to a thin platinum wire, and to fuse the glass around these wires, so that air should not penetrate the points at which they enter the bulb. It was known that by increasing the electromotive force the main wires bringing the electric current to the lamps might be reduced in size, just (to take an illustration given by Sir Frederick Bramwell) as by increasing the hydraulic pressure in pipes supplying a town with water you are enabled to use smaller pipes, because the water will pass with accelerated velocity. It was known that by using high resistance in the incandescent portion of the lamp smaller leading wires might be employed, and also a greater number of lamps might be illuminated from the same source of electricity by working, as Dr. Hopkinson calls it, in multiple arc or in parallel.

Two systems of using incandescent lamps were known, and it was recognised that when many lamps were to be lighted from one central station and at some distance, the system called the multiple arc or in parallel was best. That may be shortly described as a plan involving the use of one main wire and one return wire, each lamp being supplied with the electric current by a smaller wire from the main leading wire, and returning such portions of the current as it took to the return wire, the main leading wire and the return wire being supposed to be parallel. The other system, which is little employed, was the use of lamps in series. In this case the whole current is sent to each lamp in succession, and accordingly lamps of comparatively low resistance are required.

The desideratum in 1879 was to obtain lamps of high resistance for the multiple arc system which could be made commercially—that is, in large quantities, with reasonable cheapness—and, above all, that they should have durability. Edison, Lane-Fox, Swan and others had been working with this object in the same direction. On the 19th December, 1878, in a lecture given by Swan at Newcastle, he described an experiment for the production of light by passing a current of electricity from a dynamo over a slender rod of carbon enclosed in an exhausted globe. On January 17, 1879, he lectured on the same subject at Sunderland, illustrating his lecture by experiments exhibiting certain electric lamps. On the 4th February, 1879, he again lectured at Newcastle, and he then exhibited the lamp which is marked in this evidence with the exhibit mark F J B 1. It

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consists of a bulb made entirely of glass, with leading platinum wires sealed into it, and connected with a thin pencil of carbon inside the bulb. This piece of carbon was obtained from Carré, of Paris, and was manufactured by him and shaped before being carbonised. It is $\frac{1}{75}$th of an inch in diameter—that is, considerably thicker than the carbons now used, and being straight, the leading wires are sealed in bulbs at opposite ends. This renders it liable to the defect which is alluded to in the correspondence between Mr. Swan and Mr. Stearn, namely, rupture of the carbon, or its separation from the wires by expansion and contraction under the great heat to which it is exposed. This lamp was exhibited again at Gateshead on the 13th March, 1879, and seems to have been kept lighted for ten to twenty minutes at a time on two or three occasions without injury. I have no evidence how long it would last if continuously used. Swan, in the spring of 1879, ordered from Carré carbons in the shape of a hairpin, a model of which he produced, marked J W S 1. It is practically identical in form with some of the carbons now used in lamps, but with a larger sectional area. Lamps made with this would not have the defect to which I have alluded. He says that probably towards the end of 1879 he made some lamps with these hairpin carbons. They are referred to by Mr. Stearn in a letter dated November 26, 1879, in which Fig. 2 is a sketch of a lamp so mounted. But I do not lay much stress upon this as an anticipation of Edison, for although Heaviside and other witnesses speak of having seen these lamps in 1879, I think the fair result of this evidence is that these were experiments which did not succeed in producing a commercially successful result before Edison's patent. On the 2nd January, 1880, Swan obtained a patent for one of the most valuable inventions connected with the manufacture of incandescent lamps. That was for preparing the carbon by passing the electric current through it, and heating it to incandescence while the bulb was still connected with a Sprengel air pump in action. This is now always done, and the effect is to make the vacuum much more perfect, or rather less liable to be impaired by air or gas coming from the carbon itself when first heated in a vacuum. On the 20th January, 1880, he obtained a patent for a horseshoe strip of cardboard prepared for an incandescent lamp by converting it into a substance like parchment, by treatment with sulphuric acid and then carbonising. On the 27th November he obtained a further patent for the application of this process to cotton thread. This has proved a most valuable invention. It produces a non-structural tough material, said by one of the witnesses to be as hard and stiff as a metallic wire; and this is now largely used for incandescent lamps.

Mr. Edison applied, with the object of producing a lamp of high resistance, his untiring and apparently inexhaustible ingenuity. His specification, which I have to consider, shows, as Sir Frederick Bramwell states, that he was not aware how much was actually then known to electricians like Lane-Fox and Swan; and Edison conceived that he was the first inventor of some lamps in which they seem to have anticipated him. Edison availed himself of the more perfect vacuum obtained by the Sprengel pump, and also of the known principle of increasing the resistance of the carbon by diminishing its sectional area, which had become possible to a much greater degree owing to the perfect Sprengel air pump and the dynamo.

Of the important points raised in the construction of his patent of November 10th, 1879, the most important is the extent of the second claim, whether it includes every lamp of the kind there described, the light giving carbon in which is a filament, or whether it means only lamps with such filaments as are particularly mentioned in the body of the specification. Another point is, first, whether the word "lamp" in that claim does not mean merely the filament of carbon. A third question of construction is whether the carbonisation of the filament is to be effected before or after it is attached to the platinum wire With respect to the sufficiency of the specification it is urged that Edison ought to have defined exactly what was meant by the word "filament," and that his patent for 1879 is void for insufficiency of the specification in this respect, and also because it does not give sufficient directions for carbonising the filaments. None of the modes of making the filaments particularly described it is said are practicable, or at any rate some are not, especially the several modes of making the filaments from a putty composed of lampblack and tar, and from that putty compounded or coated with various substances. Also, if the patent means that the filament is to be carbonised after being attached to the platinum wire, this it is said is impracticable because the platinum wire is thereby made porous and brittle, and could not be sealed to the glass so as to prevent air getting at the point of sealment, or through the pores in the wire.

The proper mode of construing a specification, as laid down by Lord Wensleydale in Neilson *v.* Hartford, is to "hold a fair hand between the patentee and the public, willing to give the patentee on his part the reward of a valuable patent, but taking care to secure to the public, on the other hand, the benefit of that provision which is introduced in the patent for their advantage." This refers to the condition expressed in every patent that the patentee shall particularly describe and ascertain the nature of his invention, and in what manner the same is to be performed. Lord Westbury's exposition of the rules of construction (taken from his judgment in Simpson *v.* Holliday) is somewhat more explicit—"With respect to the rules that govern the construction of specifications," he says, "they are the ordinary rules for the interpretation of written instruments, having regard especially to the fact that the specification must clearly fulfil the obligation imposed on the patentee by the proviso contained in all letters patent, namely, that the grant shall be void if the patentee shall not particularly describe and ascertain the nature of his invention and in what manner the same is to be performed." It is therefore made a settled rule that the specification must be so expressed as to be perfectly intelligible to a workman of ordinary knowledge, and it must follow that if there is any obscurity or ambiguity in the specification which is likely to mislead, this defect ought not to be remedied by any refined or secondary interpretation of the language. "It was contended before me," he says, and the Vice-Chancellor is reported to have said that it has been settled by authority, "that the most liberal construction is to be given to the patent that it will sustain, especially in those cases where the Court is satisfied that the invention is really new and useful." If the words *most liberal construction* are intended to denote some principle of interpretation different from the ordinary rules for the construction of written instruments, I am not aware of any such authority. The Vice-Chancellor is made to say that this *liberal construction* is especially adopted in cases "where the Court is satisfied that the invention is really new and useful; but novelty and utility are necessary for the validity of every patent." There is probably some inaccuracy in the note of the judgment. That case went to the House of Lords. None of the learned lords in any way dissented from the passage I have read. I take from the speech of Lord Chelmsford, then Lord Chancellor, the following passage:—"The construction of a specification, like other written documents, is for the Court. If the terms used require explanation as being terms of art or of scientific views, explanatory evidence must be given, and with this aid the Court proceeds to the office of construction." The particular decision in that case was that a description of a process for producing a purple coloured aniline by mixing it with dry arsenic acid and allowing the mixture to stand for some time, or accelerating the operation by heating, was void, because it could not be done without heating it; and that is described as an alternative process.

With regard to the construction of Edison's patent (No. 4,576) of 1879 I observe, first of all, that the provisional specification begins by stating the necessity that lamps connected in multiple should be employed without main wires of great size, and that it is essential that these lamps should have a high resistance. It is stated that this has been set forth in a previous patent of Edison of the same year, and that lamps of great resistance had been obtained by a long wire of platinum or other metal pyro-insulated, which means coated with an incombustible substance, and coiled so that but a small radiating surface was exposed. Then it is said that the present invention relates to lamps of a similar character, except that the carbon threads and the strips are used in place of metallic wire, and connected with the platinum wire sealed into a bulb exhausted of air. The description of the mode of manufacture is then given, but not so much in detail as in the complete specification.

Turning to that I find that it commences with a short statement that the object of the invention is to produce incandescent lamps of high resistance. Then follow four paragraphs stating in what the invention consists. The first of these is the coiling of the carbon wire or sheets so as to offer great resistance and present but a slight surface for radiation; the next, the placing of such light-giving body of great resistance in a nearly perfect vacuum; the third states that the connecting wires are platinum sealed into the glass; the fourth is the method of manufacturing carbon conductors of high resistance and securing a perfect contact between them and the wires. The specification next states Mr. Edison's view of what had been done up to that time. It is admitted that this is inaccurate in many respects. He appears to have been unaware of the attempts that had been made to do the very thing at which he was aiming, that is to increase the resistance of carbon burners in lamps made of bulbs of glass exhausted of air, and the connecting wires being of platinum sealed into the glass. He seems ignorant that bulbs made entirely of glass had been used, or that they had been exhausted of air so as to form a vacuum. The statement is that theretofore the air had been replaced by gases that did not combine chemically with the carbon. The specification then proceeds to describe several modes of making the carbon burners. I find mentioned:—(1) Cotton thread; (2) any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber; (3) such fibrous material rubbed with a plastic compound composed of lampblack and tar; (4) carbon filaments made by a combination of tar and lampblack; (5) sometimes a thread rolled within such compound; and (6) sometimes the compound with a volatile powder such as camphor or oxide of zinc worked into it, in which case he says to make the light insensitive to variations of the current a considerable mass of matter should be used. The mode of collection is stated to be moulding the lampblack and tar material round the platinum wires, where they are formed to the carbon, and afterwards carbonising them. Coiling is then described, and it is stated that the inventor has carbonised and used cotton and linen threads, wood splints, paper coiled in various ways, lampblack, plumbago and carbon in various forms mixed with tar and kneaded so that the same may be rolled out into wires of various lengths and diameters, each one wire of a uniform size throughout. There are three drawings, two showing carbons very closely kneaded, one of them being within the bulb; and in each case there are clamps connecting the platinum wire cemented within the carbon with the wires sealed in the bulb. The other filament is a straight piece of the substance which is to be coiled attached to the platinum wire at each end. The figure and description of it in the specification show that the coiling and carbonisation are to take place after such attachment. Then come the claims, which are four in number.

"(1). An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured by the metallic wire, as set forth. (2). The combination of the carbon and filament within a receiver, made entirely of glass, through which the leading wires are attached, and from which receiver the air is exhausted, for the purposes set forth. (3). A coiled carbon filament or strip, arranged in such a manner that only a portion of the surface of such carbon conductor shall radiate light, as set forth. (4). The method herein described of securing the platina contact wires to the carbon filament, and carbonising of the whole in a closed chamber, substantially as set forth." I do not agree that the word "lamp" in the first claim means only the filament of carbon. The claim is an electric lamp for giving light by incandescence, which the

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filament alone could not do. The words "consisting of" are inapt, but the wording of the whole specification is exceedingly inaccurate, and this is also an example of such inaccuracy; "containing" would be a better word. I construe this claim to mean lamps such as described, in which the distinguishing features are carbons of high resistance made as described, and secured by metallic wires as set forth. This seems to me to make the meaning of the second claim more clear. Having in the first claimed lamps with carbons, made as described, the inventor proceeds to claim all lamps with the combination described in the second claim. These are (1) the carbon filament, (2) in a receiver made entirely of glass, (3) through which the leading wires pass, (4) and from which the air is exhausted. All these four things Edison, as is apparent in the early part of the specification, supposed that he had invented. I do not think he intends to lay more stress on one than on another of them; in fact, the only one as to which it is possible to say there was any novelty was the carbon in the condition of a filament. I take from "Johnson's Dictionary" the meaning of the word—"a very slender thread." The third claim relates to the coiling, on which great stress is laid in the provisional and in the complete specifications, and the fourth is the mode of attachment of the carbon to the wire. The claims, as I read them, are (2) a combination of four requisites for the lamp, (3 and 4) claims for two of those requisites separately, and (1) claim for particular modes of making and attaching to platinum wires the first item of the combination, namely, the carbon filament. But claim 2 comprehends lamps containing carbon filaments however made, and not only those made in the special words described in the body of the specification and included in claim 1. The defendants construct incandescent lamps with all the four elements of the combination described in Edison's second claim, but the filament made by them is essentially different from anything particularly described in Edison's specification. According to the witness Sellon the filament used by the defendants is made thus:—Cotton wool is dissolved in chloride of zinc, and being slightly heated the result is a viscous semi-liquid substance resembling in appearance a strong solution of gum arabic. This is boiled in the receiver of an air pump to extract all air; then it is forced through a die or small orifice by the pressure of a head of mercury, and the filament so formed is received in a vessel of alcohol, which solidifies in the form of thread. It is then left for a time in another vessel of alcohol, which dissolves all impurities and leaves it a non-structural thread of cellulose in an extremely pure condition. It is dried and carbonised and fitted for use in the lamp. If Edison's patent claimed only lamps with filaments such as those particularly described in the body of his specification, it is obvious that this would be no infringement. In 1879 Edison, so far as appears, never dreamt of making carbon filament in this way, but as I have come to the conclusion that the second claim is wide enough to include any lamp with a carbon filament, however made, the defendants have clearly infringed this claim.

Then comes the serious and important question whether so wide a claim can be supported. I have already pointed out the only item of the combination that had any novelty was the use of the filament or very slender thread of carbon. Edison had managed to use carbons thinner than anyone had used previously. The only advantage of a filament suggested in the specification is in high resistance by reason of its thinness or small sectional area. There was no invention described in this specification of any new principle. The principle of increasing resistance by diminishing the sectional area of the carbon was known and had been published by Lane-Fox and by Swan before November, 1879. Assuming that Edison had been the first successfully to put that principle into practice by the methods described in his specification, did that success entitle him to say no one shall make a lamp with a filament of carbon for the burner but myself? Suppose the claim had been thus worded:—"I have succeeded in making an electric lamp with the carbon burner—say, the 100th of an inch in diameter, which gives a high resistance, and I claim a monopoly of all lamps with carbon burners not thicker than that, however made," could such a claim be supported? That in effect is Edison's second claim. One of the objections made is that the claim ought to have been worded in some such way as I have just suggested in order to make it sufficiently definite; in other words, Edison ought to have indicated the exact boundary between his filament and such a Carré carbon as Swan had successfully used. From the drawings and from the great stress laid upon the coiling of the filament, the only object of which seems to be to increase the resistance by using a considerable length, I should conclude that Mr. Edison did not conceive that extreme thinness of the carbon was practicable. Mr. Swan had tried paper, cardboard, and similar material carbonised, and if he had not tried a filament he had used and obtained considerable success with the Carré carbons not more more than $\frac{1}{250}$th of an inch in diameter. He was trying these in the form of a hairpin, made and shaped to that form before carbonisation, and it seems impossible to say that Edison by reducing the thickness of the horseshoe carbon had made any vast invention or contributed largely to the knowledge that such inventors as Swan and Lane-Fox already had upon the subject. There is authority for saying that if an inventor discovers some new principle and describes a practical mode of applying it he may have a patent which would prevent another person from applying the same principle by different means. In Jupe *v.* Pratt Baron Alderson said:—"You cannot take out a patent for a principle; you may take out a patent for a principle coupled with the mode of carrying the principle into effect, provided you have not only discovered the principle but also invented some mode of carrying the principle into effect. If you have done that, then you are entitled to protect yourself from all other modes of carrying the same principle into effect"—that being treated by the judge as piracy of your own original invention. But is there any decision that an inventor who has discovered a mode of applying a known principle like this of obtaining increased resistance by diminishing the sectional area of the carbon burner can obtain a monopoly of the principle? Sir Frederick Bramwell, in his evidence for the plaintiffs, put the case in the strongest and most favourable manner by saying that Edison made the first commercially successful incandescent lamp. Unless that is so his claim to so large a monopoly would not in my opinion be arguable.

I proceed to inquire, did he make a commercially successful lamp—that is, were any of the modes of making lamps particularly described in the specification commercially successful?

In most patent cases, when the validity of the patent is impeached for want of novelty, the most important witness is the inventor. It is usual to put him in the box and expose him to cross-examination. Mr. Edison is in America, but if there was any reason which prevented his appearing as a witness at the trial, the Court has power to direct an examination in America. He has neither been produced nor has the attempt to examine him in America been made, and an objection was raised during the evidence to reading statements made by him in his later patents to show what he really had invented at and before the date of his patent of 1879. I must say that this mode of conducting the plaintiffs' case seems to me to put the defendants at an unusual disadvantage, and I think the Court is bound to prevent them from being prejudiced by it so far as possible. I shall not hesitate to refer to the language of Edison's subsequent patent as admissions by him, so far as they tell against the claim now made in his name to a large monopoly.

I have before me several patents by Edison in his own or other names. There are, amongst others, three in 1878—Nos. 4,206, 4,502, and 5,306; three in 1879, numbered 2,402 and 4,576 (which is the patent now in question) and subsequently, in 1879, No. 5,127; in 1880, No. 3,765, which has been called in the argument the bamboo filament patent; and in 1881 Nos. 539 and 1,918. Whenever he hit upon any improvement Edison seems to have applied for an English patent, without waiting to perfect the invention, and no one can read the patent in question of 1879 without being struck with the imperfection of the description in every part. In the later patent, No. 5,127, of 1879, Edison gives careful directions as to the mode of carbonising strips of CRYSTAL WIRE in the mode preferably of wrought iron. In the bamboo patent, No. 3,765, of 1880, he begins by again asserting that the practice, so far as he knows, had been to make the carbons of as low resistance as possible, and that he had discovered that the incandescent material should have the highest possible resistance in a very small bulb, and further that the carbons which are purely structural in character and known to possess these qualities—by purely structural he meant the carbon wherein the natural structure, celluloid or otherwise, of the original material is preserved unaltered, that is, it is not modified by any treatment which tends to fill up the cells or pores in structural carbon, or to increase its density or to alter its resistance. One object of this invention, therefore, is to provide such carbons, with means and methods for their manufacture. He then mentions several kinds of vegetable fibre, among others the bard, glossy exterior of the bamboo cane. Elaborate directions are given for shaving and carbonising these fibrous substances, and the claims include (1) an incandescent conductor formed of one or more carbonised natural fibres, (6) a slip or filament made of glass or fibre like cane or bamboo, and (12) the method of forming and then ot carbonising. In all there are in this patent 44 claims. To say that purely structural carbons alone possess the requisite quality was altogether an error. Swan's non-structural carbon, parchment *carbons* it is there called, are amongst the best burners known.

The plaintiffs have been challenged again and again during the cross-examination of their witnesses to prove, if they can, that any lamps with a burner made according to the specification of November, 1879, has been brought into the market in England or in America. No evidence of this has been given, and I conclude that there was no commercial use of the invention at that time. Until he had taken out the subsequent patent it seemed that Edison did not introduce any lamp to the public. Dr. Hopkinson saw some, he says, probably in 1881, made under one of these later patents. In that year—1881—Edison exhibited some at the Paris Exhibition in the month of September. These were bamboo filament lamps, and this was the first public exhibition of his lamps, at any rate in Europe. No doubt this is not conclusive that the invention had no utility, because as it has been argued improved lamps may have been invented so rapidly as to have superseded the original invention before it could be brought out publicly. But it is somewhat difficult to make out that the lamps described in the specification of 1879 were commercially successful if none were ever brought into the market, and the success of a lamp made under a subsequent patent, like the bamboo lamp, which has been largely used, can hardly support the previous patent, which it did not describe. It has been attempted to argue that the patent of 1879 did include the bamboo filament—first, because the second claim includes all filaments of carbon; and, second, because in the body of the specification Edison says, "I have carbonised and used wood splints." I can only say that I admire the courage of such an argument. The question is whether the specification particularly describes a commercially successful lamp so as to support so wide a claim. This is not answered by saying that the claim is wide enough to include all filaments, and therefore it must be taken to include all; and in respect of so much of the argument as rests on the use of the words "wood splints," those words do not describe anything so as to show a workman how to make them. Indeed, they are not intended as a description, for it is a recurring sentence, which may be properly called a passing observation, as though here, as in other parts of the specification, Edison was simply putting on paper cursory allusions to experiments; how made, and whether successful or not, he does not pause to say. But filaments made according to the several descriptions in the specification have been made, carbonised, and used, by way of experiment, in order to show that it was possible to make them.

Upon this there was a considerable conflict of evidence. Mr. Crookes, the celebrated chemist, following the terms of the specification as he un-

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derstood them, detailed experiments which he had made which failed completely, and declared that he was quite unable to make the carbons successfully from the descriptions given. On the other hand, a young man named Gimingham, who had had some scientific education, was produced as a witness for the plaintiffs, and he deposed that he had from the specification alone, without any special instruction, made carbons successfully without any difficulty. Other witnesses supported Mr. Crookes on the one side and Mr. Gimingham on the other. Some of the reasons for the success of one set of these experiments and the failure of the other were pretty clear; others I could not understand, and at my suggestion the parties agreed that the experiments should be repeated in the presence of Prof. Stokes, whom they chose as an independent expert, who should report the result to the Court. I have that report, which the parties have seen, and it is obvious from it that no one with the knowledge that existed in 1879, unless he was as practised as Mr. Edison himself or Mr. Swan, could have made a successful electric incandescent lamp from Edison's description without a long series of careful experiments and very many failures in his attempts.

With respect to the commercial success of the invention as tested by these experiments, I find from the report and a supplemental table of results, which have been handed to me as an agreed statement, that out of 100 lamps some broke down at once, thirteen lamps lasted less than ten hours, eleven more less than twenty hours, eighteen more less than forty hours, and only six above forty hours, of which four were unbroken at sixty hours, and of these four there is no further record. That is far from commercial success. No system of electric lighting could be maintained (except at an expense which could not practically be incurred) with lamps of such short life as these; and this explains most satisfactorily why Edison never sold lamps made according to the specification of 1879.

In considering the sufficiency of this specification, it must be remembered that in 1879 there was no trade or business of manufacturing electric incandescent lamps. Lane-Fox, Edison, Swan, and other inventors had given much time and attention to the subject; but except such persons there were none who had any special knowledge in the matter. The dicta that may be found in some cases that the specification of certain patents must be read as addressed to adepts in a particular trade or business do not apply. For this reason it was essential that the specification should be carefully explicit; it ought to be such as would enable an intelligent working man to make an incandescent lamp without having to try experiments. Take, for example, the process of carbonising filaments. In his subsequent patents Edison gave elaborate directions for this. In this patent, though dealing with filaments made of a putty compounded of lampblack and tar, common thread, thread coated with the putty, the putty combined with camphor, or oxide of zinc, and other substances for the manufacture of carbon filaments, he contents himself with saying that the cotton thread is to be properly carbonised, the fibrous vegetable substance is to leave a carbon residue after heating in a closed chamber, the tar putty is to be carbonised in a closed chamber by subjecting it to a high heat. Nothing is said to indicate what sort of closed chamber, of what it is to be made, how it is to be used, the degree of heat to be applied, nor the length of time during which the heat is to be kept up. There is no mention of any packing to be used in the chamber, nor of any precaution to prevent distortion of the filaments during carbonisation. There was no industry in 1879 in which carbonisation of anything so small as a filament was used. It was known to chemists that one mode of carbonising was to pack the substance to be carbonised in powdered charcoal, which when heated gradually combined with any oxygen which might be in, or might during the process find its way into the vessel used, and thus the substance to be carbonised might be protected from being consumed. This mode of carbonising is mentioned in the patent of Pulvermacher for making arc carbons before 1879; but this was not generally known, and it is not alluded to in Edison's patent which is now in question. Carbonising filaments in an ordinary clay crucible without such packing will not do; they are consumed, and nothing but ash remains. It seems it can be done in an iron box with a lid carefully luted if the heat be gradually applied and for a short time; but the carbons now used commecially are exposed to furnace heat applied gradually at first and kept up for a period of eleven to 14 hours, and they are carefully packed in powdered charcoal and wound on a frame and dried so as to yield as they contract. I have no reason to suppose that anything like that time or so great a heat could be successfully used with filaments in an iron box without packing. I am satisfied that considerable experiment would have been necessary in 1879 to discover what sort of closed vessel would do, whether packing was necessary, and what amount of heat, and for how long, and how it was to be applied. The specification seems to me altogether insufficient in these respects.

Then as to the tar putty, it seems it may be made by kneading the materials with some exertion for an hour and a-half. The only direction given is that it is to be kneaded till it assumes the consistency of thick putty. I have no reason to doubt Mr. Crookes honestly tried to make it and failed; a workman could not have fared better and could not have succeeded without much experiment. The filament which is to have a volatile powder, like camphor or oxide of zinc, worked into it has been imitated by dusting the tar putty filament with these materials very carefully, but I do not think it has been done in the experiments as Edison had intended. The description is vague, but I conclude from the mention of a volatile powder that the object was to use something that would volatilise in the process of carbonising, and that a considerable mass or thickness of carbon was to be used which would be left by such volatilisation in a very porous condition, and would thus have its resistance increased. The experiments seem to me a mere pretence of carrying out this; no such carbon has been shown to be of any practical utility. Considerable evidence has been given to show that coating the carbon with a non-conducting, non-carbonising substance would cause its destruction and incandescence by decomposition of the coating, the oxygen in which when free would destroy the carbon filament. The evidence leaves it somewhat in doubt whether this occurs before an actual fracture of the carbon occasioning the intense heat of the arc.

I do not think it necessary to observe at length upon other objections that were made on the specification. One of these referred to the effect on the platinum wires of exposing them together with the burners in the process of carbonisation, which, as I have mentioned, the drawing in Fig. 2 and the description of it showed what Edison intended. Another is the using of the copper helix to assist in the coiling of the burner; another is the use of the coil of the carbon, which Edison describes for the purpose of measuring the resistance by length without enlarging the radiating surface in proportion to the length of the barner. This seems to have been abandoned as useless.

My opinion is that the patent of Edison (No. 4,576, of 1879) is invalid; first, because the second claim is for a monopoly of incandescent lamps containing a filament of carbon for a burner, which claim, I think, is far too wide considering how little Edison had actually invented; secondly, because his specification does not describe a lamp which ever became, or, as I think, could have become, commercially successful; thirdly, because the directions therein contained are so insufficient that no one could have made the carbons he describes without considerable previous experiment; fourthly, because one of the processes described, namely, mixing the carbons with volatile powder, I believe to be practically injurious if done as Edison directs; fifthly, because the coating with a non-conducting, non-carbonising substance, if not injurious, is of no practical utility; sixthly, because the same may be said of coiling the filaments, on which the patentee lays great stress.

This patent of Mr. Edison (No. 4,576 of 1879) has been the subject of litigation in a previous suit between the present plaintiffs and Messrs. Woodhouse and Rawson, who were manufacturing incandescent lamps, and were sued by the plaintiffs for infringement. The case went to the Court of Appeal, and both in the court of first instance and in the Court of Appeal the patent was treated as valid, though apparently with some hesitation. I am bound by these decisions, and should follow them of course, whether I agreed with them or not, if the evidence in the two cases were the same. But that is not so.

On one point which Lord Justice Cotton seems to have thought essential the Courts were completely misled; they were given to understand that the carbon burner in the lamp F J B 1 exhibited by Swan before the date of Edison's patent was shaped after and not before carbonisation. It is now admitted that this was not the fact; it was a carbon made by Carré, and used as made by him without alteration. But further I am told there was no evidence in that case as to the difficulty of making the carbons described in Edison's patent from the description in the specification. I understand that no contest took place as to the sufficiency or utility of any part of Edison's patent, and that nothing like the evidence as to the previous knowledge on the subject was given in that trial which has been adduced in this. With respect to the construction of the patent the opinion which I have expressed agrees with that of the majority of the learned judges in the Woodhouse and Rawson trial. The case has been brought before me with such an elaboration of evidence on every point that I think myself bound to act upon my own opinion, believing, as I do, that if the same materials had been before the learned judges in the other case they would have arrived at the same conclusion as I had done.

The other patent in question in this action is that of Cheesborough (No. 4,847) of 1878, amended by disclaimer of the 12th November, 1884. The specification describes and claims a method of preparing the illuminating portion of an electric lamp, and also a material for the manufacturing of the illuminating part. Shortly stated, the carbon to be prepared is surrounded with a carbon gas or liquid, and then heated intensely by the passage of the electric current. This causes a decomposition of the surrounding hydro-carbon, and the deposit upon the heated surface of an extremely dense form of carbon, such deposit being in a greater quantity upon the hotter, that is the thinner, portions. The specification states that the carbon of the ordinary sort when heated by the electric current exhibits points and lines of unequal brilliancy. Carbons prepared by this process when so heated glow with a uniform brilliancy throughout. A French chemist, Deprez, in experimenting on the reduction and volatilisation of carbon, discovered that when the carbon was heated in an atmosphere of hydro-carbon this deposit occurred, and interfered with his operations, and he described this in a Paper which was published in England some years before 1879. But Deprez did not utilise this product in any way, and his experiments had nothing to do with electric lighting. Assuming that Cheesborough derived his knowledge of the mode of producing this material from Deprez's Paper—I believe Cheesborough was not the real inventor?

Sir HORACE DAVEY: No, my lord. Sawyer and Man were the real inventors—he is the English patent agent.

Mr. JUSTICE KAY: Yes, I understand. Assuming that the patentees derive their knowledge of the mode of producing this material from Deprez's patent, their invention consists in applying it to the purpose of making uniform the light-giving power of a piece of carbon when heated by the electric current, and the beauty and the merit of the invention consist in thus enabling an imperfect carbon by a sort of automatic operation to improve and perfect itself. I have no doubt that this is a good subject for a patent. I had more hesitation upon the claim for the material, which certainly was not discovered by him; but that is not the whole of the claim, it is for a material for the manufacture of the illuminating conductors of electric lamps produced by electricity heated in a carbon gas. That does not prevent anyone from making the same material and using it for other purpose. The claim is really for the use of the material for the burner of an electric lamp. This seems to me equally valid. Another objection that pencils cut from the lime cylinder, coated with carbon, would not make effective burners seems to me to arise from a mis-

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construction of the specification. It is not the lime cylinder, but the deposit of the carbon which is to be made into burners. The defendants have used this process of Cheesborough, but they say for a different purpose. Their object is to bring all their carbons to one standard of illuminating power, an operation for which they have invented a somewhat cacophonious word, "standardising;" but Sellon, one of their principal witnesses, admitted that the process would cure any inequalities of light-giving surface in the particular carbon so treated. These, he says, in their cellulous threads seldom occur. However, I cannot resist the conclusion that the defendants by this use of the process for carbons of incandescent lamps are infringing Cheesborough's patent.

The plaintiff's reply in this case was unfortunately interrupted. The Attorney-General asked leave if the Court required more assistance on any point to add somewhat to the reply. I have not thought it right to trouble him further. Every point has been put again and again to the scientific witnesses; twenty-one of the working days of the Court have been occupied trying this case. I have not arrived at the conclusion I have intimated without considerable thought and care, and I do not think that further argument would be a useful expenditure of public time. I must therefore decline to trouble counsel any more in the case. I have been provided with a copy of the print of the shorthand notes. They contain, as is perhaps inevitable in such a case, a considerable number of verbal inaccuracies, some of which completely distort the meaning of what was said.

The action so far as it relates to Edison's patent of 1879 must be dismissed with costs. There must be an injunction to prevent any further infringement of Cheesborough's patent, and the defendants must pay the costs of the action so far as it relates to them. The costs must be set off in the usual way.

On the application of Sir HORACE DAVEY, in order to comply with the Patent Act Mr. JUSTICE KAY consented to certify that the objections of the defendants were all "reasonable" objections, and in order to allow costs on the higher scale that the case was of sufficient "importance and difficulty."

On the application of Mr. BREMNER a certificate was also granted in the case of the Cheesborough patent giving costs as between solicitor and client.

Mr. ASTON applied for costs on those points of the Edison patent on which the plaintiffs were successful, but the learned judge refused to grant the application.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *July 7th*, 1888.

The dispute regarding overhead wires in this city has arrived at a climax or crisis, and the result is that at least 100 arc-lights will remain unlighted until peace is again restored. A few days ago, becoming somewhat weary of the delays interposed by the local United States Illuminating Company, the Board of Electrical Control addressed to that company a letter notifying it that its wires along certain routes where subways had been provided but had not been used would be operated at the peril of arrest on the part of all engaged in the work. To this, Mr. Lynch, the president, replied that he had been doing his best to get cable to make tests in subways, but had been unable to secure any satisfactory guarantee as to the durability of such cable for the intended purpose. At the same time the company re-asserted its doubts as to the efficiency of the subway system within the meaning of the law. This reply seems to have acted on the Board like a red rag on a bull, as its secretary was immediately instructed to send a reply to the company expressing surprise at its lack of good faith in its relations with the Board, and addressing the company in the following language:—"You will be allowed no longer to operate your conductors in the shiftless, reckless manner heretofore adopted by you, as evidenced by the numerous reports of dangerous places in your lines made by our inspectors day by day, and if you are quite right in your assumption that your business cannot be done according to the directions given you by this Board, then you must distinctly understand that you will not be allowed to do business at all in this city of New York." The company is told, too, that its objections are "specious, calculated to deceive, not founded on fact, impertinent to the issue, and in opposition and evasion of the laws of the State." When such polite phraseology is used it will be seen that the situation is critical, and it need not be wondered at that, rather than proceed to extremities at the present, the company decided to discontinue operating its lines in the districts named by the Board until the question had been definitely disposed of in a court of law. In view of the undoubted fact that public sympathy and opinion is with the Board in this subway fight, and that the Board has been vested with very full powers by the State, it is evidently the best policy for the company to find a *modus vivendi* under the new conditions, as the other companies appear to be doing. At the same time there are certain points to be considered on the company's side. The subways themselves are anything but what they should be, and in many instances are reported to be full of water. Moreover, no provision has yet been made for local distribution, as the manholes are placed only at the ends of each block. In case a subsidiary conduit should be built, the company will be charged $1,000 a mile per year per duct. The cost of the whole conduit is said to be only $4,000 per mile, an outlay which makes the rent seem outrageously high. Another point is that legal proceedings to test the right and power of the Board in this matter had already been initiated. In the meantime, the mayor had himself expressed the opinion that the commissioners could not compel the electric companies to put their wires into the subway until they had adequately provided for local distribution.

As an appendix to the above, which outlines, as I have said, a very serious condition of affairs, it may be added that Prof. W. A. Anthony, at a meeting of the New York Electric Club, held last week, presented a Paper on overhead wires, in which he took the ground that the dangers of overhead wires had been greatly exaggerated, while the difficulties of placing the wires underground had been not less unfairly minimised. He pointed out how few were the number of deaths from contact with the electric light wires, and then contrasted their number with the fatalities daily reported in connection with other city conveniences, such as horse cars, carriages, and the like. As Prof. Anthony pointed out, the danger from overhead wires is by far the least of all the reasons for removing them.

It is interesting to note the fact that a new electric art makes its bow to the public this week. The Thomson Electric Welding Company of Boston has just issued a very handsome pamphlet, giving details as to the apparatus which it has built for the purpose of putting into commercial operation Prof. Elihu Thomson's process of electric welding. The method, as most of your readers are doubtless aware, consists in causing large currents of electricity to pass through the abutting ends of the metals to be welded, thereby generating heat at the point of contact, which also becomes the point of greatest resistance, while at the same time mechanical pressure is applied to force the parts together. The metal being heated to the welding temperature, and the pressure backing it up, so to speak, the complete weld is effected, and every test made has shown, with every variety of metal, that the interior of the weld is as perfect as the exterior. The machines now being built by the company will handle all kinds of work, from the finest wire to bars over 3in. in diameter, while special machines are made for heavier work, such as shafting, locomotive frames, tubes, &c. In one form of the apparatus a small converter is placed in the base so as to take current from a distant dynamo, at a central station, for example. In the other case the dynamo and the welding apparatus are combined in the one machine, which can be put anywhere in a manufacturing establishment, and be driven directly from an engine or from line shafting. There can be no question that this apparatus is intended for very extensive application, and that use will be found for it immediately in a great many places. As to the patents on which the art is based, they are broad and comprehensive, but it will not surprise you to learn that there are interferences and counter claims.

If I recollect rightly I made brief mention in my last letter of the fact that at Wabash, Ind., tower arc lights had been replaced by incandescents on low poles for the purposes of street illumination. What gives the more interest to this change is the fact that Wabash was one of the first, if not the first, to adopt tower lighting. In the new system which is being put in by the Heisler Company, 132 lights of 30 candle-power each have been dispersed at street intersections on low poles which carry the light about two-thirds of the height, or

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12ft. from the ground. The same steam plant as was used for the arcs is used for the incandescents, leaving, it is claimed, a very large margin of power available for commercial lighting. It is said that the change has proved satisfactory. I daresay that the results are being watched pretty closely, as should the plan be a continued success it is likely that the tower system would find in it a formidable competitor.

I have just said that tower lighting would find a competitor in this system of low lighting, as it does, for that matter, in the Edison municipal system. It is also likely that gas, too, would find it very often difficult to fight against. One of the arguments in favour of street gas lighting has been that it affords a much better distribution, from having a light every few yards along the street. There is, perhaps, something in this, but as the same can now be said for electricity, the argument, as an exclusive one for gas, vanishes. I notice, by the way, that down South, the number of new electric light companies organised during the past six months was 80, as compared with 33 in the same period of 1887, notwithstanding the fact that the number of new gasworks fell off from 24 to 18. Another indication of the way the wind blows is shown in the remark made by a leading gas journal last week, to the effect that in the city of Boston the electric motors introduced there had diverted from the gas company a patronage that was equal to the consumption of no less than 50,000,000 feet of gas per annum; and it need not be said that the number of electric motors there is very rapidly on the increase.

There are various and conflicting reports as to the phonograph and graphophone, and the most trustworthy of these rumours indicate that the two interests have been combined. So far as can be gathered, the practical basis upon which negotiations have been concluded is that Mr. Edison through certain patent complications, as in other cases in which he has similarly suffered, no longer has the practically absolute control of the phonograph that he once had, and that the phonograph as now built embodies certain very material improvements which have been made and embodied in the graphophone during the last few years by Mr. Tainter, of Washington, one of the associates, I believe, of Prof. A. G. Bell in other lines of work. Such being the case, a company formed as the result of the combination will it is said place the two machines, the phonograph and the graphophone, on the market, under the name of phonograph, and will ultimately, it may be expected, build one machine embodying the best features of the two, as well as other improvements which will inevitably be made. I believe that the "new phonograph," as it is called, has recently been exhibited in England, as it has been here. It is said to be surpassed by the graphophone in many important respects, as to the simplicity, ease of operation, and effectiveness of record.

The July number of the New York *Electrical Engineer*, which is just out, finds in the dilapidated condition of some electric light plants an exact reproduction of the state of affairs which existed in the telegraphic service thirty years ago, and it believes that, as surely as history repeats itself, the same remedy will be applied, namely, the consolidation or union of interests. The parallel hardly seems exact, however, and, as a consequence, the inference, though logical, may be unsound. In the case of the telegraph service, outside connections from city to city are a first and absolute necessity, whereas in the case of a local lighting company all that is necessary is a reasonable local patronage, altogether irrespective of what may be done in a city only a mile away. It might be argued that with a strong combination of parent companies there would be less likelihood of competition among the local companies, which have often been started, not so much because the town wants another plant, as because the company wants another customer. On the other hand, now that the manufacture of dynamos is virtually open to everybody, and when new lamps come out nearly every week, there may be no more reason for combination on the part of the manufacturers of such apparatus than there is on the part of engine builders, whose name to-day is legion. There have been moves made in the direction of a grand consolidation, and the diplomacy employed has been of a very high order. The golden opportunity for such a combination presented itself several years ago, at the time of the old Gramme pool, but it slipped by. To day we have ten builders of electric lighting apparatus where one existed then. There is a good deal of force, however, in the view presented by the *Engineer*, and the situation is an interesting one. It can readily be understood that there would be nothing small about a combination which embraced some thirty or forty manufacturing companies, and at least a thousand local central stations.

I note that the *Electrical Review* (of New York) this week gives some views of Mr. Edison's new laboratory, at Llewellyn Park. This laboratory, which has also a library and a workshop, is one of the finest in the world. It comprises a main building and power room, in which is located a couple of Armington and Sims engines, of 150 horse-power each, driving Edison dynamos, whose current is used for lighting and other purposes. At the rear of the main building are four separate one-story brick structures — the galvanometer house, the chemical laboratory, the pattern room, and the metallurgical building. In the main building considerable space is devoted to the library, which now contains a large number of books, and bids fair to reach 100,000 volumes. Mr. Edison has spared no expense in the equipment of the laboratory, and he has gathered around him a staff of great ability and efficiency.

Last week, Mr. Alfred Shedlock read a Paper before the New York Electrical Society on the "O'Keenan Battery," intended for domestic electric lighting. Possibly some of your readers may be familiar with this battery, as it has come to us from abroad, but to those who are not, a short description may not be out of place. Mr. O'Keenan has simply taken the ordinary gravity type of battery in which zinc and copper sulphate are employed, and has arranged it so as to make it as efficient as possible and automatic in its action. The zinc plates are suspended within porous partitions and flanked on each side with a lead plate. The sulphate of zinc circulates around the zinc plates and settles at the bottom of the vessel within which the plates are placed. Upon this is a layer of the sulphate of copper in contact with the lead plates, and above all is a layer of water. A hopper connected by a slot with the layer of copper solution keeps that solution constantly saturated, while a steady stream of water constantly serves to keep the sulphate of zinc solution at the proper density, the saturated solution making its escape through a trap at the proper time. The copper is deposited on the lead plates, and when of sufficient thickness the lead plates are lifted out and the copper stripped off. Being of the purest quality, this copper can readily be sold at a good price. The battery is usully worked in connection with a set of storage batteries, which it charges continuously, there being two sets of the latter charged in parallel, and discharged in series, so as to obtain an increased E.M.F. for the lighting circuit. Mr. Shedlock stated that the primary battery of this shape, having 12 cells, is adapted to give an available daily supply of electricity of about 126 ampere-hours at 16 volts, or any other number of amperes in proportion; in other words, the battery is able to light fifteen 12 candle-power 3-watt lamps for three and three-quarters of an hour, or a less number of lamps proportionately. The cost of the zinc and the copper sulphate, less the value of the copper deposited, is about 50 cents per day, or at the rate of about one cent per lamp hour.

Telephone Extension to Lancaster.—The Lancashire and Cheshire Telephonic Exchange Company (Limited) have just completed an important extension by connecting Lancaster to their trunk line system. Lancaster hitherto has been one of the very few commercial towns in Lancashire not possessed of telephonic communication with other places, but now they will be able to enjoy this important business facility. The building of the line has been executed with extraordinary despatch by the company, notwithstanding the many difficulties to be met with in carrying their work through a country extending from Blackburn to Lancaster, covering near upon thirty miles. The first delivery of poles and other stores was made at Wilpshire Station on May 18th, and the communication opened to the public on July 13th.

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BOOKS, &c., RECEIVED.

"Electric Tramways." Messrs. Booth, Ellson and Co. (Melbourne.)

"*Transactions* of the American Institute of Electrical Engineers." Vol. V., No. 9. (New York.)

"Price List of Messrs. John Bell and Son." (London.)

"*Proceedings* of the Royal Society." Vol. XLIV., Nos. 268-269. (London: Harrison and Sons.)

CORRESPONDENCE.

THE LONDON CHAMBER OF COMMERCE AND THE PROPOSED ELECTRICAL TRADES SECTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The subject of forming an association to represent the commercial interests of the electrical industry has been frequently under discussion during the past few years, and there is apparently a consensus of opinion in favour of some kind of organisation being formed to secure united action; but the chief reason why the past attempts to establish such combination have failed is the difficulty of defining the scope and limits of the proposed association.

We all recognise the necessity for combination in matters of common interest, but we are not all agreed as to what our common interests are. This is probably attributable more to the peculiar conditions of the industry in this country than to any fundamental difference of opinion. My object, however, is not to discuss this, but to point out how I think the difficulty referred to can in a large measure be overcome.

The proposition before us now is that we should assist the London Chamber of Commerce to form an electrical trade section. This is not a new idea, for it has often been spoken of, and was suggested by me to the Chamber more than a year ago. There were, however, at that time difficulties in the way of the scheme being carried out; but now that the Electric Lighting Act has been amended we may expect the industry to enter upon a new phase, and united action will become more important than ever.

We are indebted to the editors of *Electrical Plant* for reviving the suggestion that we should avail ourselves of the organisation of the London Chamber of Commerce, and in view of the public meeting which the Chamber will shortly convene in regard to the matter, the present is an opportune time to point out the advantages which the proposed arrangement offers.

The Chamber consists of firms and individuals, and anyone feeling an interest in the transactions of the Chamber can become a member upon payment of an entrance fee of two guineas and an annual subscription of one guinea. Its work is divided among different trade sections, which are again divided into sub-sections according to the needs of the respective industries.

The sections are composed of representative men selected from the members, and one member of each section is elected to the general council. In this way each trade is brought into communication through its representative with all the other trades represented by the Chamber, whilst the various trade sections are not precluded from taking independent action in regard to their own esoteric affairs. The status possessed by the Chamber would at once secure to the electrical industry an influence in Parliamentary and official matters which would be practically unattainable by a separate association formed under existing conditions. The Chamber has been established many years, has done much good for other industries, and its organisation and its mode of procedure are well defined and intelligible, and the secretary of the Chamber has had a large experience in the best methods of promoting and defending trade interests. We should therefore have the enormous advantage of being relieved from the unprofitable work of defining the precise functions of an organisation and of settling its constitution and rules. All that is necessary is that those who are concerned with the commercial interests of the business should allow themselves to be nominated as members of the Chamber, and then elect a representative section or committee. We should not have to concern ourselves with questions of ways and means, for all necessary office accommodation, staff, and a good central place of meeting would be provided for us by the Chamber.

The monthly *Journal* and the annual volume of *Proceedings* published by the Chamber afford means of intercommunication, and of permanently recording the work of the Chamber in regard to our affairs. The facilities of the Chamber for obtaining reports on the state of the industry in other countries and for collecting statistical information are such as no separate association that we could form at present could hope to secure. The following extract from a recent annual report of the council will indicate the special advantages offered to individual members:—

"Although the more immediate object of the Chamber is to serve the interests of members in their collective sense, it is also sought, within the limits of impartiality and fairness, to assist individual subscribers, not only by the communication of information as to treaties, tariffs, prices, foreign legal procedure, foreign exhibitions, the registration of trade marks, and the issue of certificates as to local trade customs, but also by the influence of the Chamber being employed to obtain the support of H.M. Government to members' interests in foreign countries. . . . It is not too much to say that there is very little information in or out of the office which cannot now be obtained and transmitted with the least possible delay."

It may perhaps be urged as an objection to the proposal that those members of the industry who are resident in the provinces would feel themselves excluded, but the membership of the Chamber is not limited to persons residing in the metropolis, and the inconvenience to which country members are put by the meetings being held in London must necessarily apply to every organisation having its head-quarters in London. On the other hand, those members of the industry who join the provincial Chambers of Commerce are brought into communication with the members of the London Chamber by means of the Associated Chambers of Commerce, a central body which represents now some 70 Chambers of Commerce in all parts of the United Kingdom.—Yours, &c.,

112, Belvedere-road, Lambeth, S.E., E. GARCKE.
July 16, 1888.

THE CONDITIONS OF REGULATION IN DYNAMOS FOR CONSTANT POTENTIAL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The very low induction which, as I read them, Mr. Esson's figures disclosed, led me naturally enough to imagine that his extra exciting power was to be debited chiefly to self-induction. The explanation which is now given by him entirely alters the affair, and is, I think, fully sufficient for the maintenance of his point.

Mr. Esson has, since my previous letter, pointed out to me a reaction from the armature upon the field which I must own to have overlooked, and which is, I believe, very often confused with the self-inductive effects. It may be sometimes concluded that, since the cross-magnetisation of the armature on the whole exerts no influence upon the field, no diminution in the E.M.F. occurs on account of a current flowing through it. But it appears that the lead of the brushes involved by the magnetic distortion due to this current causes a direct weakening influence on the field. This Mr. Esson points out is due to the windings enclosed by the angle of lead on both sides of the theoretical neutral line acting differentially to the field winding, and the effect is therefore almost directly proportional to this angle.

I think that a further weakening effect as a function of the angle of lead may be due to the virtual reduction of section in the air gap by the crowding of the magnetic lines towards the end of the pole-piece remote from the armature pole of like sign.

The remedy for all these evils seems to be a high magnetic density in the armature, and a large number of commutator segments; both the self-induction and the magnetic distortion will then be minimised.—Yours, &c., GUY C. FRICKER.

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WHO IS CHEESBOROUGH?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Commenting on Mr. Justice Kay's judgment in the great incandescent lamp case, *The Times* of this morning says: "The material used by Cheesborough was not invented by *him*; others before him had selected it as suitable for electric lamps. He took a material produced in one quarter, a discovery made in another, and the inchoate results of a great deal of general groping after the attainment of uniformity of composition and section in carbon filaments. He put these things together, and produced a very interesting combination, but it is extremely hard to say exactly how much of the result belongs to him. *He* gets all the reward, however; and not only so, but is enabled to take toll from all the incandescent lamps that are manufactured, as well as to throw considerable obstacles in the way of further improvement."

It would enlighten some of your readers, and be very instructive, if you could give them some idea of the personal appearance and biographical antecedents of this bad man. Is he as great a rogue as he appears, or does he look a greater rogue than he is?—Yours, &c., IGNORAMUS.

July 17, 1888.

[In our issue of 4th May, p. 728, we explained that Cheesborough is a patent agent, in whose name the inventions of Messrs. Sawyer and Man (who are aliens) received protection.—ED. *E.*]

"LIGHTNING IN AN ELECTRIC INSTALLATION."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your impression of July 13th contains two distinct and most important reports upon lightning which I think should be read and studied most carefully by all interested in the electric lighting industry. Read as you may and in what language you choose, the reports upon thunderstorms vastly differ; but more so the opinions of the various observers. The natural conclusion we may be allowed to draw from it is that we know precious little about it; and the sooner we set about the thorough study of the phenomena the better.

As far back as 1859, being engaged in making a primitive Morse relief writer, I had my left hand upon the insulated knob of the key, and in my right hand I held a wooden handled screwdriver, with which I was trying to adjust a screw. Suddenly my body was thrown backwards, head raised, arms rigid. I felt the last moment was coming, but my eyes were fixed upon a ball of bluish phosphorescent mass 1½in. in diameter, rolling slowly on the side of two trunk wires in the corner of the room. I was bound to follow the awful spectacle, as if in a mesmeric state. I found myself at last relieved; the ball had vanished, and only left us traces of its former presence, a distinct sulphurous strong original smell. (I say original because Prof. Krausse and myself shortly after the occurrence tried to find out the similarity of the smell; but we could not succeed, although we burnt all sorts of metals in all known gases.) I thought so much of this experience, and so greatly was I interested in the phenomena, that I read up all I could get hold of on the subject of atmospheric electricity, but I could get no information as to the previous observance of the phenomenon which I have described. The only substantial proof of its reality, and one which could speak for itself, was my *screwdriver*, the blade of which was converted into a saw of minute but very regular teeth. A second experience dates from 1882, when in the North of England I had charge of an installation of six 1,000 candle-power arc lamps supplied from an alternating-current machine, all in series, over a range of nearly 1½ miles. The cable was carried upon ordinary wooden posts. It had rained very hard, and there were signs of a heavy thunderstorm. I thought here is a chance at least to observe the phenomena of atmospheric discharge *versus* an unprotected circuit of a high potential. I was not at all disappointed in my expectation. The lightning struck the furthest lamp from the dynamo, melted the clamp pieces of a cut-out, and the melted brass ran in such a way as to make immediate contact, which caused the lamps to relight, and the whole circuit was in proper working order. My engineer, however, observed the effect at the moment upon the dynamo. Ever since, without wishing to be an alarmist, I declare it to be our duty to study the element of lightning, and whenever possible to adopt means to protect *all* electric-lighting installations.—Yours, &c., ERNST FAHRIG.

24, Listria Park, Stamford Hill, London,
July 12th, 1888.

COMPANIES' MEETINGS & REPORTS.

Eastern Telegraph Company (Limited).

The 32nd half-yearly ordinary general meeting of this Company was held yesterday (Thursday) at Winchester House, Old Broad-street, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. George Draper) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN stated that the revenue for the past six months had been £359,706, or £27,844 in excess of the revenue for the corresponding period of the previous year. These figures included the dividend of £31,200 on their investment in the Eastern and South African Telegraph Company, which was £7,800 more. Nearly all the shares in that company belonged to the Eastern Company. Owing to an interruption of the cable they had received £1,300 less from the Black Sea Telegraph Company, but they were not without hope that the final dividend for the year from that Company would make up in some measure the lower interim distribution. Their investment in the Ordinary Shares of the Direct Spanish Telegraph Company, in which they had a controlling influence, had given them a return of £676 against *nil*. That company had now turned the corner, and would, they expected, in future give a good dividend to its shareholders. The total working expenses had been £87,134, or £4,099 more than in the corresponding period of the previous year. The expenses attending repairs and renewals of cables had been £38,412, or a decrease of £5,491, although they had charged under this head the whole cost of duplicating the Zante-Patras section, about sixty miles. Therefore, after charging all expenses, including income-tax, interest on the Debentures, Debenture Stock, and Preference Shares, they were able to pay a dividend and bonus at the rate of 6 per cent. per annum, and to carry to the general reserve fund £75,000, carrying forward a small balance of £884 to next account. They had charged the whole cost of triplicating the Porthcurno-Malta cable and extension to Zante to the reserve fund, which was thus left at £342,338, which, with the special reserves stated in the balance-sheet, made the total amount of the reserves £362,606. They had also charged the amount expended on the new ss. "Amber" to the maintenance of ships fund. The issue of the Four per Cent. Mortgage Debenture Stock to pay off the Five per Cent. Debentures was now complete, and the premium on the issue of the same, £2,366, had been credited to the reserve fund. That was a remarkable instance of the strong position which their stock held on the London market. The total capital of the Company amounted to £5,900,000, and the capital expenditure to £5,965,000. They proposed to make arrangements to dispose of the £62,000 of Six per cent. Debentures of the Direct Spanish Company, and when that was complete the capital and the capital expenditure would practically balance. They would then be able to increase the investments on account of their reserve funds. The extraordinary withdrawals, partly from the reserves and partly from the revenue, had enabled them to keep down their capital, and he hoped in future to maintain their very steady and respectable dividends, and at the same time increase their reserve fund, which was a most important fund for such a company as this. With a strong reserve fund at their back their shares would be regarded on the market not for speculative purposes but as an investment. He might summarise the accounts as follows:—The gross revenue was £27,844 more; the balance brought forward from last half-year was £16,305 more than in the corresponding period of 1887; and the total expenses, including ships and income-tax, were £3,341 less, so that they were able to place £27,000 more to the reserve fund and to pay £19,000 more (or ½ per cent. more) bonus than in the corresponding period of last year. He thought he had now placed a most satisfactory statement before the shareholders. Just before coming to the meeting he had referred to the remarks which he made at the last half-yearly meeting—a meeting which he would always remember on account of the very kind observations which were made by shareholders at the honour which had been conferred on him, an honour which he had accepted as being connected with an institution by which they had all so long stood. In reading over his remarks on that occasion he found that he had made certain prophecies. He then said that in all probability, with the progress they were making, they would be able to pay the shareholders the 1 per cent. bonus which had been temporarily taken away from them on account of the reductions in the rates which were forced on them at the Berlin Telegraph Conference. They had recouped their position, and they were that day enabled to pay their regular 5 per cent. dividend, with a bonus of 1 per cent., thus placing the shareholders in the position they held before the reduction of the rates. He thought that they must regard that as a very satisfactory statement. During the past year they had added immense strength to their system by the laying of a third line from Porthcurno to Lisbon, Gibraltar, Malta, and Zante, giving them another important cable, and thus making them independent of the French line through France. They were, however, so anxious to have their work done in a thoroughly efficient and prompt manner that they were still desirous of having the line through

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France. They had been in negotiation for a considerable time with the French Government, but there had been difficulties in the way. With the merging of the Submarine system into the Government system, the French people would be free to deal with them respecting the line through France. He believed that there was a spirit abroad among the nations that the great system in which the shareholders were interested was now more or less international, and that while contributing nothing to it they derived the same benefit from it as we enjoyed in England. He believed that the feeling was gaining ground, and he was so far hopeful in the future that they would find less difficulty than heretofore in negotiating with foreign Governments. They had an instance of that at this moment in Portugal, where there was a disposition to meet them fairly. They would endeavour to encourage that feeling, as far as possible, for the more feeders the Company had the better for the shareholders. They were doing a most satisfactory business at the Cape, but feeling that that system was not as perfect or as secure as they would like it to be, they were about completing arrangements whereby they would obtain an alternative route from the Cape, joining their system at St. Vincent, and utilising the line lately laid along the West Coast of Africa. That would give them greater security, and meet a requirement of the Government—in short they would thus have such an independent position that their strength would be naturally increased. They had been strengthening the position of the Company in every way. He concluded by moving the following resolution :—

"*That the printed report and accounts of the Directors to the 31st of March, 1888, submitted to this meeting be, and the same are hereby received and adopted. That a dividend on the Preference Shares of the Company to the 30th of June, 1888, at the rate of 6 per cent. per annum, be paid, less income-tax, and that, in accordance with the Directors' recommendation, a dividend be and is now declared of 2s. 6d. per share, with a bonus of 2s. per share, both free of income-tax, on the Ordinary Shares of the Company, making, with previous payments by way of dividend on account, a total payment of 6 per cent. on those shares for the year ended 31st March, 1888.*"

The VICE-CHAIRMAN (the Marquis of Tweeddale) seconded the motion.

Captain GOODSALL put a few questions, and

The CHAIRMAN having replied, the motion was put and carried unanimously.

A vote of thanks to the Chairman, Directors and staff for their able and successful conduct of the Company's business during the past year was then proposed, seconded, and carried unanimously.

The CHAIRMAN acknowledged the vote, and the proceedings then terminated.

[We shall publish a full report of this meeting in our next issue.]

West African Telegraph Company (Limited).

The third ordinary general meeting of this Company took place at the offices, 98, Cannon-street, on the 13th inst., under the presidency of Major-General Sir Fred. J. Goldsmid, C.B., K.C.S.I.

The SECRETARY (Mr. R. N. Moir) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN : I think only very few words will be necessary for me to add to the report, as it is itself a statement of facts and figures. I should like to call your attention to the meeting of last year and to what was said at that meeting. I think you will find that any promises that were made or any expectations held out have been as far as possible fulfilled. There are one or two things over which we have had really no control. For instance, the traffic has not increased to that extent that we should have been glad to see, but in other respects I think you will find that the working has been satisfactory, and the whole line is at the present moment in good condition and good order. You will remember that at the last meeting it was stated that six stations had been opened in addition to the previous line from Senegal to Sierra Leone. Those six stations were from Grand Bassam to Loanda, through Accra, Kotonou, Sao Thomé, Gaboon, and Principé. It was shown last year that the amount of revenue was somewhat small, but no material or defined explanation was required, because we could state to you that the receipts were only for three months, while the expenditure was for very nearly the whole year. This year has been different. This year has been a year of working, and revenue and expenditure may be much more fairly contrasted. Again last year we had to explain that in starting a line there were a great many expenses which naturally occur in the first year of working an undertaking of this kind ; and this year, though it is not actually a year of starting, still there are many expenses that I think will not naturally follow in after years, because this is really only the second year of working. With reference to our subsidies I may say a few words. You will remember that at the last meeting it was represented that there were some difficulties in the way of realising the subsidies and guarantees until the accounts were placed on a clear footing. Since that period it will be satisfactory to you to know—and it is important you should know this—that the French subsidy has been paid to the end of 1887, and that the Portuguese guarantee has been paid up to the end of September last year. There is now, therefore, every reason to suppose that those payments will be regular and our accounts be put into a more systematic groove. We have no reason to anticipate any difficulties in the receipt of those payments. In that respect we are in a more flourishing condition than we were in last year. I should now like to say a word or two as to the smallness of the traffic receipts. Statistics for the complete line are available from September, 1886, but it would hardly be fair to compare the first three months' working of the complete line with the corresponding period in 1887. Taking, however, the first five months of the present year and comparing the number of words with that of the corresponding period in 1887, after making due allowance for the loss resulting from the interruption on the Sao Thomé-Loanda section, we may fairly consider that the volume of traffic has increased at least 15 per cent. For the present we must rely on our guarantee and subsidy hoping for better results in the future, when the system is connected with the Cape. It is, however, satisfactory to note when considering the returns of traffic that, whether we take the first three months of 1888 as compared with the corresponding period of 1887, or the last six months for which we have received accounts as compared with the six months immediately preceding, there is in each case a slight increase apparent, showing that the tendency is in the right direction. We have endeavoured to economise the working expenses by giving over two of our stations to the African Direct Telegraph Company. The cost which this arrangement will entail will be far more than compensated by the saving in establishment expenses. I do not think I need enter into any further details now, but probably what will be more interesting to you, as to myself and the Directors generally, is something in connection with our prospects. I have received a letter from Mr. Gray, who is unfortunately not able to be present to-day, but he wishes me to read it as coming from the India Rubber Company, with which we are so intimately connected. The following is the letter, which is dated the 10th inst.:—"I understand that your ordinary general meeting takes place on Friday, and that you may wish, in dealing with the prospects of the West African Telegraph Company, to make some reference to the probability of extending the cable from Loanda to the Cape of Good Hope. Anticipating this wish, I may say that this Company is earnestly working towards the completion of this extension, and we have every hope that by the end of this year the connection will be made. When the new lines are completed, the West African Company's property will be enhanced in value on account of the new traffic which will be thrown over this Company's lines. As the negotiations are at present under treaty I am unable to give you further details, but should we be successful in carrying the matter through you cannot fail to see how the increasing of the feeder to your system without any expenditure on your part must be to the advantage of your Company." I do not think you require any statement from me to show that the prolongation of the line to the Cape of Good Hope will be of enormous importance in a pecuniary point of view, and that it ought considerably to increase the receipts of the Company. I will not detain you any further, but will propose

"*That the report and accounts be received and adopted, and that the proposed dividend of 3s. per share be accordingly paid.*"

Sir HENRY C. MANCE, C.I.E., M.Inst.C.E., seconded the motion.

The CHAIRMAN expressed his readiness to answer any question, but no shareholder rising to address the meeting he put the motion and declared it carried. Continuing, he proposed a resolution for the confirmation of the appointment of Mr. Edward March Webb as a director of the Company.

Mr. JOHN MILES seconded the motion, and it was carried unanimously.

Sir HENRY MANCE then proposed the re-election of the retiring Director, Mr. Robt. Kaye Gray. He expressed his regret at the absence of Mr. Gray, who, however, he stated, was in Lisbon on business connected with the Company. They had derived the greatest possible benefit from Mr. Gray's intimate knowledge of the affairs of the Company from the time of its inception.

Mr. MILES seconded the resolution, which was carried unanimously.

On the motion of Mr. LLOYD, seconded by Mr. WELLS, Messrs. Kemp, Ford and Co., chartered accountants, were re-elected auditors of the Company.

An extraordinary general meeting was then held.

The CHAIRMAN stated that the object of the meeting was, as they would have observed from the notice, to correct an error in the Articles of Association. The alteration was quite inevitable. The resolution was as follows :—

"That the Articles of Association be amended in manner following, that is to say :—

"(*a*) Article 31 (as altered by the special resolution passed on the 20th of July, 1887, and confirmed on the 8th of August, 1887) shall be rescinded, and the following Article shall be substituted for it, namely :—

"'81. The number and qualification of the Directors may from time to time be altered and fixed by a resolution of a general meeting in accordance with the Company's regulations, but, until otherwise fixed, the minimum number of the Directors shall not be less than three, and the maximum number shall not be more than nine, and no one but a member of the Company who shall hold in his sole name registered shares or stock of the Company of the nominal value of not less than five hundred pounds shall be eligible as a Director.'

"(*b*) Article 84 shall as from the date of the said special resolution, passed on the 20th of July, 1887, and confirmed on the 8th of August, 1887, be deemed to have been and shall henceforth be rescinded, and the following Article shall as from the date of the said special resolution be deemed to have been and shall henceforth be substituted for it, namely :—

"'84. The continuing Directors at any time may act notwithstanding any vacancy in their body, provided always that in case the Directors shall at any time be reduced in number to less than the minimum number for the time being fixed by the Company's regulations or a resolution of a general meeting, it shall be lawful for them to act as Directors for the purpose of filling up vacancies in their body, but not for any other purpose,'"

Mr. MILES seconded the resolution, which was carried unanimously.

On the motion of Mr. WELLS, seconded by Mr. LLOYD, a vote of thanks to the Chairman and Directors was passed.

The CHAIRMAN, in reply, said he believed that the Directors had all done their duty conscientiously, and so long as they might be on the Direction he felt sure they would continue to do so. They would be only too delighted when they could pay a larger dividend.

The proceedings then terminated.

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The Telegraph Construction and Maintenance Company (Limited).

The half-yearly general meeting of this Company was held on Tuesday, at the offices, 38, Old Broad-street, E.C., Sir Daniel Gooch, Bart., M.P., in the chair.

Mr. W. SHUTER (the Manager) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, the object of this meeting, I think, is rather for you to make inquiries than for me to make any speech, because there is not anything to speak about. During the last six months our ships have been chiefly employed in repairing cables, and they have done that so far successfully. They have been engaged in picking up a cable at a depth of 2,200 fathoms, and they are still employed in that work. We are, I hope, in a position to do a good deal more of that work in the course of the current half-year. You will have seen, I have no doubt, because it is advertised, that we are paying an interim dividend at the rate of 10 per cent. for the past half-year, and the dividend warrants go out to-morrow.

Mr. SHUTER: They go out to-night.

The CHAIRMAN: So that they will be in your hands to-morrow. I am afraid I have nothing to tell you more. Our manufactories have been tolerably busy on other work besides cables, and we are satisfied so far with the work of the past half year; but I shall be happy to answer any question any shareholder wishes to put.

After a pause,

The CHAIRMAN continued: If there is no question I am afraid that this meeting is at an end. These meetings are not very useful ones; they bring you here for very little purpose. However, it was your desire to have them, and we are only too glad of course to meet you. There is no resolution to submit.

Mr. LOUIS: Can you give us any information about the Bermuda cable? Has it been advertised for?

The CHAIRMAN: No. There is nothing doing in reference to the Bermuda cable. It is a very necessary cable, and it ought to be laid. However, there is nothing doing about it at the present moment.

A vote of thanks to the Chairman and Directors then terminated the proceedings.

The India Rubber, Gutta Percha, and Telegraph Works Company (Limited).

A half-yearly general meeting of this Company was held at the Cannon-street Hotel, on Thursday last, for the purpose of obtaining the sanction of the shareholders to the payment of an interim dividend of 5 per cent., or 10s. per share, free of income-tax. Mr. S. W. Silver presided.

The SECRETARY (Mr. William J. Tyler) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, the business to-day is of a very formal nature. Before I move the adoption of the motion that calls us together I think I should say that the year's operations thus far have been of a satisfactory character; so much so that we look forward to meet you at the close of the year, when our books are made up, and to present you with accounts which will fully justify the motion referred to, namely,

"*That an interim dividend of 5 per cent., or 10s. a share, free of income-tax, be declared, payable on and after the 20th inst.,*"

which I now move.

Mr. NEIL BANNATYNE: I beg to second the motion that the Chairman has just moved.

Mr. WEBBER said that seeing that the dividend last year only amounted to £13,000 he would like to ask whether the telegraph works were now in full swing, or whether they were only partially employed. In the last balance-sheet it was stated that they had 120 miles of cable, and he wished to know whether that was disposed of. Looking at the balance-sheet of the Telegraph Construction and Maintenance Company of last year he saw that they found employment for their ships when they were not required for cable laying; did this Company adopt the same principle. By the last balance-sheet of the Company he had referred to he saw they made a balance of £88,738 net profit, while this Company only made the paltry dividend of £13,000. He was quite at a loss to know how it was that one factory could not keep pace with another. Seeing that they had a balance at their bank of £30,000, he wanted to know why it was that their coal merchants were told that they must take a four months' bill for the coal they supplied. Many people who might otherwise supply the coal were turned away entirely on account of that, which he considered an outrageous way of doing business. He thought also that the coal should be put up to tender. Other people did so, and he thought it would be advantageous for the Company to do likewise.

General TREVOR asked whether the accounts were sufficiently made up to enable the Directors to state that the 5 per cent. now proposed to be paid had been actually earned out of the profits of the half-year's working.

The CHAIRMAN: I think, as we meet here for a special purpose, we scarcely expected to have these questions put to us; but at the same time we are quite prepared to give the very best reply we can. As regards the India Rubber Works, the telegraph portion is only partially employed. The 120 miles of cable that you spoke of is earning a good return. As to our ships, we lose no opportunity of seeking employment for them; in fact, one has been engaged in the service of the Italian Government. The question relating to coal I shall leave the managing-director to reply to. As to the accounts about which General Trevor asked a question, I should say that our books are made up only once a year, and I can add nothing to what I have already said on that point.

General TREVOR: You cannot say, then, that the 5 per cent. has been earned out of profits?

The CHAIRMAN: Yes, our impression is that we have earned it.

Mr. GRAY (the Managing-Director): In reference to the remarks that Mr. Webber has made as to the way in which we are supplied with coal, I have no doubt that Mr. Webber feels a little aggrieved that he cannot sell coal to us, he being a coal merchant. He has offered us coal from time to time for the last two or three years, but either the price or the quality has not been so good as we could get elsewhere: and because he is a shareholder he has put forward claims now and again to get a preference which I do not feel inclined to give to anybody, I do not care who he may be. I do not think there is any trading concern in London that buys on better terms than we do. We do not pay a higher cost for them; in that he is entirely mistaken. And as for the quality of the coal, I have a regular test taken every week, and it is reported to me, showing the value of the coal that we are getting; in fact tests are going on all the time, and I have returns every week showing how much water can be evaporated per ton of coal. It is done in the most careful manner, and I do not know that there is any place in London where the coals can be tested with greater care and accuracy. I feel perfectly certain that they are bought well. We are not bound to anybody for them. The man that we get the coals from I have never seen, and nothing is done in the way of making contracts but under my instructions. We buy where we can buy cheapest in the interests of our shareholders.

Mr. WEBBER said that he had offered the coals at less cost.

Mr. GRAY: It is not true.

Mr. WEBBER said it was true. He was perfectly independent of their coal contract, and could do without it.

The CHAIRMAN then put the motion to the meeting, and it was carried unanimously.

Mr. HANSON then proposed a vote of thanks to the Chairman and Directors for the care and attention that they had given to the affairs of the Company. He knew a little how business was conducted in the City of London, and he thought he was right in stating that a more efficient Board for conducting such affairs as theirs did not exist. He also expressed the hope shadowed forth by the Chairman, that in February, 1889, the accounts would not only be so satisfactory as to afford them a 10s. dividend, but he trusted that the Directors would be able to see their way to resume the old dividend, and pay them a pound a share.

The motion was seconded by Mr. TREBLE, and carried unanimously.

The CHAIRMAN briefly acknowledged it, and the proceedings terminated.

The Maxim-Weston Electric Company (Limited).

An extraordinary general meeting of this Company was held at Cannon-street Hotel yesterday (Thursday), in compliance with a requisition from shareholders, to appoint additional Directors.

Mr. Hugh Watt, M.P., occupied the chair.

The SECRETARY (Mr. John Wright) having read the notice convening the meeting, and, at the wish of a shareholder, the requisition of the shareholders,

Mr. LOUIS HIRSCH formally proposed that five gentlemen be elected as additional Directors.

Mr. ROSE seconded the motion.

The motion was carried unanimously.

Mr. HILDYARD then submitted that the following gentlemen should be added to the Board in compliance with the motion:—Messrs J. M. Klench, John Marks, G. H. Hildyard, W. D. Harvest, and J. G. Couchman.

A SHAREHOLDER asked how many shares each of these gentlemen represented.

Mr. JOHN NEWTON said that Mr. Klench held from 250 to 500, and Mr. Marks something like 700 to 1,000. Mr. Hildyard, he was sure, was one of the largest shareholders, very few gentlemen surpassing him in point of their interest in the concern. Mr. Harvest also stood in the position of a large shareholder, as also did Mr. Couchman. In short, there could be no possible objection to any of those gentlemen on the ground of their stake in the Company.

The CHAIRMAN wished to explain that he was never opposed to an addition to the Board. He thought that it should consist of more members than as at present constituted. It might be invidious for him to say what the numbers should be—five or seven. He would leave that entirely to the meeting. Personally, since their last meeting, he had not sold a single share, holding, as he did, still 8,000 or 9 000 of them. With regard to the gentlemen named, they were all qualified to act as Directors. If he might be allowed to make one observation, he would say that it was usually a very difficult thing, according to his experience, to get the largest shareholders in a company to act as directors, or, indeed, to take any active part in relation to its affairs. He thought that if they could get business men of high character and reputation to accept a seat at the board of any company they ought to consider themselves extremely fortunate. He would venture to say that the position of the Company now was a very different one from what it was in 1883, when a committee was formed, consisting of Mr. Swaby and himself, to take up the electric lighting industry at a time when it was undoubtedly discredited throughout the country. Millions of money had been lost in it, and he thought he might say that for the years 1885-6, when they paid 7½ per cent. and 5 per cent. dividend, they did a feat unexampled in the history of electric lighting in this country. So far as he was concerned, he would welcome any addition to the Board calculated to improve and extend the connection of the Company, thus enabling it to have a more prosperous career in the future than it had in the past. Up to October or November, 1887, there was every prospect of being able to pay 5 per cent., but three or four very large con-

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tracts fell through, which did not allow them to do so. The accounts for the year were presented on the same basis as in previous years, with this exception, that the amounts credited to patents were less than in previous years. He wanted to mention one fact with regard to the position of the Company. Of course internal dissension meant destruction, and when those gentlemen came to him a week ago or so and suggested a compromise, so that the committee and the Board should meet there on that occasion, if he might say so, presenting a united front to the shareholders, he for one offered no objection. If those five gentlemen were determined to join the Board and throw in their lot with the present Directors, he thought the shareholders would act in a very suicidal manner if they did not accept of their services, not only cheerfully, but with acclamation. The secretary had prepared a statement of contracts in negotiation between March and July this year, and he found they amounted to £120,000. Six corporations were now in treaty with the Company with a view to very considerable contracts, while contracts were being negotiated with several of the largest railway companies in the country and with other companies besides. They were also in negotiation with two or three departments of the Government for several contracts, as well as with some private firms who seemed to be under the impression that they could carry out such contracts on equal if not on superior terms to those of any other electric lighting company doing business at the present time. Their prospects, therefore, were, he thought, all that could be desired. He did not intend to say anything whatever as to the gentlemen who were proposed to join the Board. He would only say to the shareholders—theirs be the duty of appointing them, as it ought to be; and as to the gentlemen appointed, theirs be the responsibility. He sincerely hoped the Company would succeed, and he believed it would. He had a strong belief in the Maxim patents. The Weston machine was rather an expensive one, but they were now in a position to manufacture it. They manufactured all their arc lamps, and the only thing that they did not manufacture was their incandescent lamp. Referring to the recent decision in the case of the Edison and Swan Company *v.* Holland, he was happy to say that the Maxim-Weston Company had not been threatened with any action in this country, while he was equally happy to state that in the event of such a contingency arising, by their agreement with the American Company they were entitled to a very considerable sum from that Company to defend their patent rights. He hoped that no litigation would ever ensue. It now remained with the shareholders to say whether the gentlemen nominated for seats at the Board—all of whom had conformed with the Articles of Association, inasmuch as they had been nominated seven days prior to the present meeting, and no other nominations having been received—should be elected. To have only two Directors was absurd, and that was practically what they now had, because the last accounts he had of Mr. Brown's condition were very unsatisfactory. Personally he thought there could be no objection to seven Directors, but he thought it was extremely desirable that, whatever action the meeting took, it should be done harmoniously, so that as a company they might present a united front to their opponents, for at no time in the history of electric lighting had opposition been so fierce as it was at the present time. But notwithstanding this fact, as he had said, he found railway companies, private firms, and others going to the company and saying that they would prefer its system to any other. During the present week they had the offer of a contract in London which they refused at a price something like 15 per cent. in excess of the tender of another company, which accepted it, the terms of payment being twelve months. While on that question he ought to say this—and he had not concealed it from anybody—that it was extremely desirable that the Company should have more capital, because if they had not, they would be heavily handicapped in their operations. The expenses connected with installations, such as for the engines, boilers, cable, and so on, were very heavy, and if they were required to give twelve months credit to compete with their rivals it necessitated a large capital. One company, he believed, had been taking contracts on the three years' system—that was to say, by dividing the payments over three years. He thought he would take this opportunity of explaining so far the position of the Company to the meeting.

Mr. HILDYARD then formally proposed, and Mr. WHITE seconded, the election as Directors of the Company of the gentlemen already named.

The CHAIRMAN put the motion, which he declared carried.

Mr. SWABY then, amid a scene of great confusion, demanded whether any of the books and other valuable documents of the Company were missing, and loudly protested that the meeting had been illegally called.

Mr. HIRSCH reminded the Chairman that the business which the shareholders had been summoned to transact having been finished the meeting was at an end, and the question should not be answered.

Mr. KLENCK returned thanks for the newly-elected Directors, assuring the meeting that their earnest desire would be to promote the interests of the Company, and if they found anything "fishy" in connection with its management they would take the first opportunity of laying it before the shareholders.

Mr. SWABY still persisted in putting his question, but

The CHAIRMAN, having first proposed a vote of thanks to the committee, which was duly seconded and passed, vacated the chair.

Mr. JOHN NEWTON said that the committee had fought a good battle for the Company. They had used every effort to put an end to litigation, having made, as they had heard from the Chairman, a compromise. That compromise was only made because they represented a vast sum of money in the Company. If they had only consulted their feelings there would have been no compromise, but they should have fought to the bitter end. They wanted peace. In conclusion, he asked them to vote a sum of money that would cover the expenses of the committee in connection with their investigations.

Mr. GEORGE RUSSELL: How is it to be done? The business is concluded.

Mr. SWABY: I should subscribe my share if we got a fair and not a false balance-sheet. (Uproar.)

A SHAREHOLDER: How much do you want?

Mr. KLENCK said that two committees had been working since March, but he thought 100 guineas would cover everything.

At this point the proceedings became exceedingly noisy and irregular, there being no chairman of the meeting, and

On the motion of Mr. KLENCK, seconded by a SHAREHOLDER, Mr. Louis Swaby, one of the Directors of the Company, was invited to preside.

Mr. RUSSELL said that Mr. Watt had informed them that two members of the committee formed a quorum. If that was in accordance with the Articles of Association of course it could not be altered, but he wished to know whether the gentlemen newly elected would take care that more than two were present at every meeting.

Mr. NEWTON said the matter could be simply settled by the shareholders emphasising the principle of paying fees to those gentlemen only who attended the meetings.

The CHAIRMAN, in answer to a shareholder, said that he believed Mr. Watt had sent in his resignation.

Mr. NEWTON said that Mr. Watt would retire at the end of October, so he had told the committee. But let there be no mistake, it was not to their interest to quarrel with Mr. Watt. They might desire to do so, and no doubt many would like to have something more than a mere quarrel with that gentleman. But he (the speaker) did not, because he was a shareholder of the Maxim-Weston Company, and wished to improve the value of his investment. No one had a stronger feeling against Mr. Watt than he had, but he was not going to jeopardise his interests in the Company by a futile indulgence in personalities.

The CHAIRMAN then proceeded to give an account of his own stewardship in connection with the Company and the manner in which he had been vilified in public in connection with the Company's management, with the object of vindicating himself before the shareholders, but——

Mr. NEWTON interposed and said that the question was not before the meeting and could not be gone into. Besides, Mr. Swaby had been justified in a court of law, and what more could he want? They all knew that he had been justified, and had no need to repeat that justification now.

The CHAIRMAN: Very well, I will drop the subject.

Mr. MARKS objected to the proposed grant of 100 guineas to the committee, for the reason that they were now holding an informal meeting, the proceedings at which could not be held binding on the Directors.

Mr. KLENCK did not believe in doing anything for nothing. They had expended certain sums of money, and they ought to be reimbursed.

Mr. NEWTON thought that 50 guineas should cover their expenses.

Mr. RUSSELL said it could not be passed as a resolution, but might be made in the form of a recommendation to the Directors.

A long and noisy discussion ensued at this point as to the amount to be granted to the committee; and finally, on the motion of Mr. J. H. JONES, seconded by Mr. LEE, it was resolved

"*That the Directors be recommended to reimburse the committee of shareholders for their outlay in the interests of the shareholders a sum not exceeding 100 guineas.*"

Mr. HENDERSON raised an animated debate by wishing to move that Mr. Watt be forthwith suspended from his seat at the Board. The discussion was continued for some time with equal heat by both Mr. Watt's partisans and opponents, the meeting ultimately terminating in "the most admired disorder," without coming to any resolution on the subject.

Western Counties and South Wales Telephone Company.

An adjourned meeting of the shareholders of this Company was held on Thursday, July 12, at the Royal Hotel, College Green, Bristol, for the purpose of sanctioning the raising of additional capital to enable the Company to carry out contemplated extensions. Mr. Charles Nash presided.

Mr. H. F. LEWIS (secretary and general manager) having read the notice convening the meeting,

The CHAIRMAN said it had been thought desirable to defer the arrangement for issuing a further amount of share capital, so that the first resolution attached to the report was withdrawn, and he now moved the second resolution, which was as follows:—

"That the Articles of Association be altered in manner following, that is to say:—

"(*a*) The following article shall be substituted for Article 71, namely, 'They may borrow any sum or sums of money on such security and terms as to interest or otherwise, as they may deem fit, and may secure the same by mortgage or other debentures, or by bond or other securities, or by any mortgage or charge of, or upon, the whole or any part of any property, funds, assets, or effects of the Company, or its uncalled capital; but so that not more than £20,000 be owing at any one time without the consent of a general meeting, and provided that no part of the said sum of £20,000 shall be borrowed without the consent of the United Telephone Company (Limited), and no borrowed money shall, without the like consent, carry interest at a higher rate then 6 per cent. per annum.'

"(*b*) In Article 91, the word 'and' coming after the word 'agencies' shall be omitted, and the words 'trunk lines and new business' shall be inserted after the word 'branches.' The clause, as amended, shall apply as from the formation of the Company."

The sum mentioned (the Chairman continued) might be sufficient to carry them through the present year, and they hoped that money would be obtained at a lower rate of interest than if share capital had been offered—probably not exceeding 5 per cent. He would just repeat what he thought he said at the last meeting, viz., that it was necessary they should have

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further capital in hand to enable them promptly to cover some further portion of the large district which formed the territory of the Company. It would be their duty very carefully to select from the long list of places mentioned in the report those that were likely to give them a speedy return, and to arrange for opening exchanges in them, and also for connecting them, where desirable, by trunk lines. The only other point, he thought, was that it would not be necessary to borrow the whole of this money at once. That would be done at intervals as required. The last clause of the resolution was only inserted for the purpose of removing ambiguity and making the meaning of the clause plain. There had been a doubt as to whether it included trunk lines or not, and there would be no doubt about it any longer, as these words made the matter perfectly plain. He would only add that the general progress of the company continued to be very satisfactory, and that from week to week they were getting considerable accessions of business. Since they last met there were two places where arrangements were now in progress for speedily opening exchanges—he referred to Cheltenham and Swindon. Perhaps they might not be very valuable in themselves, but Cheltenham, when connected with Gloucester and the Stroud district, and Swindon, if connected with Bath and Bristol, would, he believed, bring a very considerable increase to their business.

Mr. MARK WHITWILL seconded the motion, which was carried unanimously.

The CHAIRMAN said he should like to supply an omission he made at the annual meeting in June by expressing what he was sure was the feeling of the Directors, their high appreciation of the great energy and ability of Mr. Lewis, the general manager. During some very heavy work that had been going on lately, Mr. Lewis had been very ably supported by the members of the staff. They often had to work long hours. That they had done willingly, and he thought it was only due to them that it should be mentioned.

Mr. HENRY FEDDEN said he had seen a great deal of Mr. Lewis's work and would like to confirm what the Chairman had said in regard to it. He never knew a man who was more earnest in his work than Mr. Lewis, who had shown a thorough determination to make the company a success.

Commander D. M. FORSYTH, R.N., also testified to the great help which Mr. Lewis had rendered, both in the formation of the company and in its subsequent development.

Mr. LEWIS briefly returned thanks, and the meeting terminated.

Petroleum Engine Company.

The statutory meeting of the Petroleum Engine Company (Limited) was held on Wednesday last at the Cannon-street Hotel, E.C., Mr. Henry Pawson presiding.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said: This meeting is called simply in compliance with the statute which regulates companies' affairs. The business may be purely formal; but there is this fact, which it may not be out of place to mention—in fact, I have great pleasure in naming it—the Royal Agricultural Society have within the last few days awarded its silver medal to this Company for its important invention. There were only two silver medals awarded. The Society can award for new mechanical inventions within the year as many as 10 silver medals. On this occasion there were no fewer than 69 applications for medals, but only two were granted; and this Company, for its petroleum engine, occupies the first place. Now, this, as you will not be surprised to learn, has caused a great number of applications to be made to our licensees, Messrs. Priestman Bros., for information regarding this important invention, for it has not become known to everyone yet. It will be one of the exhibits at the Highland Agricultural Society at Glasgow in the course of next week, and I have no doubt it will attract as much attention there. Orders are coming in now, and our licensees, Messrs. Priestman Brothers, are erecting extensive workshops for the purpose of producing engines rapidly; and although I am not in a position to tell you what amount of business has been done at the present time, yet I can entertain no doubt that we are on the eve of a great business, and in due time I hope we shall be in the happy position of being able to declare a dividend.

Mr. DUNLOP asked had the whole of the Company's capital of £100,000 been issued, and were there any debentures or charges on the property outstanding?

The CHAIRMAN said there were no charges of any kind against the company. All the shares were allotted, with the exception of a very small reserve.

Mr. WALLACE said in purchasing his shares he was influenced a great deal by the well-known reputation of Messrs. Priestman Brothers. He concluded his remarks by putting a series of questions to the Chairman, a copy of which he handed in.

The CHAIRMAN, in reply, said the Company absolutely controlled all the patents of the engines for Great Britain, India and the British Colonies, including those taken out by Messrs. Priestman and Hume. The Company's guarantee that Messrs. Priestman would adequately introduce and push forward the sale of engines was that they had expended many thousands of pounds of their own capital in the concern, and the only return they could obtain was from the manufacture and sale of the Company's engine, out of which the Company received a royalty. Messrs. Priestman were not interested in any other motive power invention which could come in competition with the petroleum engine. The Directors' remuneration was £100 a year each, and there were four of them. The Directors had decided on measures which would very considerably reduce the yearly expenditure of the Company. Measures were being taken—and the Board expected very important results—to introduce the invention in the Colonies and India and push it to the fullest extent. It was true that the special oil used in lighthouses by the Trinity Corporation had been tested for working the Company's engines and found suitable for that purpose. The result was most satisfactory. The Company did not defray any of the expenses of advertising and otherwise for making the invention known.

In reply to Mr. MICHIN, the CHAIRMAN said the Company had nothing to do with the Company working the petroleum engine in the United States; that Company would not in any way trench on their ground.

The shareholders were then invited to elect an auditor, and, on the motion of Mr. IRVING, seconded by Mr. TIPPING, unanimously appointed Mr. Ernest, who had been carrying out the duties.

Mr. MICHIN moved, and Mr. TIPPING seconded, a vote of thanks to the Chairman, which was carried.

The proceedings then terminated.

Anglo-American Telegraph Company (Limited).

Report of the Directors to the ordinary general half-yearly meeting of the proprietors, to be held at Winchester House, 50, Old Broad-street, London, E.C., on Thursday, the 26th inst., at 12 noon:—

1. The total receipts from 1st January to 30th June, 1888, including the estimated balance of £2,344. 18s. 4d. brought forward from the last account, are estimated at £77,575. 18s. 8d. This amount, however, is subject to revision, dependent upon the result of the law suit still pending between this Company and the Paris and New York Telegraph Company. The traffic receipts show a decrease, as compared with the corresponding period of last year, of £19,635, the reasons for which are explained in paragraphs 6 and 7 of this report.

2. The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amount to £42,189. 6s.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
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DURO METAL
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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3. One quarterly interim dividend of 5s. per cent. on the Ordinary Stock, and of 10s. per cent. on the Preferred Stock, was paid on 1st May, 1888, absorbing £17,500, and a second quarterly dividend of 5s. per cent. on the Ordinary Stock, and 10s. per cent. on the Preferred Stock will be paid on the 1st of August, 1888, absorbing £17,500, leaving a balance of £390. 12s. 8d. to be carried forward to the next account.

4. The Company's repairing ss. "Minia" has been engaged during the past half year in the repair of the St. Pierre-Duxbury cable, broken off Cape Sable, N.S., and of the Northern Placentia cable, near St. Pierre. The Island Cove cable, broken by an iceberg, was repaired by the officers of the station at Heart's Content.

5. The 1873, 1874, and 1880 cables are in good working order, but the interruption to the Brest-St. Pierre cable, announced in the last report, still continues; the ss. "Minia" is now engaged in effecting the repair, and as she has already made satisfactory progress, the Directors have every reason to believe that communication by this cable will be restored before the close of the season. The St. Pierre-Duxbury cable was again broken on the 28th May, at a distance of 299 knots from the latter place. The Company's system of cables and land lines in Newfoundland and Prince Edward Island is working satisfactorily.

6. The traffic passing over the lines of the joint-purse companies during the past half year shows a considerable decrease as compared with the corresponding period in 1887. This decrease is explained principally by the fact that the Commercial Cable Company reduced their tariff from 1s. to 5d. per word on the 15th September last, thereby entering into competition with the associated companies at equal rates.

7. The Directors regret to report that the very encouraging increase of traffic, the principal part of which followed immediately upon the reduction to 6d. per word on the 5th May, 1886, has not been continuous, and has now practically ceased, for although Atlantic cable traffic is much larger than that carried to any other part of the world, it does not develop with sufficient rapidity to admit of the present tariff being made permanent. The result of over two years' experience of the reduction of tariff from 1s. 8d. to 6d. per word has been an augmentation in the volume of traffic of about 140 per cent., and this fact proves beyond question that with the present system of coding messages, and with the large number of competing cables, exceptionally low rates upon such long and costly lines of communication cannot be made to pay. The Directors trust that arrangements will soon be made between all the companies for the establishment of more remunerative rates.

8. The attention of the public has been frequently drawn, through the Press, to the large amount of the Company's capital, and this is alleged to be the sole reason why low rates cannot be made profitable upon the cables of this Company. The Directors, in answer, would point to the fact that the margin between revenue and working expenses produced by the 6d. rate is too insignificant to show sufficient profit upon any amount of capital necessary, even at the prices of materials and labour now current, to relay or renew such a system of cables and land lines as that possessed by the Company, without taking into consideration the absolute necessity of building up a substantial renewal fund, which is now admitted on all hands to be indispensable to the permanent existence of cable companies.

9. The appeal of the Paris and New York Telegraph Company against the judgment of the Tribunal of Commerce, in favour of this Company, came on for hearing on the 10th April. The Court of Appeal decided that before final judgment could be given reference must be made to the Conseil de Prefecture for the interpretation of certain administrative matters in connection with the concession of the Paris and New York Company. The Directors fear that the final decision in the case will not be obtained for some months, as either of the parties to the suit has the option of appealing to the Conseil d'Etat, and which will probably be availed of.

LEGAL INTELLIGENCE.

The United Telephone Company v. Tasker, Son and Co.

In the Court of Appeal on Wednesday last this case came before Lords Justices Cotton, Fry and Lopes as an appeal against a decision of Mr. Justice Kay (which we reported last week), who had ordered the plaintiffs to extend an undertaking previously given, and to supply the defendants with 96 telephones instead of 52, as at first agreed.

LORD JUSTICE COTTON was satisfied that, though the undertaking was given in general terms, it was given upon the understanding of both parties that only 52 telephones which were infringements of the patent were in use by the defendants, to which 52 the undertaking and the injunction would apply. As soon as the blunder was discovered the defendants ought to have consented to a limitation of the undertaking to the 52 telephones, and his lordship thought that Mr. Justice Kay ought to have been satisfied on the evidence before him that the undertaking had been given by the plaintiffs as applying only to the 52 telephones, and he should have limited the undertaking accordingly. That, his lordship thought, was the undertaking which the plaintiffs intended to give. He did not say that the plaintiffs were bound to give any undertaking, but they were willing to do so, and they had a right to have the undertaking limited to that which they intended to give. With regard to costs, the defendants had made a mistake as to the number of infringing instruments which they were using, and as soon as they found it out they ought to have acceded to the plaintiffs' desire that the undertaking should be limited to that which they intended to give, and ought not to have compelled the plaintiffs to apply to Mr. Justice Kay. The costs, therefore, of the application and of the appeal must be the plaintiffs' in that event.

LORD JUSTICE FRY did not doubt that the misstatement of fact was a *bonâ fide* error on the part of the defendants, or that there was no intention to deceive. But when the error was discovered the defendants ought to have assented to confining the undertaking to the 52 instruments which were in the mind of the plaintiffs when they agreed to give the undertaking.

Lord Justice Lopes concurred.

The Court allowed the appeal.

Re Emile H. M. Andreoli.

In the Official Receiver's Department of the Court of Bankruptcy a receiving order in this case was made, on May 29, the debtor residing at Loughborough Park, and accounts have been furnished showing total liabilities £4,919, of which £3,577 are unsecured, with assets *nil*.

The following is taken from the Official Receiver's observations:—The debtor states that he is a journalist and foreign correspondent, which profession he followed for many years previous to 1878, when, having a small capital, he started a weekly newspaper called *The Paris Exhibition of 1878*, afterwards changed to *Industry*, and acted as editor thereof until August, 1882, the undertaking resulting in a loss. From 1882 to 1884 he was engaged in certain negotiations in connection with Italian railways, which also proved unsuccessful. The debtor further states that he has been engaged in electrical experiments, which he has conducted with borrowed moneys, and has taken out two patents, and that in 1886 he started a French paper (*L'Ingénieur Electricien*), which was published in Paris until January, 1887. Since the beginning of the present year he has been engaged in experiments in electric bleaching, from which valuable results are anticipated.

IMPORTANT NOTICE.

WOODHOUSE & RAWSON

INCANDESCENT ELECTRIC LAMPS.

OWING TO THE JUDGMENT BY Mr. JUSTICE KAY IN "EDISON versus HOLLAND AND OTHERS," THE ABOVE LAMPS CAN NOW BE SUPPLIED FREE OF ROYALTY.

Prices and Full Particulars to be obtained from

The WOODHOUSE & RAWSON Electric Supply Company of Great Britain, Ltd.

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DISTRICT AGENTS WANTED.

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NEW COMPANIES REGISTERED.

BARNOLDSWICK GAS AND LIGHT COMPANY (LIMITED).—This company was registered on the 7th inst., with a capital of £12,000 in £10 shares, to manufacture, sell, and supply gas or any other illuminating power in the parish of Barnoldswick, in the county of York, and generally to carry on the business of gas manufacturers and gasfitters, electrical engineers, and every other business in any way connected with the manufacture and sale of gas and electricity, or other illuminants. The subscribers are :—

	Shares.
H. Slater, Barnoldswick, manufactrrer	120
J. Pickup, Barnoldswick, general dealer	50
J. Broughton, Barnoldswick, mason	40
J. D. Roberts, Barnoldswick, physician	40
S. Slater, Barnoldswick, pork butcher	60
C. Brookes, Barnoldswick, grocer	15
J. Hartley, Barnoldswick, innkeeper	20

The number of directors and the names of the first directors will be determined by the subscribers to the Memorandum of Association. The company in general meeting will determine remuneration.

GREENWOOD AND BATLEY (LIMITED).—This is the conversion to a company of the business of engineers and machine makers, carried on at the Albion Works, and elsewhere in Leeds, by the firm of Greenwood and Batley. It was registered on the 7th inst., with a capital of £400,000 in £10 shares. The subscribers are :—

	Shares.
*Arthur Greenwood, Albion Works, Leeds, engineer	1
*G. Greenwood, 16, Great George-street, engineer	1
Henry Greenwood, Albion Works, Leeds, engineer	1
*J. H. Wurtzburg, Albion Works, Leeds, engineer	1
*Rear-Admiral P. H. Colomb, 97, St. George's-road, S.W.	1
*Major-General E. Micklem, 36, Hans-place, S.W.	1
*Lt.-col. R. Vivian, 5, Hans-place, S.W.	1

The number of directors is not to be less than 5, nor more than 7; qualification, £500 in shares or stock. The first are the subscribers denoted by an asterisk. The remuneration of the Board for the first five years is to be £4,000 per annum for the managing directors, and £1,000 per annum for the chairman and ordinary directors.

H. DALE AND COMPANY (LIMITED).—This is the conversion to a company of the business of electricians and manufacturers of scientific and mechanical inventions, apparatus and materials, carried on by Henry James Dale and E. J. Dale, at 26, Ludgate-hill, E.C. It was registered on the 5th inst., with a capital of £10,000, in £5 shares. The subscribers are :—

	Shares.
*H. J. Dale, 184, Elthorne-road, Hornsey Rise, electrician	1
E. J. Dale, 184, Elthorne-road, Hornsey Rise, electrician	1
*R. C. Beauchamp, Wormsley-road, Hornsey	1
*E. G. Price, 9, Kirby-street, Hatton-garden, electrician	1
C. D. Smith, 35, Clifton-crescent, Asylum-road, Old Kent-road	1
J. Hulme, Glen Eldon-road, Streatham, accountant	1
W. Jackson, 20, Cornwallis-road, Holloway, electrician	1

The number of directors is not to be less than three nor more than ten; qualification, £100 in shares or stock. The first are the subscribers denoted by an asterisk. The company in general meeting will determine remuneration.

SCIENTIFIC APPLIANCE MANUFACTURING COMPANY (LIMITED).—This is the conversion to a company of the business of electricians and manufacturers of scientific and mechanical inventions, apparatus and material, carried on by Henry James Dale and Edward Jonathan Dale, at 9, Kirby-street, Hatton-garden. It was registered on the 5th inst., with a capital of £10,000, in £5 shares. The signatories and directors are the same as in those of H. Dale and Company, Limited (*see* above), and the same regulations as to qualifications and remuneration will apply.

THE EAST STRAND AND DISTRICT ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—Registered by the Law Land Company (Limited), with a capital of £5,000, in shares of £5 each, with power to increase. Object, to apply and obtain, either singly or jointly, licenses, provisional orders, or Acts of Parliament for the supply of electricity; to establish and carry on the business of suppliers of electric energy, of manufacturers of and dealers in electrical apparatus and appliances, of all descriptions, used or intended to be used in any way in, or which are applicable to, the generation, distribution, storage, measurement, conversion or utilisation of electricity, and the business of an electric light and power company in all its branches, and of engineers and contractors, and such other business as the directors of the company for the time being may consider desirable for the interest of the company. The first subscribers are :—

	Shares.
J. Dunn, F.R.I.B.A., 1, John-street, S.W.	1
G. E. Lloyd, 4, King's Bench-walk, E.C.	1
A. W. Lightbody, 222, Strand, W.C.	1
S. H. Burbury, 1, New-square, Lincoln's Inn, W.C.	1
E. Wilson, 5, Adams-court, New Broad-street, E.C.	1
A. M. Lloyd, Norfolk House, Victoria Embankment, W.C.	1
J. G. Lorrain, Norfolk House, Victoria Embankment, W.C.	1

The company is registered without Articles of Association, and, consequently, the regulations of Table A of the Companies Act of 1862 apply.

CITY NOTES, &c.

ANGLO-AMERICAN TELEGRAPH COMPANY.—The Board of Directors of this company have declared an interim dividend for the quarter ended 30th June, 1888, of 5s. per cent. on the Ordinary stock, and 10s. per cent. on the Preferred stock, less income-tax, payable on the 1st August, to the stockholders registered on the books of the company on the 10th July, 1888.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended July 13th, 1888, amounted to £4,582.

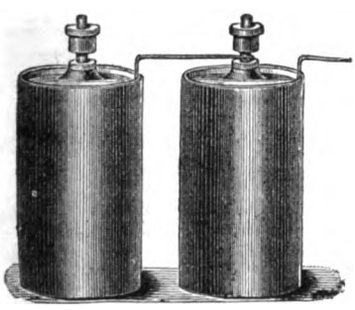
ELECTRICAL PURIFICATION COMPANY (LIMITED).—The acquisition and working of patents granted to Mr. W. Webster relating to the electrical treatment of sewage will be undertaken by this company.

GLOBE TELEGRAPH TRUST COMPANY.—The Directors of this company have declared a final dividend of 3s. per share, less income-tax, on the Preference shares, and of 3s. per share on the Ordinary shares, free of income-tax, making with the previous payments, a dividend for the year of 6 per cent. on the Preference shares, and 3½ per cent. on the Ordinary shares.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended July 13th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £3,789.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended July 15 were £2,525, as compared with £2,398 in the corresponding period of last year.

PERSONAL.—We are informed by Mr. S. Sudworth that he has left the firm of Sudworth and Co. (Limited), electricians and manufacturers, of South Hackney, and has established himself as an electrical engineer and contractor for electric light installation work. Mr. Sudworth omits to mention his present address.



Dr. GASSNER'S PATENT

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TELEGRAPHIC WORK, ELECTRIC BELLS, AND MEDICAL USE.

Possesses all the advantages of a Leclanché Cell, and none of its deficiencies.

Can be placed in any Position, on side or upside down, in very Warm or very Cold places, so that for Ship use, carrying about, as well as for General Purposes, it is a PERFECT DRY CELL. *Sole Wholesale Depot for England—*

MAYFIELD, COBB & CO., LTD., 35a, QUEEN VICTORIA STREET, LONDON, E.C.

THE NEW BURGLAR ALARM CONTACT (Patent applied for); cannot get out of Order. Rubbing Contact, and Wetproof.

THE NEW INDICATOR MOVEMENT (Patent applied for). Simplicity and Efficiency.

Trade Terms and particulars on application to MAYFIELD, COBB & CO., Limited.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, July 18, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending July 18, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American	40½ 41½	3 6 3	Jan., Apr., July, Oct.	41⅞	40¾
2,614,820	Stock	20/0	Do. Preferred	66 67	4 2 1	,, ,,	68	66
2,614,820	Stock	nil.	Do. Deferred	13½ 14	...	February	14¼	13⅜
130,000	£10	3/0	Brazilian Submarine	12⅜ 12⅝	4 15 0	Mar., June, Oct., Dec.	12⅝	12 9/16
16,000	10	8/0	Cuba Submarine	13¼ 13⅜	5 16 6	February and August	...	...
6,000	10	10/0	Do. Preference	19 19½	5 2 6	,, ,,	...	..
12,931	5	4%'87	Direct Spanish (£4 paid)	3⅜ 4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference	9 10	5 0 0	April and October	...	...
60,710	20	2/0	Direct United States	9⅛ 9⅜	4 5 4	Jan., Apr., July, Oct.	9⅜	8 7/8
380,000	10	2/6	Eastern	12 12⅛	4 9 9	,, ,,	12 5/16	11⅞
70,000	10	3/0	Do. 6 per Cent. Preference	14¾ 15¼	3 19 0	,, ,,	15¼	14⅞
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	3 16 3	February & August	...	...
250,000	10	2/6	Eastern Extension xd	12⅜ 13	5 0 0	Jan., Apr., July, Oct.	13	12 13/16
22,050	10	5/9	German Union Telegraph and Trust	9 9¼	7 7 4	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	6½ 6⅝	4 16 2	Jan., Apr., July, Oct.	6⅝	6
178,992	10	3/0	Do. 6 per Cent. Preference	14 14½	4 4 3	,, ,,	14½	14
150,000	10	5%	Great Northern	13¾ 14¼	5 5 3	Jan., July, and April	...	...
17,000	25	5/0	Indo-European	36 38	6 11 9	April and October	...	...
38,348	10	3%	London Platino Brazilian	5⅞ 6¼	...	May and November	...	...
9,000	8	4/0	Reuter's	7⅞ 8	5 0 0	April and October	8	...
338,225	Stock	12%	Submarine	140 150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America xd	6½ 7	7 2 10	January and July	7	6⅝
150,000	100	8%	Do. Debentures	110 115	6 19 2	June and December	...	...
88,321	10	nil.	West India and Panama	1/16 1⅛	...	...	...	...
34,563	10	9/0	Do. 1st Preference	10¾ 11¼	...	April and October	11	...
45,181	15	3/9	Western Brazilian	9⅝ 10⅛	6 5 11	March & September	10⅛	10
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	102 104	5 15 5	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	5/16 6/16	5 0 0	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	1/4 3/8	3 13 6	...	...	...
80,000	5	5/0	United xd	13 13¼	5 11 1	June and December	13 5/16	13¼
50,000	5	2/6	United River Plate	5⅝ 6¼	...	April and October	5 15/16	5⅝
			ELECTRIC LIGHT.					
24,357	5	1/2 Feb.'86	Anglo-American Brush (£4 paid)	2¼ 2⅜	...	...	2⅜	...
23,692	5	nil.	Do. (fully paid)	3¼ 3⅜	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅛ 2⅜	...	...	2 7/16	2 3/16
312,000	½	0/1½d '86	Maxim-Weston	1/16 1/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance xd	39 40	5 19 11	March and July	40¼	39¼
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	17½ 18¼	5 9 7	February & August	18⅛	17½

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

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The Right Hon. Sir H. J. SELWIN-IBBETSON, P.C., Bart., M.P., *Chairman.*
LORD CLAUD J. HAMILTON, M.P., *Deputy Chairman.*

Hon. EVELYN ASHLEY.
J. SPENCER BALFOUR, Esq.
MICHAEL BIDDULPH, Esq., M.P.
W. P. BOUVERIE, Esq.
ARTHUR CLARKE, Esq.
Sir WILLIAM FORWOOD.
EDWARD LAWRENCE, Esq.
ERNEST NOEL, Esq.
Sir JOHN PENDER, K.C.M.G.
J. DENISON PENDER, Esq.
The Right Hon. LORD SUDELEY, P.C., F.R.S.
LEOPOLD SALOMONS, Esq.
JOHN C. SALT, Esq.
C. A. WHITMORE, Esq., M.P.

Offices—**WINCHESTER HOUSE, OLD BROAD STREET, LONDON, E.C.**

The principal objects of the Corporation are:—

1. Performing the duties of Trustee, Executor and Administrator.
2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the duties of the family solicitor.

The Corporation acts as Trustees for the Debenture Holders in Public Companies.

For terms, &c., application should be made to the General Manager at the Company's Office.

GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 532.—Vol. XXI. FRIDAY, JULY 27, 1888. Price 4d.

NOTES.

We would direct especial attention to the meeting which is to be held at Botolph House (12, Eastcheap) at 3 p.m. this (Friday) afternoon, which will be called upon to decide the question of the formation of an Electrical Section of the London Chamber of Commerce. The promises of support which the movement has already received are both numerous and influential, and we anticipate that a representative gathering will attend the meeting this day. In case any of our readers have not yet received a copy of the circular which has been issued by the Chamber of Commerce, we reprint the text further on.

With reference to the statements made by the Lord Mayor, in his speech at the Mansion House Banquet to the English Committee of the Paris Exhibition, on Saturday evening last, we cannot but express surprise at the inadequate manner in which English electrical industries threaten to be represented. The English exhibits as a whole will fully represent the manufactures of this country, but those representing the industries in which we are especially interested will, as we have said, be very meagre and incomplete. Many of our largest firms are holding aloof, although we understand that appeals, both personal and otherwise, have been made to them by various representatives of the Paris Exhibition Executive Committee, and by the Society of Telegraph-Engineers and Electricians. It is presumed that the feeling generally is that exhibitions do not pay We doubt this very much. They may not pay directly—that is, few or no orders may be traced to the exhibitions themselves—and we may be told that French tariffs practically exclude many articles of English manufacture; but in cases of this kind sometimes the benefits accrue long after the effort has been made, and an exhibition in Paris does not mean an exhibition only to Frenchmen but to the world. Those who have articles which are worthy of introduction to South Americans, Chinese and Japanese may all find a convenient centre for the display of their wares at the forthcoming Paris Exhibition. We trust that even yet it is not too late to find some of our leading firms avail themselves of the saving clause by which the Lord Mayor held that, although the present space was fully appropriated, yet some extra room might be found for exhibits of a specially interesting character that might come in at the eleventh hour.

The formation of the Metropolitan Electric Supply Company, with a capital of £500,000, is probably the most important step which has yet been taken with a view to the supply of electric light in the metropolitan district upon a wholesale scale. The particulars given yesterday morning by one of our financial contemporaries, though a little premature, are in the main correct. Our contemporary is of course in error in saying that the new company has obtained a provisional order "covering the district from Piccadilly in the west to Lincoln's Inn-fields in the east," the fact being that it is one of the objects of the new company to take over several minor concerns which are already in the field, and which have applied for provisional orders covering a portion of the above area. Amongst those is the Whitehall Court Company, whose central station is already well advanced towards completion. In addition, the new company has secured a valuable site in the neighbourhood of Lincoln's Inn-fields, and also an extensive wharf at the south end of Waterloo Bridge, where, we believe, the principal works will be established. The list of names connected with this enterprise furnishes the fullest guarantee for its success both from a financial and an engineering point of view. Sir William Thomson and Dr. John Hopkinson will be the consulting engineers, while Mr. J. E. H. Gordon and Mr. J. B. Verity will join the Board.

In connection with the process of sugar refining by electricity, about which various rumours have been afloat, a correspondent of the *Scotsman* tells a rather singular story. According to this authority, the cost of producing by this method a ton of refined sugar of 99·9 per cent. purity does not exceed 3s. 9d., which it appears is equivalent to a saving per ton of no less than £4. The process of boiling the sugar and the use of charcoal are entirely done away with, and all that has to be done is to feed the raw juice into one hopper and to watch the refined sugar issuing continuously from another. All this certainly sounds extremely promising, and electrical engineers may, perhaps, anticipate a very large demand for dynamos from the sugar refiners. We much regret, however, to have to state that there is just one point on which we do not feel entirely satisfied. We naturally want to know how it is done. It appears that the Company which controls the process was formed as long ago as 1884, with a nominal capital of one million dollars, of which 600 shares (amounting to 600,000 dollars) were assigned to the late Prof. Henry Friend, the inventor of the process. But, strange to say, it was part of the agreement with Prof. Friend that the method of working was never to be disclosed to any

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human being, not even to the chairman of the company. Notwithstanding this drawback, however, so much confidence was felt in the good faith of the Professor that extensive premises were erected in Brooklyn at an outlay of over £5,000, and machinery was ordered intended to turn out 500 tons of sugar per day. The manufacture and erection of the machines occupied more than two years, since to avoid the least inkling of the purpose they were to fulfil the orders were given in small sections at various works; and the machines were afterwards put together by the Professor himself, with the assistance of his wife and two near relatives. In the innermost recesses of this mysterious factory there was a "secret room," access to which was most jealously guarded by day and night. Over the portal an inscription warned the intruder that one step within the forbidden chamber would be attended with instant death. When all was ready the Professor invited the president and directors of the company to witness a small private "demonstration." They were conducted to a room which contained nothing but a table, upon which stood the electrical apparatus covered with a white cloth. They themselves supplied the sugar to be refined, and, although they were not allowed to lift the cloth, they were satisfied that there was really no deception, and that the room contained nothing besides—excepting, of course, the Professor himself. They then solemnly mounted guard for one hour and three-quarters outside the door, and at the end of that time, on being permitted to re-enter the room, they found that the whole of the raw sugar had been converted into snow-white glistening lumps. So far, so good; but, unhappily, on the 10th of March last, and before the process had been set to work on a commercial scale, Prof. FRIEND died.

IT appears, however, that prior to his death the Professor had committed the details of the process to writing, and that this precious document is now in the possession of the President of the Electrical Sugar Refining Company. We sincerely trust that the process will prove as great a success on a practical scale as it appeared to do while in the hands of the inventor; if not, we fear that some people will be grievously disappointed, as we learn that even in Liverpool and in Birmingham the shares have recently been dealt in at 400 per cent. premium. The company are very likely carrying out a sound commercial policy in keeping the process secret rather than in applying for patent protection, but in view of the history of the enterprise as now disclosed it is difficult to understand how full confidence can be felt until business has actually been done. It is said, however, that a factory will shortly be started in this country.

OTHER things being equal, we think that it is a matter for congratulation when an electric lighting scheme is undertaken by a local company, in which the consumers or the ratepayers are themselves the largest shareholders. The movement is one to which we have every reason to wish the fullest possible success, and which we hope to see extend throughout the country. We are, therefore, all the more anxious that no false step should be taken, particularly in a financial direction, by any of the limited number of such companies already in existence. For this reason we are unable to feel much satisfaction at what has just taken place in Bath. Mr. MASSINGHAM has undertaken to supply 70 lamps, with a 6-ampere current, at £19. 17s. 6d. per annum, or 17 per cent. less than the price asked by the lowest of the three firms who would have used the same system. We shall be relieved to learn that Mr. MASSINGHAM is in possession of such substantial advantages over his competitors as will justify his company in taking the contract at so low a figure.

"INSTALLATION RULES" are found to be a prolific source of discord in the electrical camp almost all the world over—although, perhaps, we should make an honourable exception of the New England States, where the question has been dealt with by a joint committee of electrical engineers and the fire-insurance companies. The latest quarrel of this description has arisen in connection with the Technical Commission appointed by the Paris Municipality to frame regulations for installing electric light in theatres, and has resulted in the resignation of M. MASCART. The point in dispute is whether the use of non-inflammable scenery and decorations should be made compulsory in connection with the electric light. M. MASCART has recently carried out some experiments (see *The Electrician*, June 22, p. 201) on the liability of textile fabrics to be set alight by contact with the globes of incandescent lamps, and it was proved that under certain conditions this is possible. But at the same time he arrived at the conclusion that the contingency is too remote to demand the employment of special precautions. The Commission, however, decided by a small majority to enforce the use of non-inflammable decorations in all theatres, whereupon M. MASCART has sent in his resignation. For our own part, we should be sorry to oppose even superfluous precautions for the prevention of fire in theatres, especially in those which are lit by electricity, seeing how much the credit of electric lighting is at stake in such installations.

A LETTER from the Board of Trade, and the discussion which followed it at a special meeting of the Dublin Corporation last Tuesday will be found in another column, and will well repay perusal. The local gas company has done its utmost to prevent the intrusion of the electric light into Dublin, and has even moved the Board of Trade for compensation on account of the gas company's plant thrown out of use by the substitution of electricity. This the Board has of course refused, and on other points has shown itself friendly to the proposals of the Corporation. It is satisfactory to notice also that Mr. MAYNE, on behalf of the defunct electric lighting company, was able to give a good account of its performances while it lived, and a satisfactory reason for its being wound up. For every sixpence-worth of plant that the company owned they had, Mr. MAYNE assured the meeting, done a full amount of business, and it was only because extension of plant became necessary just at the moment when the industry was being discredited by financial speculators that the shareholders insisted on winding up the concern rather than supply more capital. The Corporation have now determined to take the matter into their own hands.

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We reproduce this week, from a Transatlantic source, a traveller's account of what he saw of the English telegraph system and its operators in the desert wastes and cities of Persia. Mr. Thomas Stevens's descriptions will be none the less interesting to many of our far-distant readers for the characteristic Americanisms which embellish his Paper; and as a testimony of what our cousins think of us it will be hardly less welcome to English readers at home.

It is gratifying to learn, from an answer in Parliament the other evening, that the English Government have not yet given any thought to executions by electricity in this country, notwithstanding the alleged bungling of the present Lord High Executioner. Painful incidents on these occasions are not peculiar to modern executions, and are, we suspect, only rendered peculiarly painful by the presence of the modern reporters. Recent experiments, we are glad to notice, have satisfied even the New York public that the ghastly details which these gentlemen delight to furnish would probably not be wanting in the case of an execution by means of electricity.

Our Paris correspondent gives an account of an important scheme for an underground electric railway which it is proposed to carry through the centre of Paris, and which we should much like to see realised. As a mere feat of engineering such a railway would be more interesting, quite as ornamental, and possibly even more useful than the Tower of Babel which the Parisians are so enamoured of at present. The scheme in question is a somewhat ambitious one, but, so far as the technical details are concerned, we have no doubt that it can be carried to a completely successful issue.

We wish we could speak with equal confidence of the probable success of the scheme at present under consideration for working the Metropolitan Railway by electric traction. We have already, on more than one occasion, expressed our disapproval of the attempt to apply secondary batteries to this purpose. But the success or failure of the scheme is fraught with so much import to the immediate future of electric locomotion that we feel constrained to recur to the subject. The fact is, the more we think about it the less we like it. To discuss the question in full detail at the present moment would perhaps be unfair, but when the proper time arrives we shall not shrink from doing so. Meanwhile, there is just one point upon which we may offer an observation. The companies who have had the greatest experience in the manufacture of accumulators in this country are practically unanimous as to the total weight required per horse-power for cells giving two hours' discharge. This they put at 7cwt. For engines of 600 horse-power, as proposed, this means a dead weight of 210 tons for the accumulators alone! But we understand that the weight of the accumulators is estimated by the promoter of the scheme in question at only 50 tons. It would be satisfactory to know how this discrepancy arises. What is thought about the scheme in America may be seen in the letter of our New York correspondent which we publish to-day.

The negotiations between the Atlantic cable companies with reference to the adoption of a shilling tariff are still going on, but are now limited to the question of agreement with the French Pouyer-Quertier Company, and as that company is in litigation with the Anglo-American Company, the adjustment of their differences is not quite settled. The agent of the French Company has been over here for some days, and has now returned to Paris for further instructions.

Lloyd's Signal Stations Bill.—This Bill was read a third time in the House of Lords on Friday last and passed.

Electric Traction in India.—The *Indian Engineer* says that arrangements are being made to introduce electric-motor cars into Madras.

Leeds.—Messrs. Mather and Platt, of Manchester, have obtained the contract for the lighting by electricity of the new Fine Art Gallery at Leeds.

Dewsbury.—The Dewsbury Town Council has decided to adopt the electric light in all the rooms of the new Town Hall, and Mr. Wilson Hartnell, of Leeds, has been instructed to carry out the work at a cost of about £2,000.

South Hampstead.—We understand that some of the inhabitants of South Hampstead have placed themselves in communication with the Anglo-American Brush Corporation, with a view to the establishment of a central lighting station in that district, and that a practical scheme is likely to be arrived at.

The Proposed Cable to Bermuda.—In the House of Commons on Friday last, Mr. Raikes, replying to Sir E. Watkin, said he was afraid he could give no further answer than that the question of connecting Bermuda with Halifax, Nova Scotia, by telegraphic cable, was still under the consideration of the Treasury.

Export of English Electric Lighting Plant to America.—We have learnt with much pleasure that Messrs. Hammond and Co. have recently received a large order to supply the requisite plant, on the Lowrie-Hall system, for a central electric lighting station in America. This is, we believe, the first order of the kind which has reached this country.

Our "Annual Dinner."—The annual dinner of *The Electrician* staff took place on Monday last at the "George and Dragon," Ightham, near Sevenoaks, under the presidency of Sir James Anderson. The company were favoured with fair weather; an excellent dinner was provided for the forty guests by Mr. Mist, the worthy host, and a most enjoyable day was spent.

Personal.—Referring to an intimation in our last issue, received from Messrs. Woodhouse and Rawson, Mr. A. Reckenzaun writes us as follows:—"With reference to your mention in last week's issue of my appointment to Messrs. Woodhouse and Rawson, I beg to inform you that the same was premature, and was occasioned by negotiations which have since proved unsuccessful."

The Society of Arts' Tests for Prime Motors.—The tests for prime motors initiated by the Society of Arts will take place in September, on the ground belonging to the Imperial Institute at South Kensington, which has been kindly lent for the purpose by the committee of the institute. The preliminary tests will commence on the 12th September, by which date all engines must be fixed and ready for work.

Magneto Bells for Domestic Use.—We are informed that the Equitable Telephone Association (Limited) have been appointed agents for a new system of magneto-electric bells of

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great simplicity. It is expected that these bells, which have been designed by Mr. E. Cox Walker and Mr. C. C. Campbell-Swinton, will come into extensive use for domestic and similar purposes. They are to be introduced to public notice very shortly.

St. Saviour's District Board.—At a meeting of this Board held last week, a letter was read from the London Electric Supply Corporation, Limited, suggesting that in the provisional order which they are seeking for the supply of the electric light in this district, a clause should be inserted giving the Corporation power to enter into a contract with this Board for the supply of electricity.—Mr. Haggis did not think that this Board wanted to go into trading.—It was determined to acknowledge the letter.

The Zipernowski-Deri System.—We are informed that Messrs. Ganz and Co., of Budapest, have recently received several large orders for electric lighting plant from Australia to supply central stations at Melbourne, Huntershill (near Melbourne) and Huntershill (near Sydney), the first-mentioned station having a capacity of 2,700 horse-power, to be doubled later on. In addition to this orders have been received for central-station plant from Montevideo and Valencia, and for a transmission of power plant to be set up at Rives, France.

Paddington Vestry.—At the last meeting of the Paddington Vestry the Works Committee brought forward a resolution to the effect that prior to making a formal application to the Board of Trade, for a license to supply electricity throughout the Borough, the clerk be instructed to obtain a report from an electrical engineer, at a cost not exceeding £21, as to the probable outlay to be incurred in producing, storing, and supplying electricity for lighting purposes. It was agreed that the £50 should be expended on the matter, as suggested by the committee.

SS. "City of New York."—The new Inman and International liner "City of New York," the largest passenger steamer afloat, is lit throughout by electricity, the dynamos being supplied by Messrs. King, Browne and Co., of Edinburgh. There are in all about 1,000 incandescent lamps, those for the passengers being of 16 candle-power, while a few of larger type are used for cargo-working purposes. The ship is also supplied with a powerful search light. A large ventilating fan on the promenade deck, running at 1,000 revolutions per minute, is also worked by electricity.

The Telephone at Swindon.—A meeting has been held in Swindon to discuss the feasibility of establishing a telephone exchange in that town. Mr. H. Lewis, the energetic manager of the West of England and South Wales Telephone Company, explained the nature of the service, and said that as soon as twenty subscribers were obtained the company were prepared to run a trunk wire to Bath. Through Bath direct communication would be obtained with the extensive system of trunk wires which now find their centre in Bristol. He hoped also that within eighteen months of the present time the line would be completed from Bristol to London, *via* Swindon.

Clark's Standard Cell.—Mr. Durand Woodman writes from Newark, N.J., as follows:—"Sir: May I be allowed to correct an unwitting error in a communication from Mr. Kennelly in your No. 528 of June 29th. The three Clark cells of which he gives a record were not 'set up at the Edison Lamp Factory' nor 'under Mr. Howell's supervision.' They were prepared and set up in my laboratory under no one's supervision, as I was at that time without an assistant. They were made expressly for Mr. Edison's laboratory on an order coming through Mr. Howell, which accounts for the misunderstanding. As I took the entire risk of their performance, I shall consider space for this correction a favour."

Rotherhithe Vestry.—At a meeting of this Vestry held last week, the clerk read a letter from the secretary to the South Metropolitan Electric Supply Company, and Messrs. Deacon, Gibson, and Medcalf, on behalf of the London Electric Supply Corporation (Limited), stating that in the provisional order which they were seeking for the supply of the electric light in the district a clause would be inserted giving the corporation power to enter into a contract with this Board for the supply of electricity. Mr. Down was supporting the proposal, and referring to the importance of the question, which he thought should be dealt with without delay, when several members suggested that the matter should be referred to committee, which was agreed to.

Electric Traction in Australia.—We learn that Messrs. Booth, Ellson and Co., electric tramway engineers, of 5, Queen-street, Melbourne, Australia, have secured the right of tramways for the city of Sandhurst, for the term of 30 years. A large company has been floated by them to carry out the work, and Mr. Ellson (formerly with the Hammond Company, England) is now on his way to this country to make the necessary arrangements for plant, &c. The same firm has tramway schemes on hand in several other towns in the colonies. When once introduced we expect to see as rapid an extension of electric traction in Australia as has lately taken place in America. We wish Messrs. Booth, Ellson and Co. every success in their undertaking, as they have thus initiated one of the largest electric tramway schemes in the British Empire. We may add that letters for Mr. Ellson should be addressed to the General Post Office, London.

An Exhibition of Workmen's Skill.—An interesting exhibition of the skill of workmen in their own trades will be opened at the Crystal Palace on August 18th, in connection with the National Co-operative Festival. The competition will be amongst working-men members of the Industrial Co-operative Societies throughout the kingdom, and the special facilities offered to them to compete, by their respective societies agreeing to pay carriage on all exhibits, should open the door to a very large and representative display of individual work. The prize list is a good one, and the Council of the Society of Arts—who have promised to appoint the judges—will also award one of their bronze medals in eighteen of the principal classes. In addition, there are many classes for all kinds of amateur work, women's work, and children's work, and for collections of various kinds. The secretary, Mr. W. Broomhall, 1, Norfolk-street, Strand, will supply any further particulars.

Ilfracombe.—A special meeting of the Local Board of Ilfracombe was held on Saturday last to consider the question of lighting the Victoria Promenade. A letter was read from the secretary of the gas company stating that the cost of proposed gas fittings for the shelter would amount from £160 to £180, and the gas about 7½d. per hour, or about £50 per annum. A letter was also read from Mr. Woodley, with whom the Board have been in correspondence relative to the introduction of the electric light, offering to light the promenade for £150 for the first year if the Board would pay £60 if the fittings had to be taken away, or he would light the whole town for £680 per annum. A long conversation followed on the subject, and it was finally resolved that the Board should accept Mr. Woodley's terms to light the promenade for one year. The surveyor was also instructed to ascertain the cost of lighting the Parade with electricity, and on the terms being ascertained to submit them to a meeting of the Board.

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The Lighting of Drury Lane Theatre.—At the meeting of the company of proprietors of Drury Lane Theatre, held on the 21st inst., in the saloon of the theatre, Mr. Percy Lloyd observed that fire was the great thing that had to be guarded against in theatres. Had the committee, therefore, had before them the question of lighting the theatre by electricity? The electric light had been adopted with great satisfaction and success at several theatres, and in view of the many casualties of late years in such places he thought that the committee ought to give their earnest consideration to the question of lighting Drury Lane Theatre with the electric light.—The chairman, in replying, stated that the subject had been very often discussed by the committee, and also with Mr. Harris, and it was now standing over until certain inquiries had been made and certain facts had been ascertained. Nothing had been done at present, but it was obviously the right thing to do if it could be managed. In further reply, he added that the matter would certainly not be allowed to drop.

A Smash.—The *Journal of Gas Lighting* is responsible for the following story—"The directors of the Smedley Hydropathic Company, at Matlock, are introducing the electric light into the public rooms of their establishment. On the 28th ult. (but some considerable time after it was originally expected the installation would have been completed) the light was turned on for the first time. By way of giving suitable *éclat* to the event, a band of music was engaged for the occasion, and a number of persons were invited to be present. The engine was started in the forenoon, and was worked at a low pressure until about eight o'clock in the evening, when an order was sent to the driver to do his best. He obeyed; and in a few minutes afterwards there was a great smash. The two wheels of the countershaft broke—various fragments flying through the windows into the street, to the alarm of the passers by. The dynamo also broke; and, of course, the light suddenly went out. The despised gas had to be lighted, and is now in use again; and we understand is likely to be for some weeks to come."

Adoption of the Electric Light Scheme at Bath.—At an adjourned meeting of the Bath Town Council, held on Tuesday, the consideration of the proposal to accept a tender from Mr. H. G. Massingham, of Bath, to light 50 of the principal streets of the city with electric light on the Thomson-Houston system, with 70 arc lamps, was continued. The details of all the tenders received were reported in our last issue. A lengthy discussion took place. Mr. T. W. B. Cox, who opposed the proposition, said he believed the inhabitants were against the introduction of the electric light. The only successful installation which had been set before them was that at Taunton, but he was not quite sure but that they might hear of a catastrophe there. Just before the division was taken, Dr. Tuckett, a member of the council and a gas shareholder, asked if he could vote. The Town Clerk said the Council had heard the opinion he had read which stated that no persons interested could vote. Having read the law he left the members to do what they thought proper. Twenty-two voted for the resolution in favour of the introduction of electric light, twelve voted against, whilst eight, all shareholders in the Gas Company, abstained from voting.

Smart Telephone Construction Work in the North.—We mentioned last week an instance of quick work in the erection of a telephone line to Lancaster which was carried out by the Lancashire and Cheshire Telephone Company. The following instance, though of earlier date, is even more remarkable:—At the latter end of last year the Northern District Telephone Company received some important orders, and were under heavy penalties to finish the work by the 1st of November. The whole time occupied was 59 working days from the delivery of the first pole by the railway company. Twenty-six miles of new poles were erected, carrying 92 miles of copper wire; in addition to this 89 miles of wire were run on existing pole routes, this including, of course, the necessary arming of the poles, the number of poles being about 700. Two days before the completion of the lines there were several poles still to erect, and no wire was to be seen for over a distance of three and a-half miles on one portion of the route. The lines were, however, in working order at the stipulated time. The whole of the work was carried out by the district engineers, Messrs. C. M. Bailey, T. C. Bayley, and J. A. Jeckyll, under the supervision of Mr. G. F. L. Preston, the company's engineer.

Postal Telegraph Revenue.—The Select Committee on Revenue Departments' Estimates state in their report that they have taken evidence upon the Customs, Inland Revenue, Post Office and Post Office Packet Service, and Post Office Telegraphs estimates for the current year. With regard to the last-named service the committee report that the estimates of the Post Office telegraphs show continuous growth both of expenditure and of the proportion of expenditure to gross revenue. The latest account for 1886-87 shows a balance of profit of no more than ·63 per cent. upon a capital of £12,091,894. Return 31, session 1888, shows that the total deficiency of income to meet expenditure and interest at 3 per cent. on capital created on account of Post Office telegraphs from the 1st of January, 1872, to the 31st of March, 1887, amounted to no less than £3,024,899. The deficiency has latterly been increasing year by year, and for the last year, of which the accounts are included in this return, was £471,889. The unprofitable character of this Government business has been attributed to the high price originally paid for the purchase of telegraphs by the State, to the enormous increase of services gratuitously performed for the railway companies, to the tariff under which press messages are sent causing a loss amounting to nearly £200,000 a year, to unproductive work done for other departments, and to public pressure to improve the service even at a loss.

The International Congress of Electricians.—By a decree of the 16th July, 1888, the Minister of Commerce and Industry has nominated the organising committee of the International Congress of Electricians, which is to take place in connection with Exhibition in 1889. The committee comprises MM. d'Arsonval, Acting Professor at the Collège de France; Berger, ex-President of the Société Internationale des Electriciens; Boudet de Paris, member of the Committee of the Société Internationale des Electriciens; Carpentier, Vice-President of the Société Internationale des Electriciens; Cornu, Professor at the Ecole Polytechnique; Gariel, Vice-President of the Société Internationale des Electriciens; Hospitalier, Professor at the Ecole Municipale de Physique et de Chimie; Joubert, Secretary of the Société de Physique; Lemonnier, President of the Société Internationale des Electriciens; Mascart, Professor at the Collège de France; Napoli, head of the Experimental Laboratory of the State Railways; De Neville, head of the Central Laboratory of Electricity; Postel-Vinay, President of the Chamber of Electrical Industries; Potier, Professor at the Ecole Polytechnique; Raymond, Director of the Ecole Supérieure des Télégraphes; Renard, Director of the Government Workshops at Meudon; Sartiaux, Chief Electrician to the Chemins de Fer du Nord; Sebert, Vice-President of the Société Internationale des Elec-

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triciens; Séligmann-Lui, Secretary of the Société Internationale des Electriciens; Vivarez, Secretary of the Chamber of Electrical Industries; together with MM. Bouilhet, Bourdin, Delahaye, Fontaine, Hillainet, Lippmann, Pellat, Picou, Touanne, and Violle.

The Brussels Exhibition.—Some additional details which have come to hand respecting the electric lighting of the Brussels Exhibition may prove of interest. The interior of the Exhibition is lighted by 500 Khotinsky incandescent lamps, of 18 candle-power each, and by 244 arc lamps, ranging in candle-power from 1,500 to 2,500. The arc lighting of the buildings is done by the Société Thomson-Houston, MM. Bouckaert and Schuckert, and the Industrielle and Electrique Companies. In the grounds the lighting is divided between M. Pieper and the Anglo-American Brush Corporation. Pieper's installation has been working some time to a partial extent; but owing to there being a deficiency of boiler power the total number of lamps installed have not been regularly in work. The Anglo-American Brush Corporation have 58 lamps of 2,000 candle-power in operation every evening. These are distributed as follows:—10 in British section, six at the switchback railways, six on the high mast opposite the entrance from the Rue de la Loi, and 18 on independent masts all round the grounds; 18 lamps are set apart for the illumination of the arena, which was originally intended for the performances of the hipprodrome. These, however, came to an abrupt termination, but the lamps are still in use and effect a very useful purpose, as they light up a large space which is the prinicpal thoroughfare from the Exhibition buildings to the grounds, and bring into relief one of the most beautiful architectural features of the Exhibition. Some 600 horse-power is altogether employed in driving the electric light machinery, 350 horse-power being used for the lighting of the interior, and 250 horse-power for the lighting of the gardens.

A Scientific Exhibition in the Temple.—The Treasurer of the Inner Temple, Sir Patrick Colquhoun, Q.C., and the Benchers held a scientific "At Home" in the Inner Temple on Thursday evening, the 19th inst., which was attended by a large number of members and their friends. The extensive suite of rooms had been admirably adapted for the purposes of a singularly interesting scientific and artistic exhibition. In addition to the ordinary electric lighting arrangements, both the exterior of the buildings and some of the rooms were illuminated by electricity. In the corridor were shown telephones by the United Telephone Company connected with the Savoy Theatre, and guests were able to listen to the performance of the "Mikado." In the great hall there was an admirable display of arc lamps by Messrs. R. E. Crompton and Co. Sir William Thomson's compass and binnacle and deep-sea sounding apparatus, models of an electric railway, a torpedo boat and a Nile steamer, electric chronograph, telegraph instruments, writing telegraphs, and submarine cables were also exhibited in this department. A fine series of photographs was also on view. In the Parliament Chamber the Electrical Power Storage Company exhibited a battery of accumulators supplying current for various purposes. In a large marquee outside the working of the Maxim automatic machine gun and the Nordenfelt machine gun, electric torpedoes and other recent innovations in the art of warfare were exhibited. Experiments were shown by the Exchange Telegraph Company with their automatic type-printing telegraph instruments, which were connected with the Houses of Parliament. By permission of the Postmaster-General, the great hall was placed in telegraphic connection with Manchester.

The Volta Prize and the Inventions of M. Gramme.—The French Chamber and Senate will shortly award the Volta prize of 50,000fr. for the best application of the voltaic battery, and it may not be without interest, says *La Revue Internationale de l'Electricité*, to recall here the circumstances which originated the founding of this interesting prize. On the 19th Brumaire, year X., the First Consul was present at a meeting of the Institute, and heard Volta read a Paper on the "Electric Battery." The outcome of this was the founding of a prize, which was open to the *savants* of all countries for the best application of this branch of physical science. Electricity seemed to the First Consul to merit special attention, and he doubtless foresaw that it would become in the future a fruitful source of discovery. On the 26th Prairial of the same year the First Consul published the conditions and fixed the prize at 60,000 francs. The first competition opened on the 10th Messidor. We must then go on to the 23rd February, 1852, before we find any notice of the second competition. From this date the value of the prize was reduced to 50,000 francs, and competitions took place more frequently, the dates being 18th May, 1858; 18th April, 1866; 29th November, 1871. These competitions have always borne excellent fruit, the names of Faraday, Ampère, Ruhmkorff, and Graham-Bell being connected therewith. The last competition was opened on the 11th June, 1882, and closed on the 31st July, 1887. A special commission, sitting at the Ministère de l'Instruction Publique, was entrusted with making the award. The members of the commission decided by a majority of votes to award the Volta prize to M. Gramme, "for the improvements made by him in the construction of dynamo-electric machines." The improvement consists in having made a continuous-current machine, which was the starting point of that marvellous development of electrical industries which we are now witnessing. Yet in 1860 M. Gramme was a working carpenter employed by M. Ruhmkorff to put finishing touches to the woodwork of electro-static machines. He soon became fascinated by the world of magic into which he had been suddenly introduced. He hardly knew how to read or write, but this did not stop him; he wished to know, and did know. His resources were of the most modest character. His library consisted of two books, a French dictionary and a work on physics; his laboratory was equally rudimentary, containing only a sheet of gutta percha, two magnets, and a few pounds of copper. In 1868, eight years later, he made his first continuous-current machine; but the impossibility of sufficiently insulating the adjacent wires did not allow him to take full advantage of his discovery. In 1869 he advanced a step, and made a new machine with a 10 kilogramme magnet and an armature wound with 1 millimetre wire. In 1871 M. Gramme devised for M. M. Christophle a machine running at 300 revolutions a minute, and able to deposit 600 grammes of silver per hour. A little later he built another machine for the factory of M. Whohwill, of Hamburg, which gave a current of 3,000 amperes at eight volts, and was able to deposit 800 kilogrammes of refined copper in 24 hours. In these days batteries are completely discarded for electro-metallurgical purposes, and the industrial applications of electricity have multiplied in every country. A vast array of inventors have followed in M. Gramme's steps. The Commission has awarded the prize, in short, to a hard-working, modest man, who has explored the secrets of nature, and who has known how to apply them in the best and most useful way. Electricity owes much to M. Gramme. Thanks to him, it plays an important part in modern times, and will end, we are convinced, by ousting steam from its present position of supremacy.

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UNIPOLAR INDUCTION.—VII.

BY G. W. DE TUNZELMANN, B.SC.

(Concluded from page 301.)

In 1880 E. Riecke published a second Paper on "Unipolar Induction" in *Wiedemann's Annalen*, Vol. XI.

In this Paper he gives a short account of Weber's theory set forth in 1839 in the *Resultate aus den Beobachtungen des Magnetischen Vereins*. Weber's explanation of unipolar induction was founded on the theory of the existence of two magnetic fluids in each of the molecules of a magnet, and he made a distinction between ordinary induction due to the action of both fluids, which he called bi-polar induction, and induction due to the action of one fluid only, which he called unipolar induction. Weber at that time considered that his results could only be explained on the hypothesis of these two fluids, and therefore disproved the existence of Ampère's molecular currents. Later on, however, Weber found that this conclusion was not justified, and in his "Electro-Dynamische Maasbestimmungen" he arrives at the conclusion that the phenomena of unipolar induction may be explained, on the hypothesis of molecular currents, by making the additional assumption that such a connection exists between the moving electrical fluids and the material particles of the magnet, that any forces acting on the fluids are completely or almost completely carried on to the material particles.

In this Paper, Riecke discusses the phonomena on the hypothesis of the existence of molecular currents in the magnet, and comes to the conclusion that it gives a satisfactory explanation of them. He finds that both this and the method adopted in his former Paper give the same values for the E.M.F. produced, but he shows that on the hypothesis of molecular currents the effect of a rotating magnet on the element of a fixed conductor will be the same as that of the fixed magnet on the same element, when the latter is made to rotate with an equal angular velocity in the opposite direction. He considers that in view of the other evidence in favour of the existence of the amperian currents this hypothesis is preferable, and suggests that the name Unipolar Induction should be discarded as misleading, and replaced by some such term as "Electro-Magnetic Rotation Phenomena." The investigation of Ampère's method of the action of an element of current on an element of a conductor moving relatively to it involves a considerable amount of somewhat tedious mathematical calculation, and when translated into the language of Faraday's theory of action in the medium it involves the assumption which has been made in these Papers that the magnetic field of a magnet rotates with it.

In 1883, in *Wiedemann's Annalen*, Vol. XIX., F. Koch published an important and elaborate Paper on what he calls, in accordance with Riecke's suggestion, magneto-electric rotation phenomena. In this Paper the subject is approached from the consideration of the potential, which is the mathematical equivalent of Faraday's methods, and the author arrives at the result that the induced E.M.F. has its seat in the fixed portion of the conductor. He also obtains a numerical expression for the E.M.F., which shows that the E.M.F. depends on—

(1) The dimensions of the rotating magnet.
(2) The distance of the magnet from the axis of rotation.
(3) The position of the terminals of the fixed portion of the circuit.

It is pointed out that (2) and (3) do not agree with the results of some of the measurements made by Plücker (*Poggendorff's Annalen*, 1852, Vol. LXXXVII.), and the author suggests that this may probably be due to the fact that the measurements could not be relied on, owing to the variability in the resistance at the sliding contact. A series of quantitative experiments are described which confirm the theoretical conclusions.

In 1886 Dr. E. Hoppe (*Wiedemann's Annalen*, Vol. XXVIII.) published a criticism of Edlund's theory, and described some experiments which he considered showed it to be untrue. His apparatus is shown in section in Fig. 21; *a a* is a tube of soft iron; *b b* is a brass cylinder to which the iron tube is screwed, and by means of which it can be attached to an apparatus for putting it in rotation; *e* is a brass block, into which are screwed a brass rod, *g*, in a straight line with the axis of rotation; and four brass rods, *d d*, insulated from the iron tube by four gutta-percha rings, *e e*. A brass ring, *f f*, is screwed to the four rods *d d*. The other end of the rod *g* is kept in position by the gutta-percha disc *h*. A brass plate, *i*, could be screwed to the axis and joined to the ring *f f* by means of four brass rods, *k k*. The tube was magnetised by means of a bobbin, *l l*, of insulated wire, which remained fixed when the axis was set in rotation. The direction of the magnetising current was in every case such as to make the lower end of the iron tube a north pole.

Experiments were made, in the first place, to show that no currents were produced by the rotation of the apparatus in the absence of the iron tube, which, indeed, would not be expected on any theory.

The following experiments were then made:—

(1) The apparatus, without the plate *i* and the rods *k k*, was made to rotate first in one direction and then in the other, and the magnitude and direction of the current between sliding contacts at *f* and *g* were observed in each case.

(2) The ring *f f* was placed in metallic connection with the iron tube by means of a copper wire, and the currents were observed as before.

(3) The plate *i* and the rods *k k* were fixed to the apparatus, and sliding contacts made at *f* and *g*, and the currents again observed as before. When the sliding contacts were at *i* and *g* no current was produced.

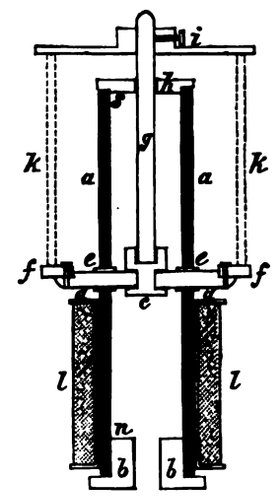

FIG. 21.

a a soft iron tube, *b b* brass cylinder, *c* brass block, *d d* brass wires, *e e* gutta-percha rings, *f f* brass ring, *g* brass rod, *h* gutta-percha disc, *i* brass plate, *k k* brass rods, *l l* bobbin of insulated wire, *n s* north and south poles of magnetised tube.

In each of these experiments the current was from *g* to *f* when the rotation was counter-clockwise, and from *f* to *g* when it was clockwise.

(4) The rods *k k* were then removed, the plate *i* remaining in place, and sliding contacts were made at *f* and at the periphery of the plate *i*. The current was found to flow from *i* to *f* when the rotation was counter-clockwise, and from *f* to *i* when it was clockwise.

Hoppe arrives at the conclusion that—

(*a*) The currents in (1) were in the opposite direction to that required by Edlund's theory.

(*b*) In (4) there should be, according to Edlund's theory, a current from *f* to *i* stronger than the current in (1), while the observed current was weaker and in the opposite direction. As Hoppe points out, this weakening of the current is easily explained if the lines of force are supposed to rotate with the magnet.

(*c*) In (3) the current observed was in the opposite direction to that required by Edlund's theory, and in the case in which no current was observed there should have been one on Edlund's theory.

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(*d*) The connection of the magnet with the ring *f* in (2) would, according to Edlund's theory, considerably increase the strength of the current, and the induction of the magnet on itself would come into play, whereas in the experiment the connection was found to have no effect on the strength of the current.

Hoppe points out that all his results are capable of being simply explained on the hypothesis of rotating lines of force.

Edlund replied to this in a Paper published in *Wiedemann's Annalen*, Vol. XXIX., and gave explanations of Hoppe's experiments in accordance with his theory. In this Paper Edlund maintains that the assumption of the rotation of the lines of force with the magnet is in contradiction with the observed result that the rotation of a magnet on its axis exerts no effect on a magnetic needle suspended in its field. It is rather difficult to understand how Edlund could have supposed this experiment to have any bearing on the question whether the lines of force rotate or remain stationary, for the direction of the needle depends on the direction of the force acting on it; and this would be the same in either case, for whether the lines rotate or remain at rest, it follows from the symmetry of the field with regard to the axis of rotation that no change will take place either in the magnitude or in the direction of the magnetic force at any part of it on account of the rotation of the magnet. Hoppe's experiments with the electro-magnet are of importance, as from the point of view adopted in these Papers they show that the field of a rotating electro-magnet magnetised by a fixed coil rotates with the magnet, as in the case of a permanent magnet; and though this result was to be expected it is of interest to have it experimentally confirmed.

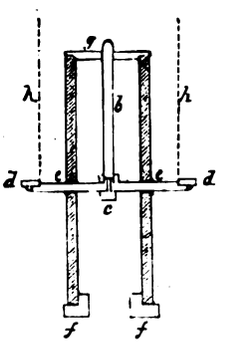

FIG. 22.

b brass rod, *d d* brass ring, *e e* brass rods, *e* brass block, *f f* brass cylinder, *g* gutta-percha disc, *h h* movable copper cylinder.

Hoppe published a further contribution to the subject in the same year (*Wiedemann's Annalen*, Vol. XXIX.), in which, recognising that some difference might possibly be supposed to exist between the action of an electro-magnet and a permanent magnet, he constructed an apparatus (Fig. 22) similar to that employed in his former experiments, but with a tube of steel permanently magnetised in place of the soft iron tube of the former apparatus. *b* is a brass rod, *d d* is a brass ring connected by four brass rods, insulated from the magnet by gutta-percha rings and connected with a brass block *e*; *g* is a gutta-percha disc, and *h h* a movable copper cylinder.

Similar results were obtained as in the former experiments, and it was also shown that the addition of the copper cylinder excited no effect on the current between sliding contacts at the end of the rod *b* and at the periphery of the disc *d*, proving that the mass of the moving conductor had no influence on the induction.

Some experiments were also made by means of an electrometer to see if there were any induced static charges at the end of *b*, or at the periphery of *d*, but the results were entirely negative.

In an appendix to this Paper Hoppe discussed Edlund's reply, and asserted that the latter had modified his former theory to explain his (Hoppe's) experimental results.

Edlund denied this in a Paper published in 1887 (*Wiedemann's Annalen*, Vol. XXX.), and maintained that Hoppe's failure to detect any electrostatic charge arose from his electrometer not being sufficiently sensitive.

In March of the same year Edlund read a memoir before the Swedish Academy of Sciences, which was translated in the *Philosophical Magazine*, 5th Series, Vol. XXIV., 1887.

In this Paper he discusses at considerable length the results obtained by different observers. He attempts to prove mathematically that the induction produced by the rotation of a magnet in an external conductor at rest and at some distance from it is inappreciably small in comparison with the induction produced when the conductor rotates about the magnet with the same angular velocity. This is in direct conflict with the experimental results of Faraday and many other observers, according to which the induction has identically the same value in the two cases.

Edlund's mathematical reasoning is perfectly correct, but it only takes account of the translatory motions of the outer portions of the magnet as they describe circles round the axis, and it is easy to see without mathematical aid that this effect will be exceedingly small. Edlund objects to the theory adopted in these Papers that it is in opposition to the requirements of the mechanical theory of heat—in other words, that it is not in agreement with the conservation of energy.

His contention is based on the explanation of the admitted experimental fact that when a magnet, *n s*, is surrounded by a metallic jacket, shown diagrammatically by *a b* in Fig. 23, in contact at its upper and lower edges with the ends of a wire, *a c b*, and the magnet and jacket are made to rotate in the same direction with the same angular velocity, a current

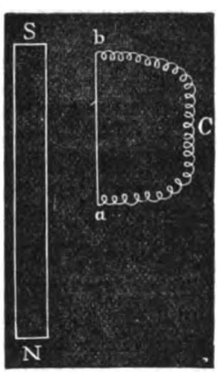

FIG. 23.

n s magnet, *a b* section of jacket, *a c b* conducting wire.

will flow through the wire. The induction is then assumed to take place in the fixed wire, and to be due to the rotation of the magnet. To this Edlund objects that the magnet may be put in rotation in either direction without encountering any resistance other than that due to friction or torsion according to the manner in which it is suspended, and, therefore moves without doing work, and thus cannot generate a current.

The obvious answer to this is that when the magnet is rotated, and the jacket and wire remain at rest, no current is generated, as he admits, and, therefore, no work is required to be done by the magnet. If, on the other hand, the magnet is rigidly attached to the jacket, it cannot be rotated without doing work, because it will generate a current in the wire *a c b*, and this will set up currents in the moving portion of the apparatus tending to oppose its motion.

J. Puluj has recently made some very pretty experiments illustrating unipolar induction, which were described in a Paper read before the Vienna Academy of Sciences in April last.

A hollow copper sphere is suspended by a fibre from a point in a vertical line with the axis of an electro-magnet, and is set spinning. If the sphere is then slightly displaced to either side of the axis of the magnet it is found to describe a circle round the pole in the same direction as its own spinning motion. The effect is easily explained by considering the relation of the currents induced in the sphere to the lines of force proceeding from the magnet.

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LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER IX.—*Magnetic Fields.*

(Continued from page 307.)

120. *The Magnetic Field of a Magnet in Terms of its Moment.*—Let us suppose a unit north pole at the point n (Fig. 82) on a line bisecting a bar magnet, N S, whose length is l centimetres and strength of each pole m C.-G.-S. units. The unit pole will be acted upon by two forces, one of attraction and one of repulsion, in the direction of a line drawn from S to n and N to n respectively. The magnitude of each of these forces will be $\frac{m}{r^2}$ (para. 108), r being the distance between the unit pole and either pole of the magnet. Now, the resultant of these two forces will be the actual force on the pole, and will be numerically equal to the intensity of field (f) at the point n. On completing the parallelogram, and drawing the resultant f we find by the simple proposition of similar triangles that

$$f : \frac{m}{r^2} :: l : r;$$

whence

$$f = \frac{m\,l}{r^3};$$

and since $m\,l$ is the moment (M) of the magnet (para. 118),

$$f = \frac{\mathrm{M}}{r^3} \text{ in C.-G.-S. units.}$$

Example.—(1) What is the intensity of the magnetic field of a bar-magnet at a point 20 centimetres distant from either pole, the moment of the magnet being 800 dyne-centimetres?

Answer.—Intensity $= \frac{800}{20^3} = \frac{1}{10}$ C.-G.-S. unit.

(2) What is the intensity of the magnetic field due to a bar magnet at a point 30 centimetres away from the centre of the magnet in a direction perpendicular to its length, the strength of each pole of the magnet being 900 C.-G.-S. units and its length 20 centimetres?

Here the direct distance (r) from either pole to the point in the field is not given, and must be calculated from the data

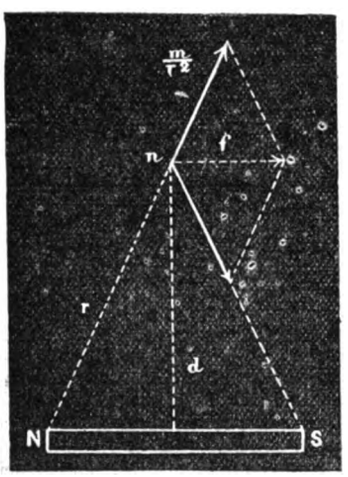

FIG. 82.

given. It will be seen (Fig. 82) that the distance r forms the hypothenuse of a right-angled triangle, of which the other two sides d and $\frac{1}{2}\,l$ are known, viz., 30 and 10. The length r is therefore the square root of the sum of the squares of the other sides (Euclid I., 47)—that is,

$$r = \sqrt{30^2 + 10^2} = \sqrt{1000} = 31{\cdot}62 \text{ centimetres,}$$

and the moment of the magnet $= m\,l = 900 \times 20 = 18{,}000$ dyne-centimetres. Therefore the intensity of the field at the required point is

$$\frac{\mathrm{M}}{r^3} = \frac{18000}{(31{\cdot}62)^3} = \frac{18000}{31620} = {\cdot}569 \text{ C.-G.-S. units.}$$

If the point at which the field is calculated is at a perpendicular distance from the magnet equal to many times its length, we may take the hypothenuse (r) or pole distance from the point as being equal to the actual perpendicular distance, and obtain a very near approximation. This could not be done in the last example without introducing an error of 17 per cent., the ratio of the perpendicular distance to the length of magnet being only as 3 : 2.

Let us now measure the field at a point situated on the continuation of the axis of the magnet, d centimetres from its centre, r centimetres from the nearer pole, and R centimetres from the further pole, supposing that a unit north pole is placed at n at the point required (Fig. 83). It is evident that

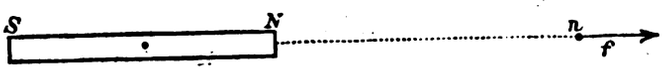

FIG. 83.

the two poles of the magnet act oppositely on the unit pole, the nearer pole (N) having the greater effect, and exerting a force of repulsion equal to $\frac{m}{r^2}$ dynes on the unit pole.

The other pole (S) acts with a force of attraction equal to $\frac{m}{\mathrm{R}^2}$ dynes, and the net or resultant force acting at n will be the difference of these two, viz.:—

$$\frac{m}{r^2} - \frac{m}{\mathrm{R}^2},$$

this being also equal numerically to the intensity (f) of field at the point. The *direction* of the resultant is *from* the magnet in a line with its axis in the diagram. If the magnet were reversed the *direction* of the resultant would be reversed, its intensity remaining the same.

Now,

$$r = d - \frac{l}{2},$$

and

$$\mathrm{R} = d + \frac{l}{2}.$$

Putting these values in the enumerator of the above, we obtain, after cancelling,

$$f = \frac{2\,m\,l\,d}{r^2\,\mathrm{R}^2},$$

where $m\,l$ is the moment (M) of the magnet. Therefore,

$$f = 2\,\mathrm{M}\,\frac{d}{r^2\,\mathrm{R}^2}.$$

Example.—What is the strength of field at a point on the continuation of the axis of a magnet 30 centimetres (d) from its centre, length of magnet 20 centimetres, and pole strength 900 C.-G.-S. units?

Moment of magnet $= 900 \times 20 = 18{,}000$ units.
Distance from nearer pole (r) $= 30 - 10 = 20$ cms.
" " further " (R) $= 30 + 10 = 40$ "

Hence,

$$\text{Intensity of field} = 2 \times 18{,}000 \times \frac{30}{20^2 \times 40^2}$$

$$= \frac{36 \times 3}{64} = 1{\cdot}68 \text{ C.-G.-S. units.}$$

Similarly, we may arrive at an approximate value of the field by a little simpler process (when the point is distant from the magnet many times its length) by reducing the formula to the form (by substituting the values of r and R and reducing by simple algebra)

$$f = \frac{2\,\mathrm{M}}{d^3\left(1 - \frac{l^2}{4\,d^2}\right)^2}$$

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from which it is evident that when d is great compared to l, the quantity within the bracket approaches unity, and we have

$$f = \frac{2M}{d^3}.$$

Example.—What is the strength of field at a point situated 2 metres away from the centre of the magnet in the last example? Here we may adopt the approximation, as the quantity in the bracket is close upon unity, and we have

$$\text{Intensity} = \frac{2 \times 18{,}000}{(200)^3} = \cdot 0045 \text{ C.-G.-S. units.}$$

(To be continued.)

SIR WILLIAM THOMSON'S NEW STANDARD ELECTRICAL MEASURING INSTRUMENTS.*

Sir WILLIAM THOMSON said the general principles and many of the details of the instruments placed on the table for the inspection of the meeting were already well known, having been described in the electrical journals. It had been considered, however, that the members of the Society might like to see some of the instruments themselves, and to have a few explanations, which he would be able to give personally, regarding details that had not

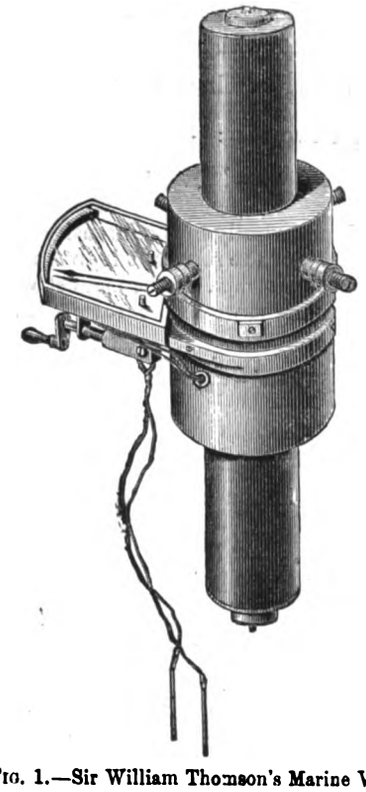

FIG. 1.—Sir William Thomson's Marine Voltmeter.

hitherto been published; and that was his reason for bringing before the Society a subject of which so large a part had been already published, and was known to members of the Society. All the instruments which they saw on the table, except the magneto-static "galvanometer," or current-meter, fell under the designation of standard electric measuring instruments. All these standard instruments, except one, were dependent upon Ampère's discovery of the mutual action between fixed and movable parts of an electric circuit. The one instrument which he excepted was the portable marine voltmeter or milliampere-meter. That instrument, as it stood before them, was a milliampere-meter, but with the addition of resistances wound on the tubular guards surrounding the stretched wire it became a voltmeter. This resistance amounted to about 930 ohms of platinoid to render the instrument a voltmeter for range from 90 to 120 volts. He should take this instrument first, as it was an exception to the others, and say a few words about it.

* Address delivered by Sir William Thomson before the Society of Telegraph-Engineers and Electricians, May 24th, 1888.

The magneto-static current-meter he introduced as an adjunct to the standard instrument, because it was exceedingly useful in extending the scale above and below the range of any one of the standard instruments. Two instruments of the magneto-static species, with one of the standard instruments, gave the means of measuring currents through the whole range, from one milliampere up to several hundred amperes.

He should briefly describe the marine voltmeter (Fig. 1) before passing on to the other standard instruments. He was sorry to say that he should not be able to let them see the interior of the instrument, but he might tell them that he had a type fulfilling exactly the description he should give of this, but with somewhat improved mechanical details, in which, by removing a screw, he could take out the works and let them be seen.

This instrument consisted of an oblate of soft iron suspended on a stretched platinoid wire in the centre of a solenoid. [The speaker here sketched on the board the type of an instrument that was being made in Glasgow.] He said that in this type the bobbin was double and divided for convenience, and the sketch showed two half bobbins, which, he said, could be put together with great ease. One of them was taken out to let a fine platinoid wire pass down through the centre carrying a little oblate of soft iron. The instrument before them was constructed with a single bobbin, and had therefore other details more complicated which he need not now speak of, because he should abandon them altogether. He felt confident that he should not adhere to the type of single bobbin, considering the much less simplicity which it involved in the more delicate and vital part, namely, the suspension of the oblate and the index-needle; which in the new form would be lighter and better adapted for working at sea, and less liable to damage from rough usage that it might experience in carriage on shore. To explain the principle of the instrument he reminded them that a long bar of soft iron (as Faraday had shown) tended to place its length along the lines of force in a uniform field

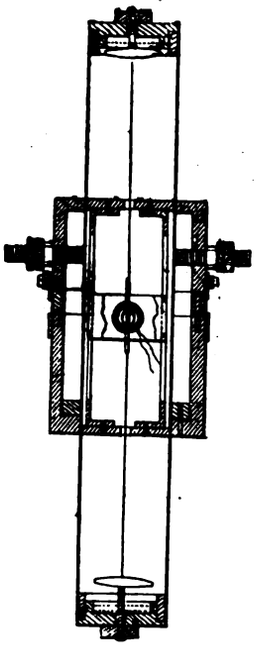

FIG. 2.—Section of Voltmeter.

of force; an oval and a flat disc tended to place its equatorial plane along the lines of force. But he (the speaker) had to choose between an egg shape and an oblate; and he found that an oblate was better for his object. The tendency of the oblate to place its equatorial plane in the direction of the lines of force of the solenoid was the force due to electro-magnetic action, which was balanced mechanically in the use of the instrument (Fig. 2). The principles on which he was led to the choice of this configuration of iron depended upon the circumstance that when they used not excessively high force in the magnetic field, so that the magnetisation of the iron should be very much short of magnetisation, a figure of a short character in which no one diameter was more than twice as long as any other diameter was much less disturbed by magnetic retentiveness than an elongated figure. In an instrument of this class the electro-magnetic force was very nearly in exact proportion to the square of the current, which is rigorously the law of the ampere-force used in—and in that respect it bore very much resemblance to—the gravity balance instruments by which the highest possible accuracy is to be attained. On the other hand, in instruments of the class to which Ayrton and Perry's ammeter belongs, the force was more nearly in *simple pro-*

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portion to the strength of the current, owing to the iron being used nearly in a state of saturation. The resultant action between the wires conveying the current, and the oblate with its equator oblique to the lines of force was a couple; and that couple was balanced by torsion of the stretched platinoid wire on which the oblate was suspended. The platinoid wire was kept stretched to about one-third of its breaking weight by two springy arrangements at its two ends. These mechanical details would no doubt be interesting to some of the members of the Society, for they were all scientific enough to know that consideration of details was the very essence of success in practical work. The elements of electrical and mechanical science—rudimentary drawings of pumps, levers, springs, solenoids and magnets—were valuable; but a pump without physical science in the packing of its piston would be useless; and in an electrical instrument the elastic, the electric, and the magnetic properties of all its parts must be considered if it is to do good duty, whatever its purpose. And really the perfecting of mechanical details was the life work of any one engaged in practical science.

He just wished to point out a difference between the instrument he was exhibiting and the type that was now being made. In the instrument shown to them there was a latent zero, and unless he turned the torsion head he could not verify the zero. The range of the instrument was essentially limited as it stood now. It ran from 90 volts to 120 volts. It was impossible to make this very satisfactorily *a long range* instrument, except by adjustable resistances, for a reason that he should presently explain. The needle was not allowed to come to the zero at all, and his reason for that was that it was only so that he had been able to eliminate practical error from change of zero in copper wires and platinum wires, which he had used until latterly, when he had adopted platinoid. The elasticity of fine platinoid wire he had found so good that the latent zero during a year's use of the instrument had not changed one-fifth per cent. in its effect on the indication of strength of current. There was, in fact, no sensible variation whatever. He then took the twist out and verified the zero and replaced the twist. He then resolved to give the instrument a visible zero—that is to say, to let the needle regularly come to zero when the current is stopped.

A million years hence the earth would have a very different gravitation force, but this wire would be constant; and actually at the present time gravity differs notably in different parts of the earth, being one-half per cent. less at the equator than at the poles. This portable marine instrument was purely intrinsic, and more constant for all time and place than any other. Gravity was the most constant force they had to deal with practically, but looking at the elasticity of metal, and looking forward some millions of years, the elasticity of a piece of metal was more perennial than gravity. But either elasticity or gravity might be considered as practically quite perfect as to perennial constancy, provided that the weight or spring was not altered by rust or rubbed down or wasted away by evaporation. The marine voltmeter was really a standard instrument of a conveniently portable kind. The platinoid-wire spring had proved most satisfactory. If, after being first mounted and stretched, and heated up to the temperature of boiling water, they knocked the instrument down roughly on its side, or kept it lying on its side for a considerable time, they found that the knocking about and rough irregular usage did not alter the indications at all. And if more rough usage, or long continued rough usage, such as rattling it over paved streets in a cab, should alter the indications, they had the ready means of adjusting the zero at any moment, and so absolutely reinstating it as a standard instrument. The two things to make it so were the constancy of that oblate and each of these pieces of platinoid wire. These were constants which might be regarded as practically absolute, so that generation after generation that little instrument would be a standard current-meter (applause).

This instrument had not yet been much used at sea. He had not pushed it forward, because he had been anxious to satisfy himself about some of the mechanical details; but an instrument exactly like the one before them had been used in one of the State Line ships (the "State of Nevada"), and had made five or six voyages between Glasgow and New York. In the first four voyages it saved breakdowns from over-incandescence estimated at about 40 lamps, and from that time forward the consumption of lamps had been considerably less.

The other standard instruments shown to the meeting were founded on the mutual ampere-force between movable and fixed parts of a circuit. He should take these instruments beginning with one adapted to the smallest currents: they were the centi-ampere, the deci-ampere, the deka-ampere, and the kilo-ampere balances. The range of the centi-ampere balance (Fig. 3) was from one to fifty centi-amperes; the next instrument was the deci-ampere, which was exhibited on the table. The centi-ampere and the deci-ampere were quite similar in appearance, the difference being entirely in the fineness of the wire in the coils. The instrument before them might be taken as representing the deci-ampere, or the centi-ampere, but the type which was being made now differed somewhat from the type before them. The type would not be improved by the difference if used solely for currents in one direction; but if for alternating currents, the copper bobbins on which the wire was wound, and the thick, double sheet-copper sole-plate of the instrument before the meeting would, by the currents induced in them, interfere very seriously with the indications. With reference to the deka-ampere meter, its range was from 2 to 100 amperes. The instrument which he exhibited was a type of those made for Sir Coutts Lindsay and Co., for the Grosvenor Gallery installation, supplied at the request of Mr. Ferranti, and a considerable number of such instruments were provided for that installation. The deci-ampere meters and the deka-ampere meters had been made for the purpose of being available for alternate as well as for direct currents, and therefore they had a slate base, and slate cores, and slate ends for the coils instead of copper; but in other respects the arrangements were the same as in the instruments exhibited. The movable and fixed parts of the circuit in these instruments consisted of two movable coils, one carried at each end of a balance, and four fixed coils, one above and one below each movable coil. The movable coil at one end was attracted down by the coil below it and repelled down by the coil above it, and *vice versâ* at the other end. They had two movable and four fixed coils in this type of instrument. There was an advantage in having the whole six coils that could not be obtained with anything simpler. They might take away the two upper and leave only the two lower coils; but a slight change in the ligament or the beam would induce a sensible error

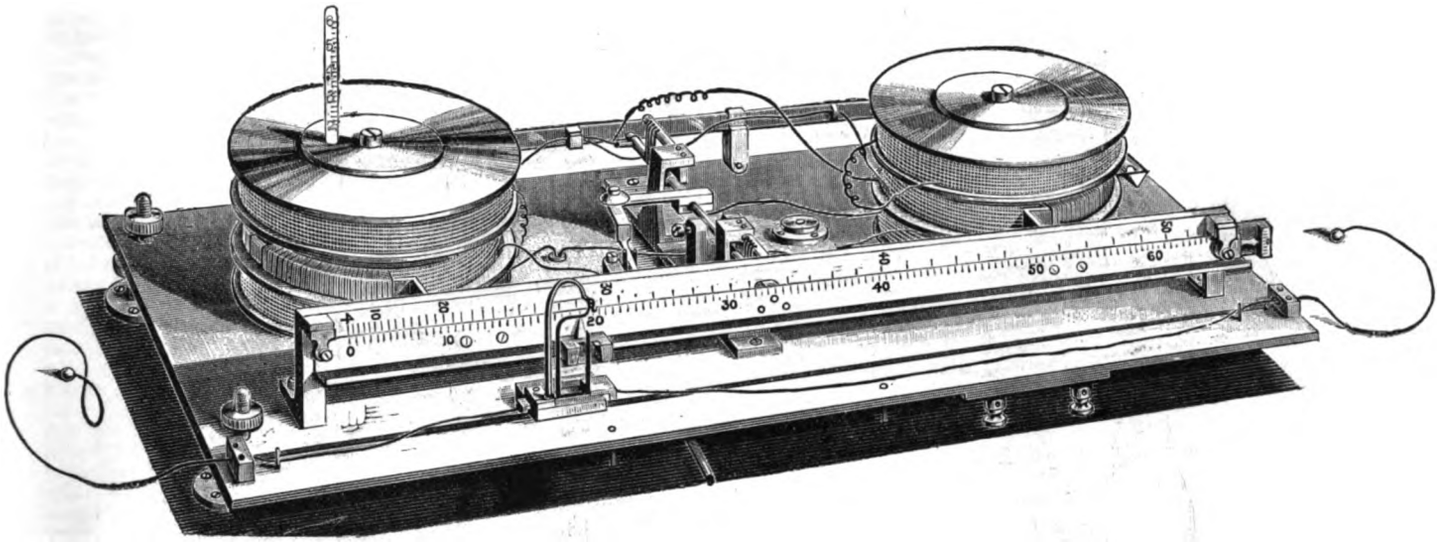

FIG. 3.
SIR WILLIAM THOMSON'S CENTI-AMPERE BALANCE.

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in the instrument. They had a minimum force for the middle position of each movable coil between two fixed coils, and by choosing the sighted position of the index to correspond very nearly to the place of minimum force they had a condition of things suited to give the highest degree of accuracy in the results. As to portability, his ambition had been that boxes from White's workshop containing his instruments might be labelled "Glass, without care—any side up" (laughter). That was the ideal, but though they were still somewhat far from having attained the ideal, this instrument might actually be turned upside down without taking any harm. Still they might have a mischance. One of these instruments labelled, as usual, "Glass, with care—this side up," had arrived at its destination broken; and it was returned to Glasgow with the lever arms bent and other bad damages, which were clearly owing not to breakdown of the suspension ligament, but simply to the instrument having been thrown on the stone floor of a foreign Custom House. The arms were re-straightened and the balance re-suspended, and everything replaced simply by the instrument maker. It was sent to my laboratory to be re-standardised, and the result was that it was found correct to within one-twentieth per cent. of what it had been before it met with the accident giving that very disintegrating extent of rough treatment. As to the resistance and number of turns of the coils, in the centi-ampere balance, of which the range was from one to fifty centi-amperes, each movable coil contained 440 turns of No. 30 copper wire; resistance 20 ohms; four fixed coils each of 1,295 turns of No. 26 copper wire, resistance 30 ohms; total resistance of the instrument, 160 ohms. That was a large resistance, but to have a standard instrument for measuring such small currents he did not see any way of avoiding doing it without a large resistance. In the deci-ampere balance the total resistance was only two ohms; the deci-ampere balance had a great advantage over the centi-ampere balance. Although founded on exactly the same principles, there was in the deci-ampere balance a far smaller proportion of space occupied by insulation, and a far larger proportion of space occupied by copper in the vital parts of the instrument, and thus a much more than proportionately small insulation, if they calculated on the proportion of dimensions on the idea of the different instruments being similar. They were not similar, because the insulation was thicker in proportion because of the fine wire. In the deci-ampere balance the movable coil was 64 turns of No. 17 copper wire; resistance, ·18 of an ohm; the four fixed coils, each one 66 turns of No. 17 copper wire; the resistance ·428 of an ohm in each, and the total resistance of the instrument 2·072, say 2 ohms. He had passed over the ampere-balance. The ampere-balance was before them; it was not adapted for the measurement of alternating currents, but an instrument slightly less advantageous could be made for alternating currents. The range of the ampere-balance was from ½ to 25 amperes. The ampere-balance exhibited was of the newest type. It consisted of two movable coils, each ten turns of copper ribbon 1·2 centimetre broad, and ·1 thick; 4 fixed coils, each 37 turns of copper ribbon 1·8 centimetre broad and ·07 thick. The insulation of these coils was very fine paraffin paper, so that it took exceedingly little space. As to the hekto-ampere balance, there was in it one point of importance with reference to the very highest accuracy, and that was the complete and thorough realisation of the minimum principle. In this they had a single rectangular ring of copper, movable, and a fixed ring of copper below it. The fixed ring consisted of ten turns of copper. In the kilo-ampere (Fig. 4) balance the range was from 50 to 2,500 amperes, and the fixed coil was made up exactly as in the hekto-ampere balance, with this difference, instead of insulating paper they were soldered together and thus formed a ring. There was great difficulty in getting a forging or casting of copper of those dimensions. The first ring was made from a forging of copper, and they had to wait a long time for it, and he found, at all events for the present, it could be made more easily and with greater certainty of satisfactory results by winding up a ribbon which gave the coil of the hekto-ampere balance.

[Here Sir William Thomson sketched diagrams on the blackboard of the kilo-ampere balance and the hekto-ampere balance, and explained their working.]

In these and all the other balance instruments the beam was supported by two ligaments, each composed of a large number of short pieces of fine copper wire. Besides bearing the weight, these ligaments had to convey the current from a fixed to a movable conductor. He had first tried bearing ribbons of thin sheet copper, and he had found it exceedingly unsatisfactory from the buckling of the ribbons. As he had not succeeded in getting a good result from an elastic bearing of broad ribbon; he had divided the ribbon into narrow bands, and ultimately into thin wires. For the lightest ligament they had about ten very fine copper wires, and for the different types of balance twenty and thirty, and so on up to 900. The number of wires in each ligament of this kilo-ampere balance was 800. The ligament was not to be seen, because there was a strengthening guard, which was fixed across the middle of the instrument, covering the ligament, and guarding it against any chance of injury from rough usage. To make this instrument portable a piece of brass was slipped in beside the ligament, and two screws were screwed down, by which the whole weight was taken off the ligament and the beam held perfectly firm.

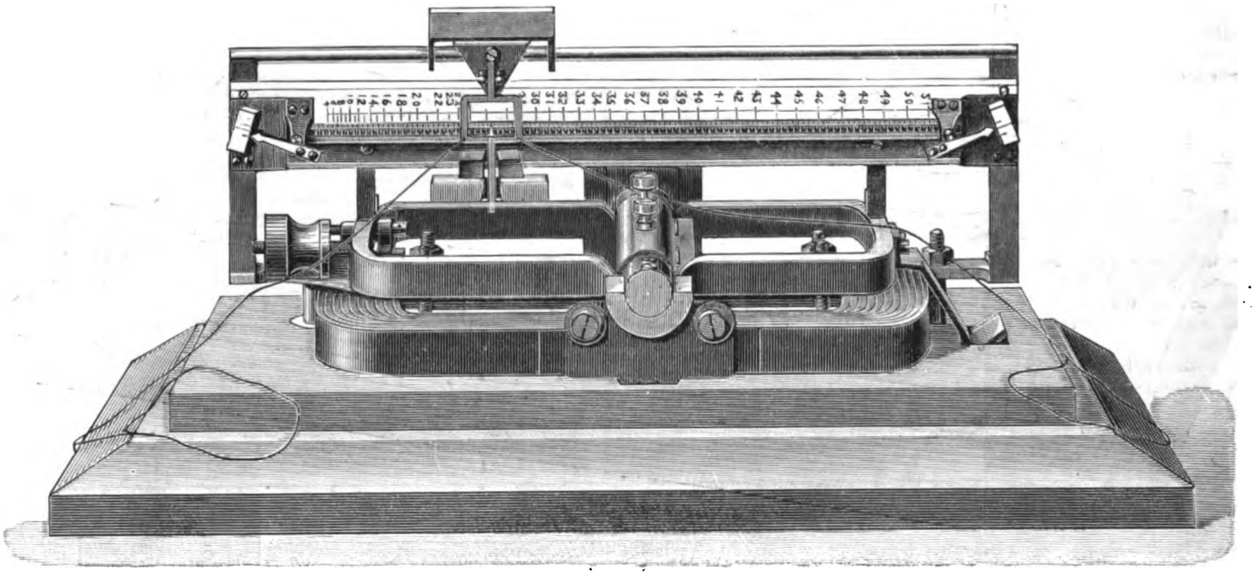

FIG. 4.

SIR WILLIAM THOMSON'S KILO-AMPERE BALANCE.

[Sir William Thomson here made a sketch on the black board of the ligament and strengthening guard.]

They had on the table before them a set of instruments capable of measuring continuously, each adjustable by comparison with the one below it, through a range of from one milliampere up to 2,500 amperes—a ratio of 2,500,000. It was very convenient to have absolute standard instruments through so wide a range; but most people would be satisfied with much less range of *standard*. For a large variety of laboratory and practical uses a deci-ampere balance, ranging from one to 50 deci-amperes, with a milliampere and a deka-ampere magnetostatic instrument to extend the range of accurate measurement down to a milliampere and up to 50 or 100 or 200 amperes, would be found very convenient as an equipment for measuring currents with perfect readiness and sureness from a milliampere up to 200 amperes.

DISCUSSION.

Sir WILLIAM THOMSON concluded his Paper amidst great applause.

The PRESIDENT then said the lecture had been highly interesting, although it was not one that admitted of discussion in the ordinary sense; but there were several gentlemen who might desire to ask questions.

Mr. W. H. PREECE said there were few members present that night who could boast of the experience he could narrate to them. It was his

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good fortune a good many years ago to have acted as assistant to the great and immortal Faraday in carrying out his classical inquiry into the lateral induction of underground wires. More than thirty years ago he first learnt how to use a differential galvanometer, for the purpose of exact measurement of resistance, designed by Dr. Werner Van Siemens, and made by the house of Siemens. Later all his experience had been acquired by instruments made by Sir William Thomson. Now, they were singularly fortunate in having in that room two of their great fathers in the art of exact measurement. They had there at that table Dr. Siemens, whose presence they greeted (cheers). These were the two philosophers who had taught them all how to measure with precision and accuracy the electrical phenomena with which they dealt practically. They had heard from Sir William Thomson the vast and the wonderful range of these instruments of precision. Many engineers imagined that when they could measure a millionth part of a millimetre by means of a microscope, and when they could judge the distance between the earth and the sun with their telescopes, that their instruments extended over an enormous range; but their range, combined with accuracy, was not to be compared with the accuracy with which electricians could measure from the ten-millionth part of a milliampere up to 25,000 amperes. And, again, not only had they got this enormous range and this great exactitude, but they had that confidence and that knowledge that, under the guidance of Sir William Thomson, they had instruments that imparted in their minds the most express and most explicit confidence. There was no engineer who could say with the same feeling of security and the same firmness of purpose that his measurements were right as electricians could who used the instruments before them. It was, he thought, Mr. Samuel Smiles who stated that attention to details was at the root of human progress. They had learnt from Sir William Thomson that attention to details had been his guiding star through all his scientific career. They were extremely indebted to Sir William Thomson for the clear and able discourse he had given them.

Dr. SIEMENS said that he was in the very unfortunate position of not having had sufficient opportunities of speaking English to enable him to do justice to the kind way in which they had received his name.

Prof. AYRTON said that he had not had any actual experience of the charming instruments they had seen before them that evening, therefore it was impossible for him to say anything about them in detail. But what he could say was certainly this: his colleague and himself had been engaged for a long while on the design and manufacture of electrical measuring instruments, and others who, like themselves, had been similarly engaged, knew the extraordinary difficulty that existed in making any one single instrument to approach approximate perfection. The mere idea of an instrument was not very difficult to arrive at, but to make that instrument a working apparatus was attended with an enormous amount of difficulty. If there was all that difficulty in getting success with one, what difficulty must there not have been to get success with the vast range of instruments before them that evening. He might say that it was surprising that Sir William Thomson, with so many claims on his time, should have been able to devote himself almost continuously to perfecting what he had done, and it only made them feel still stronger admiration for his marvellous powers, about which it was almost impossible for any one to say sufficient or to do justice to. He felt, if he might be allowed to say so, as if he were speaking of a being residing in another universe altogether, having powers that they did not quite understand, and could only look at in a reverential way. That was really what he felt that evening and what he had sincerely felt for the last 25 years (cheers). Criticism was out of the question. They might ask questions, but they could not really criticise. One question he would like to ask in connection with the first instrument that Sir William Thomson showed them. Sir William mentioned that he had used platinoid wire. He asked that for the reason that he had used platinoid wire for an electrical instrument for some time, but they had been overcome by its oxidation. He would like to know whether Sir William had been troubled with it, and, if so, what means he had adopted to get over the difficulty. They had been appalled by the vast range of instruments that evening, but they must not forget that this large contribution to electrical measuring instruments was but a very small part of the contribution that had been made by the inventor to electrical measuring instruments; indeed, almost all their delicate electrical measuring instruments were due to the same author. Nobody had used with more pleasure and at the same time with more agony the quadrant electrometer; pleasure because he was able to do with it what could not be done with any other instrument, and agony because of its peculiar habit of getting out of order. The first advantage was in no way destroyed by the second disadvantage. Take an example:—Prof. Perry and he, some years ago, in Japan, measured with the quadrant electrometer the action of paraffin oil on metals, and he was enabled to do this when it was unable to be done by any known chemical test. He might talk for a week, and still not be able to say all that he would like to say of the marvellous inventive power that they had seen that evening, and it was only one occasion of a repetition of the inventive powers which Sir Wm. Thomson had displayed for the last fifty years, not merely in electrical instrument measuring, but almost in every measuring instrument under the sun. There was no single subject to which Sir William had given his attention, even for a short time, in which he had not left his mark, and left that mark very firmly imprinted (loud applause).

Prof. FORBES wished to ask a question. There was a water tube provided in the voltmeter for preventing dangerous chances of short circuit in connecting this with very high potential mains or circuits. He had noticed that with a high-potential alternating current the voltmeter did not act when this water tube was in.

Sir WILLIAM THOMSON said that Prof. Forbes' observation was communicated to him, and he (Sir William) ascertained that there was no doubt whatever that the Professor's interpretation of it was correct, namely, that the water did not afford a sufficiently rapid electrification to allow this to give the correct mean potential when applied to an alternating-current circuit, and in these circumstances he merely substituted thin wire and let the instrument take its chance of internal contact. They must take care that there was not an electric contact, because this wire guard was not sufficient. He thanked Prof. Forbes for giving him an opportunity of saying that the instrument was now supplied with wire and not water.

Prof. ADAMS joined with Mr. Preece and Prof. Ayrton in admiration of Sir William Thomson's work. They were always exceedingly thankful to him for bringing out a new instrument, although, perhaps, for some of them, they came pretty often (laughter); but at the same time they liked to see the result of the good work if they could not buy it themselves.

Dr. FLEMING agreed with Prof. Ayrton that criticism regarding these beautiful instruments was altogether out of the question. He was, perhaps, fortunate in being able to contribute his own small quota to the discussion in stating that he had had experience in using these instruments, and that he had been privileged to hear from Sir William at various stages of the progress which he had made in perfecting the various types of these instruments during their evolution. For the past two years he had had two or three of those instruments in almost daily use, and he could speak personally of the intense comfort of using an instrument on which one could place absolute reliance. He had two instruments in constant use; one of these was a deca-ampere balance (1—50 amperes), and the other of a type not represented here, which measured from a small fraction of an ampere to 3 amperes. It gave him the greatest pleasure and gratification to be able to bear his testimony to the wonderful and satisfactory addition to the long list of instruments for which the electrical world was indebted to Sir William Thomson.

Prof. SILVANUS THOMPSON joined in the admiration expressed by the previous speakers. There were many of them who would very much like to have the full range of those instruments in their laboratories, but they could not afford to buy a whole series of instruments. He had been asking when they would get an instrument to measure an ampere correct to to 1 per cent. for half-a-crown, and an absolute ampere-meter that should be correct to the tenth of 1 per cent. for ten half-crowns. When they reflected that they could for half-a-crown get a chronometer that would give a better result than one-tenth of 1 per cent., and that now they could buy a watch that would give a result to the one-hundredth part of 1 per cent. for 10s., why should they have to pay such a price for these electrical instruments?

Mr. JAMES SWINBURNE said that he had missed the mho-ohm drum invented by Sir William.

Mr. W. P. GRANVILLE asked if any provision had been made for any source of error in the instruments in which soft iron was used.

Sir WILLIAM THOMSON, in reply, said: Prof. Ayrton asks a question whether I had any experience of platinoid being liable to oxidation. I cannot say that I have found any signs indicating such effect. I do not say that platinoid may not develop that quality of imperfection when tried for a sufficiently long time. It is only a new metal, it being only 2½ to 3 years since it was made. It is a kind of German silver with a very little tungsten added. I have found it remarkably free from oxidation. I tried it in one rude manner as regards oxidation in the new depth-recorder of my deep-sea sounding machine. I use a platinoid spiral spring and platinoid main air vessel, and other chief parts of the instrument, and I have left it between wind and water for months together always moist with sea water. It has shown remarkably little signs of oxidation, and no change whatever as regards the strength of the spring. With reference to the platinoid wire of this marine voltmeter, I have only had it for a 1½-year test, and it has not shown any sign of change, and on the whole I do not expect to find it showing anything of the kind in a thousand years. But that is not a statement which anyone has a right to make except as a probability, and I therefore recede from the assertion that this will last for a million of years, though I believe it will do so (laughter). I used to use platinum, because it may be regarded as absolutely unliable to change by oxidation, but I have found platinoid much more satisfactory as to elasticity. There is one fault of platinoid, and that is that as hitherto supplied, different pieces of the same wire are different, so that in different parts of one wire with absolutely the same gauge you had a sensible difference in resistance. Mr. J. T. Bottomley has found that platinoid varies exceedingly little in its resistance with change of temperature; and, both on this account and on account of its high-class elasticity, it is a material which deserves very careful investigation. The differences of quality between different parts of the same wire may be accounted for by the mode of working the metal in the crucible. Through insufficient mixing in the crucible the ingot may be slightly different in different parts; but that objection is probably only temporary, and platinoid some years hence may be made of practically perfect uniform quality. With reference to the rheostat, which I have omitted to mention, it is not to be taken as an accurate measure of resistance; in fact, as we have just seen, the platinoid wire may be not uniform in its resistance throughout its length. Owing to the freedom from oxidisability of platinoid this platinoid cylinder and platinoid wire work much better than the brass cylinder and brass wire of the original Wheatstone rheostat. The improvement of this instrument consists of a tightening-spring keeping the wire stretched, and a fork for guiding it, without any groove on either cylinder. Thus it works in an exceedingly convenient way, and may be turned rapidly and suddenly in either direction. As to the mho-ohm drum, also alluded to by Mr. Swinburne, I am trying all I can to bring it into practical shape, with good hops of an early result, after a serious trial made thirty years ago, and continuous efforts in my laboratory and White's workshop for the last nineteen months. Mr. Granville has asked a question with reference to soft iron, and that opens up very interesting considerations regarding magnetic induction in iron, which I first learned in working in quite another subject—the Flinders bar for the correction of the mariner's compass, so that the

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compass, if correct in one latitude, may be correct in another; for instance, in the British Channel and the Cape of Good Hope. A large part of the magnetism of the ship is due to the vertical component of the terrestial magnetism, and that portion of the magnetisation is reversed in the southern hemisphere. The object of the Flinders bar is to annul the effect on the compass of that varying part of the ship's magnetism. Flinders 90 years ago placed a vertical soft iron bar before or behind the compass for that purpose, but it did not get into general use. Some persons who wished to improve it tried again and again, and, among others, Mr. James Napier, one of the sons of Robert Napier, the founder of the great engineering firm, and I questioned him about the difficulty. I said, "If that bar gets a kick from anyone's foot when the ship is heeling over (I might have added, particularly if she is on an East or West course), the compass will show a permanent change when she is upright again." He said that was just what he found. The long and short of it was that a long thin bar is exceedingly liable to irregular disturbance. If you take a long bar of iron, of length more than twenty times its diameter (a common domestic poker answers well), and place it vertically, or, better, parallel to the terrestial magnetic force (the line of "dip"), and place a pocket compass near one end of it, you will see splendidly interesting results. First, you will generally find the upper end acts as with "blue magnetism," and the lower with "red." If you invert it very tenderly, you will find that the end which was upper still acts as with "blue magnetism." If, after you invert it, you give it a very gentle tap with the finger, it will instantly change to "red." That will not take place with shorter bars. In trying to bring the Flinders bar into practical use, I simply tried a bar of certain diameter and shorter and shorter lengths, and put it beside the compass, and found whether, striking it with blows of the mallet, I could make a difference in its magnetic effect. When the length of the bar was twenty or thirty times the diameter, then it was very sensitive to the blows of the mallet, but when not more than eight or ten times the diameter I could invert it and make no change whatever, whether I struck it with the mallet or not. I found its magnetism inverted truly according to its position, and it showed no signs of a retentiveness. Under the influence of the feeble magnetising force of the earth a bar whose length is not more than six or eight times its diameter shows no sensible effect of retentiveness in its action on the direction of the compass. I took that principle of shortening the bar in the electric current-measuring instruments of this class. The practical result is that until a current much exceeding the greatest amount provided for is passed through this marine voltmeter there are no signs of retentiveness. If I work from nothing up to 120 milliamperes in this instrument, up and down and with reversed currents, I find no signs of retained magnetism; but a current of two or three hundred milliamperes leaves a large effect of residual magnetism, which, however, is easily shaken out by turning the little reversing key which forms part of the instrument. I have to thank you for the patience and the very kind manner in which you have listened to what I have said.

A cordial vote of thanks was then given to Sir William Thomson. The proceedings then terminated.

TELEGRAPH OPERATORS IN PERSIA.*

It was a wild, barbarous country, about the Turko-Persian border, inhabited chiefly by nomad Koords, and I missed even the occasional welcome company of the Turkish telegraph line. Its disappearance seemed like casting off the last strand of western civilisation. At that time I hardly expected to see another telegraph line until I should reach Japan, my intention being to reach the Pacific through Turkestan and China.

Suddenly one day, when nearing Tabreez, I saw away off on the desert a sight that made me blink and rub my eyes to make sure that it was not a mere optical illusion I was looking at. The deserts of Persia are famous for producing bogus objects—mirages of lakes and waving palms, of lovely castles and similar fascinating scenes; but this time it was none of these. Miles away to the north, seemingly suspended in mid air, was a league-long row of telegraph poles, straight as a die, even as the pickets of a garden fence.

As I drew nearer the line assumed a more definite form. Its marvellous symmetry, I then discovered, was not the enchantment of distance, but a solid reality in English iron, with the name of the contracting firm stamped on the poles, every pole tapering from a circumference of twenty inches at the bottom to six or eight at the top, and across the dead level wastes of the Persian plains set up as evenly and perpendicularly as they might have been in Hyde Park. It is worth noting, perhaps, by the way, that the English always take particular pains to have everything of this kind very superior in the East; it is a perpetual source of wonder and admiration to the natives, a standing advertisement of England's wealth, power and ability to the multitude who have no other way of learning.

From Tabreez I was able to follow this infallible guide into Teheran. Often I could see it stretching ahead of me mile after mile, the poles so even that they seemed not to vary an inch, and disappearing in the heavens at the farther end by the curious legerdemain of the desert. The æolian music of its triple wires as the desert breezes played through them, and the messages flashed past from India to England, from England to India—how companionable it was, that bit of civilisation in a barbarous country, only those who have been similarly placed know.

During my stay in Teheran I became quite intimately acquainted with the staff, not only in the capital, but throughout all Persia. There are many curious and interesting phases of life connected with the telegraph service in such a country as Persia that are unknown here. Its alignment and its working staff represent a narrow streak of western civilisation through all that part of Asia. Men two thousand miles apart, who never saw each other in their lives, are, nevertheless, well acquainted. The lone Englishman at the little anterior control station at Dabeed is kept informed from day to day by his chums at Teheran of the doings of the European colony there.

Teheran, Ispahan and Shiraz are the three favourite stations in Persia. Operators are rewarded for good service by being stationed at these points, or disciplined for misconduct by being assigned to some lonely control station, where the only society is a few ragged villagers, and their station a mere mud hovel. Dabeed, about midway between Teheran and Bushire, is considered the worst station in Persia. The extremes of heat and cold in Dabeed are intense. From many degrees below zero in winter and raging storms like blizzards, it gets so hot in summer that the operator often sits at his instrument up to his chin in a tub of water. None of the cooling appliances that make life tolerable in India are available here.

The Ingliz telegraph-jee is quite an important personage in Persia. Outside Teheran and Bushire he is the sole representative of Europe. He is a sahib, whose salary often exceeds the income of the Persian prince or governor of the town. He has several servants, and keeps the showiest riding horses in the town, vieing in the matter of horseflesh with the local prince, with whom he is always on very good terms. He and the prince invite each other to dinner: not a day passes but the prince comes and smokes a kalian or two in the telegraph thana, and in the evening they sit beside the steaming samovar and smoke and drink tea. The prince sends his friend, the telegraph-jee, presents of fruit, or a pheasant now and then, and when the line inspector comes along and leaves with the Englishman a few bottles of choice Cruiskeen Lawn the prince knows he will not be overlooked.

The mollars and seyuds and khans and leading merchants—these, too, are all friendly, as a general thing, to the Feringhi. He is the one relief from the monotony of daily life to them, a speck of human interest upon which to centre the Oriental curiosity.

It is often a remarkable change for the young Englishman. From an unambitious berth in England, wages a pound a week, he finds himself in a month or two hobnobbing on equal terms with Persian princes, with twice as much money to jingle as the prince, and riding the finest horse in town. In addition to a large salary, inducements are held out to him to qualify himself for preferment. A sum equal to three months' salary is paid him for passing an examination in Persian. Five hundred pounds are offered as an inducement to qualify for services in India. For all these advantages about the only sacrifice he has to make is of a social nature.

Food is cheap and plentiful, and in the larger stations almost everything can be found in the bazaars. Some of the men marry and settle down in the service; they obtain wives from England, or marry the maid servants at the legations in Teheran. One or two have married American women; but by so doing the "telegraph sahib" loses caste, much as a man does out west by marrying a squaw. He loses caste in the estimation of his comrades, the Persians, and also with the Americans themselves at heart, although they consider the capture of a sahib very advantageous.

Everything is now so thoroughly equipped and organised that the telegraph service runs smoothly and efficiently; but this was far from being the case at first. The difficulties were a long way from being overcome when the line was put through. For some years it was almost impossible to keep communication open between Teheran and Bushire. Here for nearly a thousand miles it follows along the greatest caravan route in Persia. The charvadars and camel men regarded the long lengths of nice strong wire strung all along their route almost in the light of a special dispensation of Allah, sent to their favoured country so that they might obtain all the material they wanted from time to time to mend their ramshackle pack saddles, chains and harness, without paying out any money.

All summer long thousands of camels and pack mules are constantly employed along this route, and the caravan people used to render the line well nigh worthless. Whenever anything broke that could be mended with wire, the charvadar would simply shinny up a telegraph pole and help himself. In a day or two, perhaps, something else would fall to pieces; but it mattered little to the charvadar, for an unlimited quantity of good English telegraph wire was always to be had for the trouble of climbing a pole.

Next to the charvadars the wandering tribes were the worst depredators. The nomads of Persia are much given to embellishing their charms of person by means of thick wire bracelets. Copper or silver wire is their preference, but they have no objec-

* From an article in the New York *Sun*, by Mr. Thomas Stevens.

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tion to bracelets of baser metal, especially if they can obtain them without pay. To stretch a telegraph wire through country was about the same thing as placing a pot of jam where it can be easily reached by a boy. Nomads who had caught on went strutting about the country wearing a wealth of telegraph wire bracelets that made the eyes of their less lucky tribes bulge with astonishment.

Finding that they could be obtained for nothing by merely climbing up the Ingliz poles and hacking off the wire, the popularity of the new style bracelets spread far and wide among the Elianites, Susmanis, and Bactiaris. These unsophisticated children of the desert, for a long time, outdid even the caravan men. Ambitious young nomads thought they saw in the unlimited quantities of telegraph wire an opportunity to largely increase their wealth, and they began to carry the bracelets into the more remote regions as articles of commerce.

All this the English Government stood patiently, hoping that time and the employment of numerous native linemen would eventually put a stop to the depredations. The caravan people, however, finding that they escaped punishment, grew more and more enterprising and aggressive. They were not slow to discover in the thing they found so profitable sources of amusement to boot. They took to shooting at the insulators for wagers and clipping the wires with bullets for sport.

Another form of recreation was to make a mark up near the thin end of the cast-iron poles, and stand off so many paces and shoot at it. They used to gamble on the number of shots it would take to crack the pole, and bring the upper part, cross-trees, wires, and insulators down to the ground. This was, of course, rare fun for the Persians. But for those who had to bring iron poles from England, and pack them on camels hundreds of miles over the deserts, it was not quite so funny.

The English finally had to appeal to the Shah to protect the line. "Very good," said the king of kings, blandly, "it shall be stopped." Orders were sent out to cut off the hands of people who were found wearing telegraph wire bracelets. This had the desired effect, and to-day the telegrah wires are as safe in Persia as in any country.

PERSONAL SAFETY AND HIGH-TENSION CURRENT.*

BY LEO DAFT.

No apology is needed for dwelling upon this subject at length, which is done to some extent as a protest against the flippant manner in which it is frequently treated by persons accustomed to the use of high potentials. It is not by any means an uncommon thing to hear these gentlemen dismiss the subject with the remark that "one of our linemen has frequently taken a current of 1,200 to 1,500 volts without serious inconvenience." The chief danger of remarks of this character lies in the fact that there is at least a grain of truth in them, and that it is quite possible for the assertion to be apparently proved by the production of the man himself with an emphatic reiteration of the statement, probably embellished by a few observations leading the public to imagine that the experience was rather agreeable than otherwise.

Now, as a matter of fact, the actual amount or volume of current necessary to destroy any human organism has never been carefully defined, or it would satisfactorily settle the question of potential. Even if it had been, there are still many elements not considered by the ordinary observer, and rarely by the technical, which tend to modify the conditions to such an extent that a person even slightly acquainted with electrical laws may prove almost anything with the aid of a little sophistry. For example, the lineman, who is triumphantly cited as a case in point, probably underwent the quoted experience with such a small contact-area—that is to say, with merely a finger-tip, or a very small part of the hand exposed to the conductors—as to enormously increase the resistance of the circuit in which he was included, and therefore to limit the current in the manner alluded to in the quotation on page 1. Again, he may, as a lineman or engineman frequently has, have had his hands coated with oil or some better non-conductor, even more effectual than limited area in reducing the fatal flow of current. It is not enough to prove that he may have been safely exposed to these potentials under favourable circumstances since it is well known that under different conditions the result is invariably fatal. It is also necessary to show that they were such in the matter of contact-area and personal resistance as are likely to occur in practice.

A number of careful observations seem to indicate clearly that a current of 0·5 ampere is generally destructive to any human organism, and if personal resistance were always uniform, which is very far from the fact, this would, of course, definitely fix the limit of potential, and none ought to be considered safe which will not permit any properly constituted person to firmly grasp conductors without serious inconvenience. That this can be done with potentials higher than 250 volts by a person of ordinary constitution has never yet been shown, and is extremely problematical; that it certainly cannot be done with potentials much higher than 300 is a matter of daily experience in every electrical manufacturing establishment.

This is not the place to enter into any abstruse physiological discussion, but a few considerations of potential and resistance tend to define within reasonable limits the amount of current which will do serious injury. An exhaustive series of experiments to determine the resistance of the human body, measured from hand to hand under varying circumstances, shows that it ranges between 1,000 and 7,000 ohms, but a safe mean is probably 2,500 ohms, and experiments made with a view of determining the danger-point have shown that a man measuring 2,500 ohms from hand to hand, using exactly the same terminals during the measurement which were afterwards used in the test, could not withstand the potential increased beyond 250 volts. It is therefore evident that while in this case a current of 0·1 ampere was almost unbearable to a vigorous man, the same individual, with merely the tips of two fingers touching the conductor and by consequent diminution of contact-area increasing the resistance of the circuit, of which he formed part, to 10,000 ohms, was only receiving a current of 0·025 ampere. It plainly follows that with the hands firmly grasping the conductors, as in the first instance, a difference in potential of 250 volts had precisely the same physiological effect as 1,000 volts would have in the latter instance, the current in both cases being 0·1 ampere; while to firmly grasp the conductors would probably have been instantly, or at least quickly, fatal, causing by diminution of resistance a flow of current equal to 0·4 ampere.

Herein lies the danger in any attempt at precision, for the same effects may occur—and frequently do occur from different causes—resulting in fatal accident. Thus a man ignorant of the dangerous effects of moisture in reducing personal resistance may handle with impunity exposed conductors while the hands are dry, which would impart a fatal shock just after washing them or when moist with perspiration, and it is just this uncertainty which renders loose statements of the kind above quoted almost criminal where they do not result from dense ignorance.

In conclusion, it should be remarked that the above refers only to continuous currents, not taking into account the effect of alternations or static charges.

* Extract from a Pamphlet issued by the Daft Electric Light Company of New York.

BOOKS, &c., RECEIVED.

"Séances de la Société Française de Physique." January, March, 1888. (Paris: 1888.)

"Electric Lighting; its Present Position and Future Prospects." By Hammond and Co. (London: Whitehead, Morris and Lowe.)

"The *Journal* of the Franklin Institute." Vol. CXXVI., No. 751. (Philadelphia.)

The Electrical Crystallisation of Metals.—Mr. H. Warren has recently devised a very simple method of producing metallic copper in a crystallised form by means of electricity. The arrangement consists of a tube, closed at one end by a diaphragm of gold-beater's skin, and suspended in a dilute solution of chloride of sodium. This tube contains a saturated solution of sulphate of copper, the density of which is maintained by having an inner tube terminating in a point, filled with sulphate of copper crystals. A strip of copper foil 3 centimetres by 1 centimetre is introduced into the copper solution and connected by a wire of the same material to a zinc plate, which forms the negative electrode, and which is in contact with the saline solution. After a few hours small metallic copper crystals commence to form on the positive plate, and at the end of a week the copper electrode becomes a bright mass of copper crystals. Silver, antimony, bismuth, magnesium, iron, aluminium, and all the most oxydisible metals can be similarly reduced.

A Captive Balloon Struck by Lightning.—During a storm which burst over the city of Barcelona, the captive balloon in the Exhibition grounds was struck by lightning, the gas burst into flames, and the balloon was totally destroyed.

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THE CHEESBOROUGH PATENT.

In continuation of our remarks last week on Mr. Justice Kay's judgment in the Edison-Brush law suit it may be useful to add a few words with special reference to its effect on the manufacture and sale of incandescent lamps in this country. First, however, it will be necessary to state precisely what the essential feature of the Cheesborough patent really is; for on this point there seems to be almost as much misconception as on the subject of Mr. Cheesborough's personality. We have already explained, for the information of *The Times* "and others," that the so-called Cheesborough patent was Mr. Cheesborough's only by virtue of his being the English patent agent who secured the American inventor's rights in this country. The real, or alleged, inventors were Messrs. Sawyer and Man; and whatever else may be said for or against their original specification, it certainly described an entirely novel and practical application of a process which had hitherto existed purely as a scientific experiment. The patent, however, which was taken out in 1878, was chiefly occupied with a description of a wonderful and impossible lamp, and in consequence its true value was overlooked or neglected by electrical engineers for a considerable period. It was reserved for another American inventor to

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make the discovery that, embodied in this complicated and in some respects ridiculous document, there was something worth digging out and rescuing from oblivion. Need we say that the invention became the property of the Edison Company, and that with their customary astuteness they forthwith disclaimed all the rubbish with which the patent was encumbered, leaving themselves the exclusive possessors of a process which it will be hard to beat, and still harder to infringe?

Divested of its redundancies and inaccuracies, the Cheesborough patent became, in fact, the simple description of the now well-known method of preparing carbon filaments by electrically heating them in carbon gas; and as this feature of the patent has been held to be valid its infringement by the Brush Company, who employed a similar method, has now been established. It is notified that the Edison Company are about to appeal on that part of the case decided against them, but it is not yet known whether the Brush Company will appeal on the other point. Probably they will not; and the question naturally arises, how will the electric lamp industry be affected by the reaffirmation of the validity of the patent? We need hardly inform our readers that the value of the process depends entirely on what is known as flashing; and, unless some other means equally successful of giving uniformity to the carbons be discovered, the monopoly will remain with the present owners of the patent. To make lamps without "flashing" is, commercially speaking, not so easy as some people seem to suppose. In the first place it is difficult to make many carbons which are even uniform along their own length, and when this has been done, so that each lamp is uniform in itself, it will be a matter of infinitely greater difficulty to make the carbons so that they are all alike in resistance and surface. When we remember the numbers of small makers who have tried and failed, we can realise what a very troublesome business lamp manufacture really is. Nothing is easier than to make one lamp or half a dozen lamps; but it is quite a different matter to make a thousand lamps all alike as regards resistance. Even with flashing this was difficult; without it it will be still more difficult. We can imagine the Brush Company or Messrs. Woodhouse and Rawson overcoming this difficulty; but we think the small makers, with less experience, will find this a very hard task indeed.

The future of incandescent lamp manufacture, and with it the future of electric lighting, depends very much on the policy now pursued by the Edison-Swan Company. There has been a rumour in the City that they were going to reduce the price of lamps to three shillings retail. This is very much to be desired. If the Company are wise they will use their victory in such a way as to deserve it. By improving the quality of their lamps, and by lowering their price, the Company may hold their own against all competitors. But, on the other hand, if they seek to command the market on the mere strength of the Cheesborough patent, the probable consequence will be that either the lamp trade will become a prey to cheaper and inferior processes—which would do as much damage to the Edison Company as to the electric lighting generally—or else some equally good process will come to the front that will beat the old method out of the field. Of one thing we are pretty sure, the present price of lamps cannot long be maintained; and the best way to ward against competition will be to forestall it. It is known that lamps can be remuneratively made and sold at a shilling a-piece. Surely it would not be unreasonable to ask of the Edison Company to supply them at eighteenpence, if not just at present then in the not far distant future.

Probably much will be done in the manufacture of high-power incandescent lamps, and it is possible that they may replace arc lamps in many cases. Certainly they are costly to buy, but their maintenance is very much less than that of the arc lamp, giving not the same nominal power on the photometer, but the same amount of useful light in a large building, or even in the street. These large lamps are used very much in America, and they are gradually coming into use in this country. We believe there is no difficulty in making them, but makers did not put them into the market before because there seemed to be little demand for them.

Whether lamp manufacture will waken from its present state of apathy and produce 200-volt lamps, or lamps that will burn for long periods at half a candle per watt, remains to be seen. We wish there were more uniformity of practice among electrical engineers. It would certainly be worth while, if it could be arranged, that incandescent lamps should be made of a few kinds only. For instance, one ordinary run of lamps might be made to give 16 or 8 candles, and to take 40 or 80 volts. We take 80 as the higher limit advisedly. Of course, as far as leads go, the higher the electromotive force the better, but high-resistance lamps are not so durable, so a mean has to be struck. 100-volt lamps are in fashion, but we have been told by practical lamp makers that there is a great fall off in durability and facility of manufacture when 80 volts are exceeded. The 40 or 50 volt will probably be used extensively with transformers, while the 80 volts are better adapted for direct lighting, where the leads are longer.

We would also like to see engineers agree to use, say, 1,000 volts or 2,000 volts on the primary circuits, and 40, 50, or 80 on the secondary circuits, in alternating-current systems, with, say, 10,000 alternations per minute. The Americans, who have had plenty of experience, use 1,000 volts and 50 volts, and a high rate of alternation, but as English engineers prefer smaller speeds for their machines, we think 10,000, which is used in the Grosvenor Gallery installation, more suitable. We do not, however, wish to dictate, hardly to suggest, the best figures; but we do want electricians to agree among themselves, and to work together for the good of electric lighting. These questions will doubtless be discussed, amongst others, in the Electrical Section of the Chamber of Commerce, which now seems in a fair way to be realised.

C. A. BELL'S WATER-JET TELEPHONE TRANSMITTER AND SYSTEM OF TELEPHONIC COMMUNICATION.

BY G. W. DE TUNZELMANN, B.SC.

A Paper was communicated to the Royal Society in May, 1886, by Mr. Chichester A. Bell, M.B., on "The Sympathetic Vibrations of Jets,"* containing an account of some very interesting observations, some of which led to the invention of the water-jet transmitters. It is well known that a jet of water issuing from a narrow orifice gradually becomes discontinuous and breaks up into drops, as shown in Fig. 1, which is taken from an instantaneous photograph. Fig. 2 shows a jet of water from a tube fixed to a board, falling on a membrane of stretched India-rubber forming a cap to a brass tube, which can be raised or lowered by sliding in a larger tube resting on a heavy stand. The upper tube has an orifice at one side of the upper end to which is attached a vulcanite trumpet. Mr. Bell found that with this apparatus either mechanical or sound vibrations communicated to the jet could be reproduced with great loudness and distinctness. The loudness and distinctness both increase up to a certain point when the distance of the membrane from the orifice is increased. After passing this point the sound still continues to increase in loudness while losing its distinctness, until ultimately it becomes a mere un-

* See *Electrician*, June 4th, 1886, p. 80.

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musical roar, and it will then be found that the jet has become discontinuous above the membrane.

I have shown this myself as a lecture experiment, and when the board to which the jet is attached was scratched with the finger, or when a watch was held in contact with the jet tube, the sounds produced were loud enough to be heard throughout a room containing several hundred people.

FIG. 1.—Instantaneous photograph of a water jet

FIG. 2.—Apparatus for showing the production of sound by communication of mechanical or acoustic vibrations to a jet.

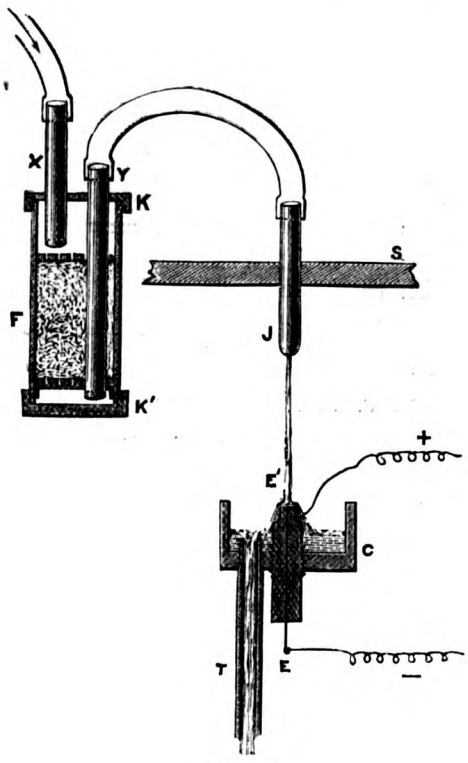

FIG. 3.

Experimental form of Jet Transmitter.—J, jet; S, sounding board; E E', ebonite plug and electrodes; C, ebonite cup; T waste tube; F, filter; K K', screw caps; X, supply tube; Y, exit tube.

The jet tube need not be in contact with the board for the latter experiment, but for the audible reproduction of sound it is necessary to have the tube rigidly attached to a board, to act as a sounding-board, but whether parallel or at right angles to it does not matter. If the jet is spoken or whistled to, it is visibly thrown into vibration, and when attached to a sounding-board the sounds are distinctly reproduced.

If the jet is allowed to fall upon a narrow vertical rod, as shown in Fig. 2, it spreads out into a nappe. Mr. Bell found that this nappe was capable of responding to vibrations in a similar way to the jet itself, and it is this property which is utilised in the construction of the water-jet transmitter.

The principle of the instrument consists in including the nappe of a jet of conducting liquid in a circuit traversed by a current from a battery, and containing an ordinary telephone. The nappe formed by the impact of a steady jet retains a constant diameter, but when thrown into vibration it undergoes periodic changes in diameter—and therefore also in resistance—which Mr. Bell considers to be due in part to the changes in diameter, and in part to changes in the contact resistance arising from the motions of the particles of liquid; so that the current passing through the circuit undergoes corresponding continuous variations in strength, as in other forms of telephonic transmitters. The simplest way of passing a current through it consists in allowing the jet to strike normally upon the exposed end of a platinum wire embedded in an insulator which is impervious to, and is unaffected by, the liquid employed, and surrounded by a platinum ring which comes in contact with the outer portion of the nappe.

The most suitable liquid consists of water acidulated with about $\frac{1}{300}$th of its volume of pure sulphuric acid. It is of special importance that this should be free from lead.

The battery must be of high E.M.F., but its resistance is of little consequence, owing to the high resistance of the transmitter. A battery of about twenty small zinc-carbon cells charged with a solution of sal ammoniac gives very good results with the liquid described, but the number of cells may be increased with advantage; not, however, to such an extent as to sensibly electrolyse the liquid, as the noise produced in the receiving telephone by the escape of gas bubbles would drown the sounds due to vibratory changes in the jet. The pressure required increases with the size of the jet, and with jets of the most suitable size a pressure of a little under three feet of water gives the best results. A simple experimental form of apparatus is shown in Fig. 3.

The jet-tube J is mounted in the sound-board S. The receiving surface is formed by the end E' of an ebonite plug. A platinum wire, E, passes water-tight up the plug, and its upper exposed surface forms the inner electrode of the transmitter. The outer electrode E' consists of a small tube of platinum foil concentric with the upper extremity of the wire E, and is insulated from it by the ebonite. After it has been fitted on, the top of the ebonite plug is turned off so as to present a smooth continuous surface, slightly convex. Fine platinum wires welded to E and E' serve to connect them with the terminals of the circuit. C is an ebonite cup which supports the plug and receives the waste water which escapes through the tube T. F is a filter, closed by screw caps K and K'. Through the upper cap pass two tubes X and Y, which are connected with the reservoir and jet respectively by means of *black* India-rubber tubing. Two perforated ebonite discs are fitted within the cylinder, and the space between them is lightly packed with coarse cotton, which has been freed from grease by soaking in a solution of caustic potash, and been thoroughly washed with dilute sulphuric acid and water. The filter is necessary to keep back particles of dirt which might stop the orifice, and also air-bubbles, the presence of which sets up vibrations and gives rise to a crackling sound in the receiving telephone.

I have made some experiments with an instrument of this kind, but with the jet tube pressed laterally against the sound-board, which was about a quarter of an inch thick, and was fixed in a vertical position. It reproduced with perfect distinctness the voice of a person speaking in the tone of ordinary conversation at a distance of 20 feet from the instrument, and when standing in a room with an open window it reproduced the sounds of a piano played in a room, also with a window open, at the opposite side of the street. On another occasion I succeeded in obtaining an exceptionally clear and pure reproduction of the voices of four boys singing in unison in a room

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in which the transmitter was placed. When an automatic Edison chalk-cylinder receiver, which had been kindly lent to me by the United Telephone Company, was used in place of an ordinary Bell telephone good results were also obtained.

This form of apparatus is, however, not suitable for practical work, as in addition to its requiring separate vessels to act as reservoir and to receive the waste liquor respectively, it requires careful adjustment whenever it is to be used.

A great many forms of apparatus have been devised for this purpose, and some of them are described in the specification of the patent which was taken out in 1886, and which covers the whole principle of the apparatus. It has been acquired, as far as the American rights are concerned, by the American Bell Telephone Company. It is only quite recently, however, that the inventor has succeeded in devising an apparatus which combines simplicity and certainty of action with durability.

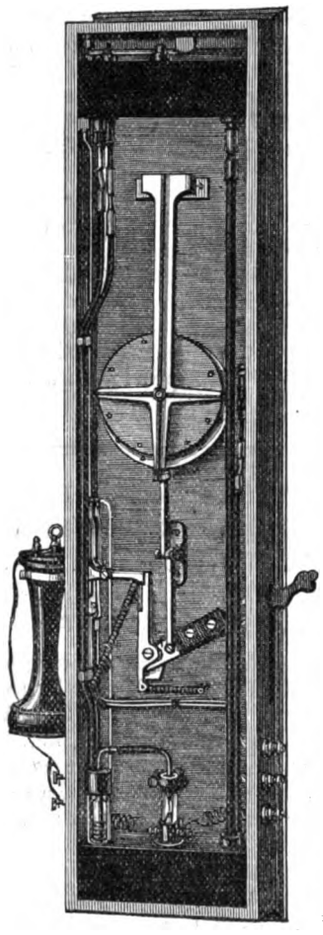

FIG. 4.

Practical form of Jet Transmitter

Fig. 4 shows the instrument with the front removed, and Fig. 5 shows the transmitter and filter on an enlarged scale.

The whole apparatus is enclosed in a case of teak or mahogany about three feet high, and is protected in front by a cover which opens on hinges, and is provided with a lock and key. There is a round aperture, protected by crossed copper wires, opposite the transmitting jet, and in using the instrument the mouth of the speaker is placed at a distance of a few inches from this aperture, as it is neither requisite nor desirable to have a jet as sensitive as that of the experimental apparatus previously described.

The electrodes in this instrument are formed of a platinum wire passing up the centre of a glass plug and a concentric ring of fine platinum wire, glass being used instead of ebonite, on account of its being found more durable. The jet and plug are contained in a glass tube attached to a wooden box resting on the bottom of the case, which receives the waste liquid. The glass plug is rigidly fixed in a vertical position, and the jet is centrally adjusted over it by means of the four screws shown at the upper and open end of the containing tube. The filter is seen on the left hand side of the jet, its exit tube has its extremity enlarged into a bell, which contains the cotton, and the fibres of this are prevented from passing into the narrow part of the tube by means of a piece of cotton material placed at the top of the bell. The reservoir consists of a second box, similar to the first, placed at the top of the instrument, and is filled by taking out a screw plug in the centre of its upper side and pouring the liquid in through a funnel.

The terminals of the receiving telephone are connected with the two left-hand binding screws, the lower one of which is connected to one electrode of the transmitter, and the upper one to a pair of springs which make contact with the lever from which the telephone is suspended, when the latter is removed and the supporting hook allowed to rise. The other electrode is connected with the lowermost of the three binding screws on the right, which is put to earth through the battery; the central right-hand binding screw is in permanent connection with the lever supporting the telephone, and with the line, while the uppermost one is connected through the call apparatus to the line, and also with a spring which makes contact with the telephone lever when the telephone is hung up.

To speak through the instrument the telephone is taken off, but the hook end of its supporting lever is prevented from rising by means of the vertical lever shown: The handle on the right-hand side of the case is now depressed, when a pin on its lower end draws back the vertical lever and allows the telephone hook to rise, placing the telephone in circuit with the line.

The telephone lever, in rising, pushes up a brass rod hinged to it, thus lifting the left-hand end of the lever above the reservoir, and opening a valve, which allows the fluid in the reservoir to flow down an ebonite tube on the left hand side into the filter. A second ebonite tube passes from the filter and opens into the top of the reservoir to allow air to escape immediately, if the filter has run partially dry from the instrument remaining unused for some time. The depression

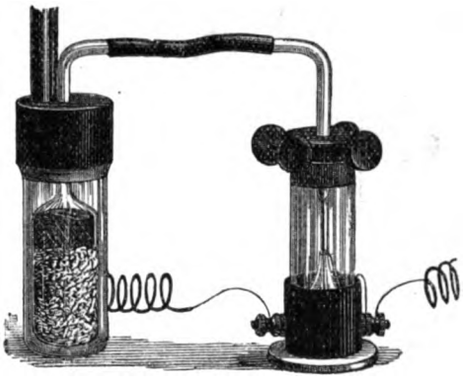

FIG. 5.

Jet and Filter of Practical Instrument

of the right-hand lever at the same time compresses an India-rubber bag, shown in the centre of the case, and drives air into the lower box through an ebonite tube seen on the right hand, which is provided at its upper end with a valve opening inwards, and forces liquid from the lower reservoir through the other ebonite tube on the right hand into the upper reservoir.

The amount of liquid pumped up by one depression of the lever is sufficient for about seven minutes' conversation; and as the average length of a conversation would in general be less than this, there will usually be enough liquid in the upper reservoir to allow of a longer conversation as often as it is likely to be wanted, without pumping up fresh liquid; which, however, does not interfere in any way with the conversation being carried on.

The object of the control lever, which keeps the telephone out of circuit until the right-hand lever is depressed, is to prevent users from forgetting to pump up a fresh supply each time.

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The instrument is chiefly valuable for use on trunk lines over long distances, as any leakage on the line can be compensated by using additional battery power, and very good results have been obtained with it on lines upwards of 100 miles in length, and passing through six or eight exchanges, and therefore subject to a considerable amount of leakage.

In general four Leclanché cells are sufficient.

The system of telephonic communication devised by Mr. Bell is intended especially for use with the water-jet, or any other form of high resistance transmitter that may be invented, and its principal advantage is that it does not require the use of any batteries except at the exchange.

With the transmitter now in use it is not practicable in the case of lines of any length to transmit speech by the direct action of the vibration of the transmitter in varying the resistance of the line-circuit, and therefore an induction apparatus is used, the transmitter being placed in the primary, and the line in the secondary circuit, and this involves the use of a battery at each sub-station.

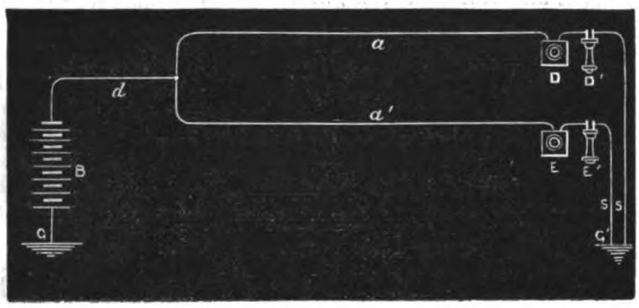

FIG. 6.

Diagram explanatory of Bell System of Telephonic Communication.—B, battery; *d*, connecting wire; *a a'*, line wires; D E, transmitters; D' E', receivers; S S, earth wires; G G earths.

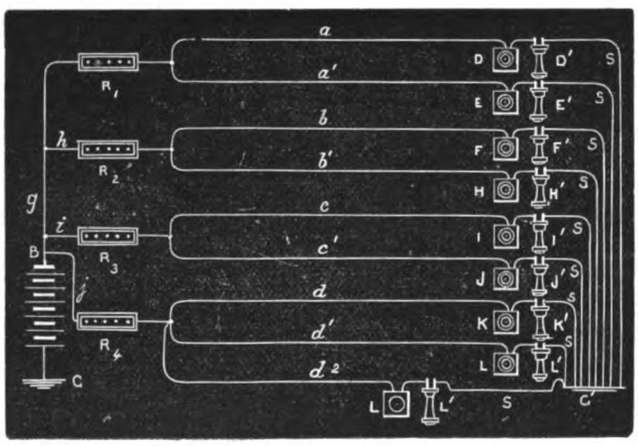

FIG. 7.

Bell system of telephonic communication. B battery, G G' earths, S earth wires *g h i j* connecting wires, R_1 R_2 R_3 R_4 resistances, *a a' b b' c c'* line wires connected in pairs, *d d' d*$_2$ three line wires connected in a group, D E F H I J K L transmitters, D' E' F' H' I' J' K' L' receivers.

Consider the arrangement shown in Fig. 6, which shows a battery, B, of high E.M.F. and low resistance put to earth at G, and connected with a line, *d*, which divides into two branches *a* and *a'*, which contain the transmitters D and E and the receivers D' and E', and are then put to earth at G' through the wires S S. Vibrations communicated to either transmitter will not be communicated to the receiver at the other station, because the earth connection through the battery forms a low-resistance shunt. If, however, a suitable resistance, R_1, is inserted in the branch *d*, as shown in Fig. 7, this will no longer be the case, and it is easy to make the resistance R_1 so large that practically the whole disturbance originated at D is transmitted to E', more cells being added to the battery, if necessary. The inventor has found experimentally that in the case of short lines (such as ordinary town lines) the resistance R_1 may be varied from about 2,000 to 8,000 ohms without appreciably affecting the action of the transmitter, supposing the jet transmitter to be used, the resistance of which is about 1,000 ohms.

In practice it is desirable to make the resistance R_1 adjustable, as it may then be varied as may be requisite to compensate for leakage in the lines due to hygrometric variations.

If the stations D and E were connected directly through a battery at the central station a battery of twice the E.M.F. would be required to give equally good results, as has been proved to be the case by experiment. Further, if the two stations are connected directly through the central battery, and the transmitters are of unequal resistance, the speaker at the low-resistance end will not be heard so well as the one at the high-resistance end; but this is not found to be the case when the connections are made as described.

A single battery can be used for all the subscribers to one exchange, if desired. Thus, Fig. 7 shows two additional pairs of subscribers using the transmitters F and H, and I and J connected through the resistances R_2 and R_3 and the wires *h* and *i* with the wire *g* from the battery to R_1, and it is found that each pair can carry on conversation without interfering with, or being overheard by, any of the others. The connection can, of course, be varied by means of a switch-board, as in the ordinary system.

Fig. 7 also shows a group of three transmitters connected through the lines *d*, *d*$_1$, and *d*$_2$, the resistance R_4 and the wire *j*, with the central battery. In this case a speaker at one transmitter, K, for example, will be heard in the receivers L L' at both of the other two stations.

At an ordinary telephone exchange a battery with an E.M.F. of 30 to 40 volts would be required, and it should have large plates. A battery of about 20 medium-sized secondary cells answers admirably; but any battery which does not run down on open circuit may be used, provided its resistance does not exceed a few ohms.

INFLUENCE OF THE CHEMICAL ENERGY OF ELECTROLYTES UPON THE MINIMUM POINT AND CHANGE OF POTENTIAL OF A VOLTAIC COUPLE IN WATER.*

BY DR. G. GORE, F.R.S.

By means of a zinc platinum voltaic couple in distilled water, with its electromotive force balanced by that of a suitable thermo-electric pile† (*Proc.* Birm. Phil. Soc., Vol. IV., p. 130), the effect of several groups of chemical substances upon the potential of the couple was examined. Measurements were made of the electromotive forces of a series of strengths of solution of each substance, and the results are given in a series of tables.

The minimum proportions of substance required to change the potential of the couple in water were as follows:—

Potassic iodate	between 1 in	433 and	494
,, bromate ...	between 1 in	344 and	384
,, chlorate ...	between 1 in	221 and	258
Potassic iodide	between 1 in	15,500 and	17,222
,, bromide.....	between 1 in	66,428 and	67,391
,, chloride.....	between 1 in	695,067 and	704,540
Iodine	between 1 in	3,100,000 and	3,521,970
Bromine	between 1 in	77,500,000 and	84,545,000
Chlorine	between 1 in	1,264,000,000 and	1,300,000,000

On comparing these numbers we find that the proportion of substance required to upset the voltaic balance was largest with the oxygen salts, intermediate with the haloid ones, and least with the free elementary halogens. It was smaller the greater the degree of chemical energy of the substance; thus it was about 400 times less with chlorine than with iodine. And it was smaller the greater the degree of freedom to exert that energy; thus it was about 5,416,000 times less with free chlorine than with potassic chlorate, or 1,570,000 times less than with the combined chlorine of the chlorate, and about 185 times smaller than with potassic chloride, or 88 times less than with the combined chlorine of that salt.

* Paper read before the Royal Society, June 14, 1888. Abstract.

† This instrument is manufactured by Messrs Nalder Brothers, Horseferry-road, Westminster.

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The order or curve of variation of potential by uniform increase of strength of the solution was different with each substance, and was apparently characteristic of the body in each case. A great number of such representative curves might be obtained with a zinc platinum or other voltaic couple in different electrolytes.

THE LONDON CHAMBER OF COMMERCE.

The following important circular has been issued by the London Chamber of Commerce :—

ELECTRICAL AND ALLIED TRADES SECTION.

Botolph House, 12, Eastcheap, London, E.C.,
24th July, 1888.

Dear Sir: It has been suggested that, with a view to the direct and effective representation in the London Chamber of Commerce of the Electrical and Allied Trades, a Section (or Committee) should be formed in connection with that body. In order that nothing should be done in this direction without the general concurrence of all concerned—whether members of the Chamber or not—you are invited to attend a preliminary meeting, at which the proposal will be considered, at the offices of the Chamber, as above, on Friday next, the 27th July, at 3 p.m. The fullest discussion is invited, and if it is considered desirable to form the Section, resolutions in that sense will be submitted, and its organisation proceeded with.

The special advantages of organising under the auspices of the Chamber of Commerce are, that the Chamber is already in possession of suitable premises and staff, under which the necessary work of the Section can be adequately performed; time will be spared to members in preparing bye-laws and other regulations of procedure; whilst no financial responsibility is involved beyond payment of the entrance fee and subscription to attain membership of the Chamber; nor is it necessary even for members, in case they are not satisfied with the management of the Committee, to continue their membership or subscription, as enrolment in the Chamber does not involve more than an annual subscription, which can always be terminated by a month's notice prior to the expiration of the current year. The formation of the Section in connection with the Chamber would in every way, therefore, be less costly and at the same time more effective than if it were attempted to form a separate Committee apart from the Chamber, which would have to rely upon its own resources.

The proposed Electrical and Allied Trade Section, if formed, would not interfere with the work of existing Associations, but would only deal with matters that are purely commercial. The Section, in fact, would be an integral part of the London Chamber of Commerce, a body composed of over 2,500 members engaged in almost every kind of trade and industry. No less than 18 Trade Sections, formed within the Chamber itself, are directly represented on the Council by their own delegates, in addition to 17 of the leading Mercantile Associations in London, and it is intended to give the same right to the remaining branches of commerce. It is, therefore, felt that so important an interest as that of the electrical and allied branches should not remain without direct representation, and this may be secured by the formation of an Electrical Trade Section, or Committee, whose chairman would possess a seat on the Council of the Chamber, to whom he would submit for confirmation all resolutions, reports, or recommendations adopted by the Section. Action would then be taken in the name of the Chamber itself.

Amongst the matters with which it is suggested that the Section might deal may be mentioned Bills before Parliament, Foreign Tariffs, Treaties of Commerce, Customs Classification, Arbitrations (for which the bye-laws of the Chamber provide), Business Extensions in India and the Colonies, Electric Lighting Legislation, Fire Insurance Rules, Telephone and Telegraphic Matters, &c., &c. On these and other subjects, the recommendations which the Section could make to the Council would be of special value, and the influence of the Chamber with the Government Departments, with Parliament, with Provincial and Colonial Chambers of Commerce, and public bodies generally, would greatly assist in carrying them out. It is also thought that professional, as distinct from commercial, men, would be brought—through the Section—into closer contact with the commercial community in regard to all matters where they have mutual interests.

At a meeting of those interested in Electric Lighting, held on Friday last, the gentlemen whose names on the other side are marked with an * joined the Chamber for the purpose of becoming members, and strengthening the representation of the proposed Section.

I am, Dear Sir,
Yours faithfully,
KENRIC B. MURRAY, Secretary.

LIST OF THOSE INTERESTED IN THE ELECTRICAL AND ALLIED TRADES WHO ARE ALREADY MEMBERS OF THE LONDON CHAMBER OF COMMERCE :—

ALABASTER (H.), GATEHOUSE & Co.
ALLEN, J. (F. Allen and Sons).
*ALLPRESS and BELSHAW.
ANDERSON BROS.
ANDERSON, J. H. (Anderson, Anderson and Anderson).
ANDERSON, SIR JAMES, Director Eastern Telegraph Company (Limited).
ANDREWS, W. S., Managing Director Indo-European Telegraph Company (Limited).
ANGLO-AMERICAN TELEGRAPH COMPANY (Limited).
ANGUS, GEO., and Co.
APPLEBY, C. J. (Appleby Bros., Limited).
BELDAM, A.
BEWICK and MOREING.
*BIGGS, C. H.
*BLACKBURN, A. B., Director Edison and Swan United Electric Light Company (Limited).
BINSWANGER, G. (G. Binswanger and Co.).
BOLLING, F. (Bolling and Lowe).
BRABY, F. (Fredk. Braby and Co., Limited).
BRAND, J., Chairman United Telephone Company (Limited).
BROOKE, C. B. (Phelps, James and Co.).
BROOKER, E. G. (Brooker, Dore and Co.).
BULLIVANT, W. M. (Bullivant and Co.).
BURROUGHS, S. M. (Burroughs, Wellcome and Co.).
BURT, J. H. (J. H. Burt and Co.).
CADIOT (E. H.) and ESPIR (F.).
CALLENDER and SONS.
CANNING, Sir SAMUEL.
CHURCHILL, J. D. (Durham, Churchill and Co.).
COOPER, Sir DANIEL, K.C.M.G., Chairman Electrical Power Storage Company (Limited).
COURTENAY, J. I., Managing Director Electrical Power Storage Company (Limited).
*CRAWFORD, Earl of, Chairman London Electrical Supply Corporation (Limited).
CROMPTON, R. E. (R. E. Crompton and Co.).
*DOWSING, H. J. (R. E. Crompton and Co.).
DAVIES, Capt. W. H., Managing Director Exchange Telegraph Company (Limited).
DENNIS, W. F. (W. F. Dennis and Co.).
DORE, S. L. (The Blackwall Galvanised Iron Company, Limited)
*DRAKE and GORHAM.
DRAPER, GEO., Secretary Eastern Telegraph Company (Limited).
DUNCAN, J. H. (J. H. Duncan and Co.).
EASTERN TELEGRAPH COMPANY (Limited).
*ERSKINE, R. S. (Kensington Court Electric Light Company, Limited).
EARLE, C. W., Chairman West India and Panama Telegraph Company (Limited).
ELLIS, B. P. (J. Aird and Sons).
FELL and WILDING.
*FELLS, J. M., Assistant Secretary and Accountant Anglo-American Brush Electric Light Corporation (Limited).
FIRTH, THOS. and SONS (Limited).
FRASER, G. C. (Fraser and Fraser).
GARCKE, EMIL, Manager and Secretary Anglo-American Brush Electric Corporation (Limited).
GRAY, ROBT. KAYE, Chairman Spanish National Submarine Telegraph Company (Limited).
GREWING, H., Chairman Telephone Company of Austria (Limited).
HAROLD, H. C. (Harold and Jenkins).
*HEAPHY, MUSGRAVE (Phœnix Fire Office, Limited).
HENLEY'S (W. T.) TELEGRAPH WORKS COMPANY (LIMITED).
HILL, PEARSON.
HODD, R., jun. (R. Hodd and Son).
HOGG, QUINTIN (Hogg, Curtis and Campbell).
HORNSBY, RD. & SONS (LIMITED).
*IMMISCH, MORITZ (Immisch and Co.)
INDO-EUROPEAN TELEGRAPH COMPANY (LIMITED).
JACKSON, Col. R. RAYNSFORD, Chairman National Telephone Company (Limited).
JOHNSON, J. G. (Johnson and Sons).
JOHNSON, MATTHEY and Co.
JONES, W. E. (Bayliss, Jones and Bayliss).
KIRK (WHEATLEY), PRICE and GOULTY.
*LAING, WHARTON and DOWN.
LOEFFLER, J. C. L., Chairman Siemens Brothers and Co. (Limited).
MACGREGOR, ALEX.
MANCHA, J. DE, Chairman Cuba Submarine Telegraph Company (Limited).
MAXIM, H. S.
MERRYWEATHER, J. C. (Merryweather and Sons).
*MORDEN, W. M. (Anglo-American Brush Electric Corporation, Limited).
*MOUNTAIN, M., General Manager Gülcher Electric Light Company.
ORIENTAL TELEPHONE COMPANY (Limited).
PENDER, Sir JOHN, Chairman Eastern Telegraph Company (Limited).
PREECE, W. H. (General Post Office).
*RAWORTH, JOHN S. (Anglo-American Brush Electric Light Company, Limited).
*REEVES, F. R. (R. E. Crompton and Co.).
*ROBINSON, MARK H. (Willans and Robinson).
*SNELL, W. H., *Electrician*.
*THOMPSON, A. (Thompson and Ritchie).
TRENCH, Col. the Hon. W. LE POER, R.E., Director Edison's Indian and Colonial Electric Company (Limited).
*TROTTER, A. P.
TWEEDDALE, The Marquis of (Eastern Submarine Telegraph Company, Limited).
TYRER, THOS. (May and Baker).
VOELCKER, Dr. AUG. and SONS.
VON GLEHN, ERNEST (Ragosine and Co.).
*WALLACE, ROGER (Kensington Court Electric Light Company, Limited).
WARNE, WM. and Co.
WATT, HUGH, M.P., Chairman Maxim-Weston Electric Company (Limited).
*WEBBER, Major-Gen. C. EDMUND, R.E., C.B.
WELLCOME, H. S. (Burroughs, Wellcome and Co.).
WILLIAMS, E. PASCOE (Merryweather and Sons).
WOODHOUSE and RAWSON.
WRIGHT, J., Secretary Maxim-Weston Electric Company (Limited).

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THE LIGHTING OF THE ADELPHI THEATRE.

The Adelphi Theatre, which was re-opened on the 19th inst., is now lighted throughout by electricity. The generating plant, which is sufficient for 4,000 incandescent lamps, has been supplied by the Edison and Swan Company, and is placed in a building below the street level at Bull Inn-court, adjacent to the theatre. The Adelaide Gallery, the Strand Restaurant, and other buildings are also to be supplied from the same source. It comprises three 156 horse-power Babcock and Wilcox safety-tube boilers, working at a pressure of 140lb. The machines are driven by four of Messrs. Willans and Robinson's double centre-valve compound high-speed engines, two of 75 indicated horse-power and two of 130 indicated horse-power. These engines are coupled direct to four Edison-Hopkinson dynamos, two for an output of 105 volts, 800 amperes, at about 425 revolutions, and two for an output of 105 volts, 475 amperes, at about 475 revolutions. The armatures are of the bar type, and the magnets are exceedingly massive, those of the larger machine weighing nearly six tons. The four sets stand on one solid mass of concrete 6ft. thick, and there is a very marked absence of noise and vibration.

It is anticipated that a very economical result will be obtained, and already at a preliminary trial at Messrs. Willans and Robinson's works, an electrical horse-power in the external circuit was obtained from 30lb. of steam per hour, and a return of 82 per cent. of the indicated horse-power. These results were obtained with comparatively wet steam, and as great precautions have been taken to supply dry steam, still better results should be obtained in practice.

The external circuits will be twelve in number, and two large distributing boards of slate, 6ft. 6in. by 4ft. 6in., have been provided. The connections take the form of large brass bars, which can be coupled by means of plugs, so as to make any number of combinations between the dynamos and circuits. In effecting changes sparking is avoided by shunting the plugs through a quick break switch. The dynamos all work on independent circuits, and one dynamo is always held in reserve, and whenever it has to relieve another already at work any dip in the lights is avoided by first of all bringing it up to full load on a resistance, and then exchanging loads between the two dynamos by the reversal of a commutating switch.

It is Messrs. Gatti's intention in the course of a few weeks to entirely dispense with the gas service throughout the theatre, so far as lighting is concerned. About 1,500 lights are required to light the bars, passages, refreshment rooms, auditorium and stage. The auditorium is lighted from the dome by means of eight 250 candle-power Edison-Swan lamps, which produce an excellent effect. Ornamental three-light brackets are suspended round the tiers, and single lights are fixed in the pit, gallery, and boxes. Duplicate circuits have been provided throughout, and great precautions have been taken with a view to secure absolute safety from fire or possible extinction of the light. The lamps for the floats, footlights, and battens are provided with collars of a special form, each carrying its own cut-out, and having extended terminals making contact directly with the main wires, which are completely enclosed in a slate casing, and on which also the lamp sockets are mounted. Proximity of any combustible insulating material to parts developing heat is thereby entirely avoided. All the other conductors about the stage are enclosed in wood casing. They are strongly insulated with india-rubber, and further protected by a sheathing of asbestos tube, and in all places where there is any liability to injury by violence or by nails being driven through the casing a lining of sheet iron is provided.

Lamps of high candle-power have been introduced in the construction of the variable resistances required for scenic effects.

The whole of the work has been carried out under the superintendence of Mr. Blackburn, Assoc. M.I.C.E., resident engineer to the Edison and Swan United Electric Light Company, to whom great credit is due for the excellence of the arrangements in every part of the installation. It may be added that the work was begun and finished within a period of eleven weeks.

DUBLIN CORPORATION AND THE ELECTRIC LIGHT.

A special meeting of the Dublin Corporation was held on Tuesday last for the purpose of considering and taking action on the following letter of the Board of Trade :—

"GENTLEMEN : With reference to the meeting which took place at this office on the 3rd inst. between the representatives of the Corporation of Dublin and of the Alliance and Dublin Gas Company on the subject of the above-mentioned matter, I am directed by the Board of Trade to inform you that, after a careful consideration of the view expressed by both parties, they propose to proceed with the consideration of the license, subject to the following remarks :—As in deference to the wishes of the Gas Company the Corporation have agreed to a limit of time being fixed within which the contemplated works should be completed, the Board of Trade will not object to the proposed limit of two years and six months being inserted in the license. They are also prepared, as power is sought to supply electricity for public purposes only, to omit the power of transfer now contained in the draft license as agreed to by the Corporation. The question of compensation to the Gas Company for public lighting plant thrown out of use by the introduction of electricity is a matter with which the Board of Trade are of opinion they have no power to deal in a license, and they are therefore unable to insert any provisions for this purpose. With regard to the remaining question in dispute—viz., the area of supply, the Board of Trade do not consider that the reasons advanced by the Gas Company are sufficient to justify this department in restricting the powers sought by the Corporation, for lighting the public streets with electricity, to streets specially named. I am to add that upon hearing that the Corporation agree to the above proposals, the Board of Trade will at once refer the draft license to counsel to settle, and will forward a copy to the Corporation for their observations before it is finally issued.—I am, gentlemen, your obedient servant, "COURTENAY BOYLE."

Mr. ROBINSON said the resolution he had to propose was :—

"*That the conditions contained in the letter of the Board of Trade of July 10th be accepted, and that they be requested to issue a license in accordance with the conditions contained therein. But, so far as the completing of the installation at present contemplated within two and a-half years, the Council desires that the clause of the license should be so framed as to leave it open to the Council to make subsequently such further extensions of this system within the city as the Council may from time consider advantageous.*"

Mr. MAYNE, M.P., objected to a limit of time, as it would involve them in difficulties. They had undertaken to do the electric lighting within two and a-half years, but they did not know what would be necessary to complete it (hear, hear), and he thought the Council should strike against the word "complete."

Mr. DENNEHY said although the Corporation had power to undertake electric lighting, there were difficulties in the way which it would be well for the Council to consider. If it turned out that they were losing £2,000 a year by this electric lighting, each member would be personally liable for it ; and they should also remember that what cost £16,000 to Mr. Mayne and his fellow directors of the late Electric Lighting Company was sold for £3,000.

Mr. HEALY said Mr. Dennehy might make his mind perfectly at ease as regarded financial loss. Nearly every town in America was using the electric light, and in a great many towns in England, and everywhere it was a success, both as an illuminant and financially. There would be no rivalry between the electric light and gas if the gas being supplied to the city went on as it was doing now, increasing in heat and not decreasing in illuminating power ; because it would eventually become invaluable for cooking purposes and everything else.

Alderman DILLON suggested that steps should be taken to have this license extended so as to include private lighting. Some of the residents in Merrion-square had set up installations for private electric lighting.

Mr. MAYNE said it was not in consequence of any financial loss that the Electric Lighting Company had to be wound up. They had made as much profit on their winter lighting as to make up for any loss during the summer. For every sixpence worth of plant that the Company owned they had full business, and they found they should purchase more lamps and additional machines. That stage in their existence happened to arrive at a most unfortunate time, when the possibility of electric lighting had brought a lot of scheming financiers into the electric lighting market, who were swindling the public wholesale ; the house of cards fell down, and people found themselves robbed of enormous sums of money, and nobody would touch electric lighting shares. When this collapse was in full swing they pressed their shareholders for a call, but the shareholders were so frightened that they insisted on winding up the Company, which was the only honest electric lighting company that had been established in the three kingdoms, established for purely commercial purposes, and not for stock-jobbing. Their shareholders were bitterly sorry ever since.

Mr. ROBINSON said that Councillor Dennehy would not be Councillor Dennehy if he did not consistently oppose every reform attempted in the Corporation. The times were progressing, but Councillor Dennehy was not progressing with the times. He begged to move the adoption of an addition to the resolution :—

"*And so far as the completing of the installation at present contemplated within two and a half years, the Council desires that the clause of the license should be so framed as to leave it open to the Council to make subsequently such further extension of this system in the streets as from time to time they may consider advantageous.*"

They had thought that by limiting their application for public purposes it would meet with no opposition from the Gas Company. They thought that at least the Gas Company would recognise the right of the Corporation to light their own streets, yet they have thrown every obstacle in the way by lodging a petition with the Board of Trade, and by opposing it in the Council by their spokesman, Councillor Dennehy. Under these circumstances he thought they were under no obligation to the Gas Company, and Mr. Boyle had stated that taking this license would not prevent them from going for a provisional order in November for private lighting.

After a somewhat noisy scene, provoked by Mr. Dennehy, the resolution was put and carried unanimously.

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CONDUCTIVITY AND THE ATOMIC THEORY.

BY W. P. GRANVILLE.

In the year 1863 Prof. Newlands pointed out that many of the physical and mechanical properties of the elements were intimately connected with their atomic weights, and since that time Meyer, Mendelejeff, Crookes, Carnelly, and others have so elaborated this conception that the "periodic law," as it is termed, is now fully established. This law states that "the properties of the elements are a periodic function of their atomic weights"—that is to say, that if the elements are arranged according to the increasing value of their atomic weights their properties are found to be gradually modified as these values increase. This gradual modification is, however, not continuous from the first of the series to the last, but proceeds in alternations or periods having points of maximum and minimum value.

My object in writing this Paper is to discuss in the light of the Atomic Theory the phenomenon of electrical conducl tivity, endeavouring to show that the conductivity of a metadepends chiefly upon the relative number of molecules it contains in unit mass; for, if conduction be the result of some state of induction or polarisation carried on continuously from atom to atom, we can readily see why the metal with the greatest number of molecules per unit mass should have the highest conductivity, because the strength of such an action between two or more bodies depends upon their proximity.

—	Metal.	Atomic Weight.		Specific Gravity.		Relative No. of atoms. A	Specific conductivity at 0° C.		Remarks.
		Value.	Authority.	Value.	Authority.		Value. B	Authority.	
Monads	Silver	107·66	Stass	10·468	Holzmann	97	657,460	Matthiessen	Annealed
	Lithium	7·01	,,	·594	Bunsen	85	...	...	...
	Thallium	203·65	Crookes	11·8	Crookes	58	55,391	Matthiessen	...
	Sodium	22·99	Stass	·974	Baumhauer	42	Sodium higher	Meyer	...
	Potassium	39·04	,,	·865	Gay Lussac	22	than potassium	,,	...
Dyads	Beryllium.	9·2	Nilson and Pettersson	2·1	.....	228	...	..	...
	Copper	63·17	Hampe	8·952	Schröder	142	618,810	Matthiessen	Annealed
	Zinc	64·90	Erdmann	6·915	Karsten	107	175,780	,,	Pressed
	Cadmium	111·6	Hauer	8·655	Matthiessen	78	143,630	,,	...
	Magnesium	23·98	Scheerer and Marchand	1·743	Bunsen	73	220,920	..	...
	Mercury	199·8	Erdmann and Marchand	13·596	Kopp	68	10,026	Matthiessen	...
	Lead	206·4	Stass	11·367	Karsten	55	50,378	,,	Pressed
	Calcium	39·9	Erdmann and Marchand	1·578	Bunsen	39	...	...	...
	Strontium.	87·2	Marignac	2·54	.....	29	⅓rd of calcium	Matthiessen	...
Triads	Gold	196·69	Berzelius	19 265	Matthiessen	98	480,540	Matthiessen	Annealed
	Aluminium	27·40	Tissier and Dumas	2·67	Wöhler	97	339,550	,,	,,
	Indium	113·47	Bunsen	7·295	Erhard	64	112,400	Erhard	Pressed
	Antimony.	122·	Dexter	6·713	Matthiessen	55	27,855	Matthiessen	,,
	Bismuth	210·	Dumas	9·823	Holzmann	47	7.536	,,	,,
Tetrads	Platinum	197·4	Seubert	21·5	Deville and Debray.	109	109,200	Matthiessen	Annealed
	Tin	117·86	Vlaanderin	7·294	Matthiessen	62	74,850	,,	Pressed

Perhaps the first thing to attract the attention of a student of modern chemistry is the great variation in the atomic weights of the different metals, varying, as they do, from 7 in lithium to 210 in bismuth. At first one would imagine that the metal with the greatest weight per atom would also have the highest specific gravity. But this by no means follows; an atom of cadmium, for instance, has nearly double the weight of an atom of copper, yet, bulk for bulk, copper is the heavier of the two metals. The interpretation of this must be that a mass of copper contains a greater number of atoms than a mass of cadmium—in other words, has greater atomic density. If this be so, we can readily obtain the comparative number of atoms per unit volume by simply dividing the specific gravity by the atomic weight.

The atomic theory divides all the elements into distinct groups, according to their "valency," the theory being that with certain of the elements, such as silver, thallium, potassium, sodium, &c., the atomic construction is simple. These are classed as monads, whilst in other metals, grouped as dyads, triads, and tetrads, the atoms are linked together in twos, threes, and fours, to form molecules, each molecule forming a united whole, or system, having a common centre of action.

In the following table I have grouped according to their valency those metals whose conductivities have been ascertained, and, amongst other data, have added a column showing the relative number of atoms per unit volume, calculated, as before explained, by dividing the specific gravity by the atomic weight, and then, so as to avoid fractions, multiplying by 1,000. The specific conductivity given is the reciprocal of the resistance of one cubic centimetre. By comparing columns A and B, it will be seen that in a remarkable degree (as far as our knowledge extends) electrical conductivity varies according to molecular density, the only variation from this law being with magnesium and mercury, and the conductivity of the latter is greatly affected by its fluidity, for, according to experiments by Cailletet, Bouty and also by C. L. Weber, the conductivity at the point of solidification is increased in the ratio of 4·02 to 1, and whereas in the liquid state the temperature coefficient is very small, they found that in the solid state mercury has the same temperature coefficient as the other metals.

I have purposely omitted from the above list those metals which are strongly para-magnetic, as they seem to form a class by themselves, having approximately the same specific gravity, atomic weight, atomic density, and conductivity. By comparing their atomic densities with those in the foregoing table, it will be seen that the actual conductivity is less than might have been expected. May not a possible reason be that extra work is done by the current, because the phenomenon of magnetism is produced as well as that of conductivity?

	Atomic weight.	Specific gravity.	Relative No. of atoms.	Specific conductivity.
Iron	56·02	7·84	140	101,780
Nickel	58·59	8·9	152	79,365
Cobalt	58·6	8·6	147	106,140

In Table I. I have inserted the dyad metal beryllium because its relative number of atoms greatly exceed that of any other metal, and it would therefore be very interesting to ascertain by actual experiment if its conductivity is proportionally high. Perhaps the extreme smallness of its atomic weight may in a great measure compensate for the large number of the atoms, for lithium, which has the smallest atomic weight of any of the metals, is reported to have a very low conductivity, but on whose authority I do not know.

No doubt the conductivities that have been ascertained are only very approximate, for even with copper, a metal very

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readily prepared in a pure state, the *absolute* conductivity is open to much doubt, for, as is well known, copper can be now obtained having a higher conductivity than Matthiessen's standard for the pure metal. We can, therefore, well understand that with many of the rarer metals, and particularly those less easily isolated and more readily oxidisable, great errors may arise, as a mere trace of a foreign substance materially affects the result.

SOUTH KENSINGTON.

EXAMINATIONS OF THE SCIENCE AND ART DEPARTMENT.

(Continued from Vol. XX., page 192.)

Honours Examination.

Full marks can only be got by answering all the questions.

41. Describe the apparatus and operations necessary for the determination of the mechanical equivalent of heat by means of observations on the heat developed in a wire when an electric current is passed through it.

Answer. A convenient form of apparatus for making this determination is shown diagrammatically in Fig. 30.

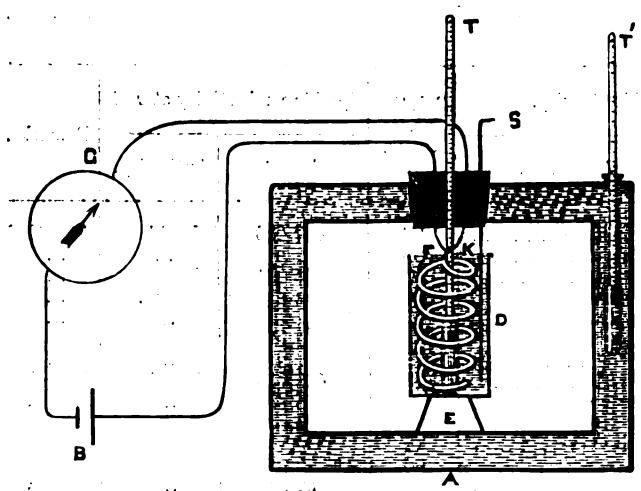

FIG. 30.

B is a battery capable of sending a sensibly constant current through the circuit for a considerable time. Joule found in his experiments that there was no difficulty in maintaining a sensibly constant current for an hour or more. The strength of the current is measured in absolute units by means of the tangent galvanometer G, and when great accuracy is required the value of H, the horizontal component of the earth's magnetism at the position occupied by the tangent galvanometer, should be determined at the time of each experiment. The determination of H may of course be avoided by using some form of electro-dynamometer instead of a tangent galvanometer. Thick copper conducting wires lead from the battery and galvanometer to the ends of a long fine wire of some highly resisting material, such as german silver or platinum, doubled upon itself and rolled into a spiral, the connections being made at F and K by soldering. The spiral is contained in a calorimeter, D, of copper or brass, containing distilled water, and resting on a glass tripod, E, within a metal vessel, A, with double walls, in the space between which a stream of water is allowed to circulate slowly in order to maintain it at a constant temperature. This vessel is closed at the top by means of a cork, through which pass the conducting wires. A stirrer, S, is used to ensure that the whole of the water in the calorimeter should be at the same temperature at the time of an observation, and a thermometer, T, by which the temperature of the calorimeter can be ascertained. The vessel A serves to protect the calorimeter from external sources of heat, and thus ensure a uniform condition in the surrounding temperature throughout an experiment. The constancy of the temperature of the water circulating through A is tested by means of the thermometer T^1.

When a determination is to be made the circuit is closed, and as soon as the current becomes steady a series of readings of the thermometer T are taken at equal small intervals of time, say every four minutes for example, the water in the calometer being stirred in the intervals between the readings, and observations of G and T^1 being made at intervals in order to be certain that both the current and the temperature of A remain constant during the experiment. When the current is turned off readings of T should continue to be taken at the same equal intervals of time, counting from the moment of breaking contact, and these observations should be continued for a time equal to that occupied by the former portion of the experiment, the same precautions being taken to maintain the water in the vessel A at a constant temperature. The last series of observations enables us to determine the loss of heat by radiation, and therefore the corrected temperature readings, namely, the readings which would be obtained if there were no loss by radiation.

Adding the water equivalent of the calorimeter to the mass of water contained in it, and multiplying the sum by the corrected increase of temperature, we obtain the amount H of heat given to the calorimeter during an interval of time t. If C be the strength of the current in absolute units, J the value of the mechanical equivalent of heat, R the resistance of the spiral in absolute units, we have to determine J, the equation

$$J H = C^2 R t,$$

in which, of course, the value given to H must be the mean value obtained from the observations.

42. How would you determine the value of an unknown resistance if you were supplied with a battery, a Thomson's quadrant electrometer, and any wires, keys, or resistance boxes you might require? If the electrometer were not fitted with a replenisher and gauge, how would you guard against errors due to a loss of charge by the electrometer during the experiment.

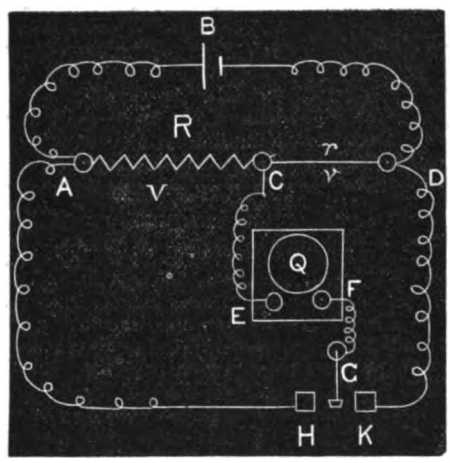

FIG. 31.

Answer. Let r (Fig. 31) be the resistance to be measured, R a resistance box, B the battery. Join up R and r in series with the battery. Let C be the common terminal of R and r, A and D the remaining terminals. Join one terminal E of the quadrant-electrometer Q with C, and the other terminal F to one of the binding screws G of a key. Let the key have two other binding screws, H and K, joined to A and D respectively, and be capable of putting G in connection with either H or K.

First measure v the potential difference between C and D, and then V the potential difference between A and C. Adjust R so that V is nearly equal to v, then R will be nearly equal to r. Then measure the ratio of v to V, which will give that of r to R, for since the current through R and r is the same we must have

$$\frac{r}{R} = \frac{v}{V}.$$

In order to eliminate the effect of a gradual loss of the charge of the electrometer, a series of measurements should be made of v and V alternately, and the mean values taken for substitution in the above equation.

43. Explain exactly how you would determine experimentally in absolute measure the electromotive force of a constant cell.

Answer. Assuming that we have not at our disposal any cells of known E.M.F., in which case we could measure the E.M.F. of the given cell by balancing it against a measured fraction of the E.M.F. of the standard battery, the simplest method depends on the fact that if a known current, C, traverses a known resistance, R, the potential difference E between the terminals of R is given by the equation $E = C R$.

The arrangement is shown in Fig. 32.

R is a variable resistance, P and Q its terminals. B is the given

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constant cell, B′ a stronger constant battery, G a reflecting galvanometer, T a tangent galvanometer or electro-dynamometer, by which the strength of the current is measured in absolute units, K and H are keys.

The resistance R is adjusted so that when the key K is depressed while the current through B′ is flowing through R, there is no deflection in the galvanometer G.

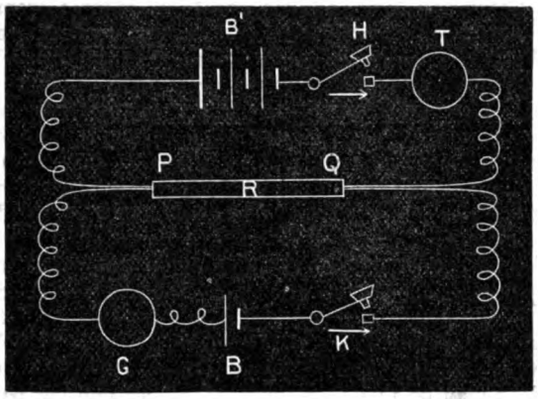

FIG. 32.

If R is measured in ohms and C in amperes, the product will then give the E.M.F. of B in volts.

44. Two metal balls, supported by insulating stems at a small fixed distance apart, are electrified so as to attract each other with force f. If now the balls are immersed in bisulphide of carbon (specific inductive capacity = 2), show what force they will exert on each other :—

(1.) If their respective charges remain the same as when they were surrounded by air.

(2.) If the difference of their potentials is the same as when they were in air.

Answer. Let e and e' be the charges of the same ball in media of specific inductive capacities K and K′. Let V and V′ be the potentials at a distance r from this ball, due to the charges e and e'.

Let f and f' be the forces between the balls in the two cases, and let W and W′ be the values of the total electrical energy of the system of two balls.

Then we have $$V = \frac{e}{K}, \quad V' = \frac{e'}{K'}.$$

Let the ball have equal displacements in the two cases, then the amounts of work done will be in the ratio $f : f'$. But the total electrical energy is the sum of the products of each charge into the potential of the charged body, so that

$$\frac{W}{W'} = \frac{e\,V}{e'\,V'}.$$

But the difference of energy after equal displacements will be in the same ratio, so that

$$\frac{f}{f'} = \frac{e\,V}{e'\,V'}.$$

Hence by substitution we have

$$\frac{f}{f'} = \frac{\frac{e^2}{K}}{\frac{e'^2}{K'}} = \frac{e^2\,K'}{e'^2\,K},$$

or

$$\frac{f}{f'} = \frac{V^2\,K}{V'^2\,K'}.$$

In the case considered in the question K = 1 and K′ = 2, so that when the charges remain the same $f' = \frac{1}{2}f$, and when the potential difference remains the same $f' = 2f$.

45. In an experiment for the determination of the capacity of a condenser by the ballistic-galvanometer method connections were made as follows : The current from a battery of Leclanché cells was allowed to pass continuously through a set of coils of total resistance 11,000 ohms. Then (Fig. 33) the condenser (C) to be measured was charged by joining its coatings one to each of two points in the circuit separated by an intervening resistance of 3,000 ohms ; after which it was discharged through the ballistic galvanometer (G), and the throw was read by the motion of a spot of light on a straight graduated scale ; mean reading, 64·2 scale divisions.

Next (Fig. 34) the condenser was removed, and the galvanometer was joined in multiple arc with a coil of 200 ohms forming part of the battery-circuit, the resistance of the galvanometer-branch being made up to 20,123 ohms. The galvanometer thus showed a permanent deflection of 58·44 scale-divisions.

Time of one complete vibration of galvanometer-needle = 8·452 sec.

Determination of Damping.—The galvanometer-needle having been set vibrating, the first elongation observed was 104 scale-divisions, and the twenty-fourth elongation was 45·5 scale-divisions.

$$\frac{1}{23}\cdot\log\frac{104}{45\cdot5} = \log 1\cdot0366.$$

Distance from galvanometer-mirror to centre of scale = 85·75 cm. 300 scale-divisions = 19·04 cm.

The deflections are so small that they may be identified with their *sines* or *tangents* without sensible error.

Calculate, from the above data, the capacity of the condenser.

Answer.—Let E be the potential difference between the terminals of the condenser = $\frac{3}{11}$ of the E.M.F. of the battery.

Let C be the capacity of the condenser, K the reduction factor of the galvanometer (K = H/G in Maxwell's notation), θ the throw of the needle, T the time of a complete oscillation of the needle, λ the logarithmic decrement, ρ the ratio of damping, Q the charge communicated to the condenser.

We have then

$$C = \frac{Q}{E} = \frac{T\,(1+\frac{1}{2}\lambda)\sin\frac{1}{2}\theta}{\pi\,E}$$

Now $1/n$ of the current will pass through the galvanometer, where n is determined by the equation

$$\frac{200}{20123} = \frac{1}{n-1},$$

which gives $n = 102\cdot125$.

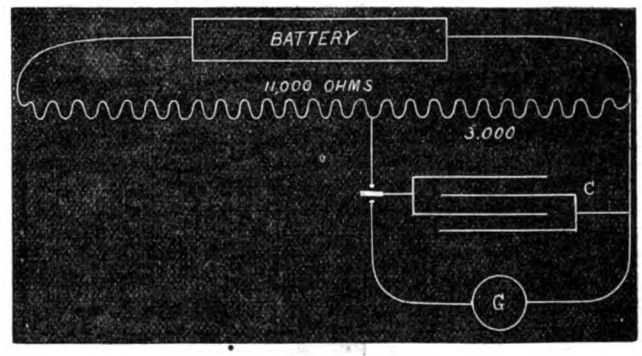

FIG. 33.

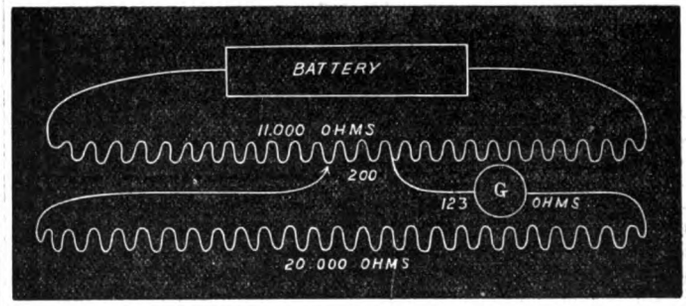

FIG. 34.

Let i be the strength of the current through the principal circuit, ϕ the steady deflection of the galvanometer.

Let r be the resistance between the extremities of the shunt circuit, then we have

$$\frac{1}{200} + \frac{1}{20123} = \frac{1}{r},$$

which gives $r = 197\cdot062$ ohms. Now the battery resistance may be neglected in comparison with that of the rest of the circuit, so that if R be the total resistance of the circuit traversed by the current i we have

$$R = 10800 \text{ ohms} + 197\cdot062 \text{ ohms} = 10997\cdot062 \text{ ohms}.$$

Now we have

$$\frac{\frac{11}{3}E}{R} = i = n\,k\tan\phi.$$

Thus we obtain

$$C = \frac{11}{3}\cdot\frac{K\,T\,(1+\frac{1}{2}\lambda)\sin\frac{1}{2}\theta}{\pi\,R\,n\,K\tan\phi}.$$

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As the angles are small enough to be identified with the sines or tangents, this expression contains only the ratio of two angles, and therefore the scale deflections may be written instead of the angles.

Again $\lambda = \log \rho$, or $\rho = e^{\lambda} = 1 + \lambda$ approximately,

so that $\frac{1}{2}\lambda = \frac{\rho - 1}{2} = \cdot 0183$ and $1 + \frac{1}{2}\lambda = 1 \cdot 0183$.

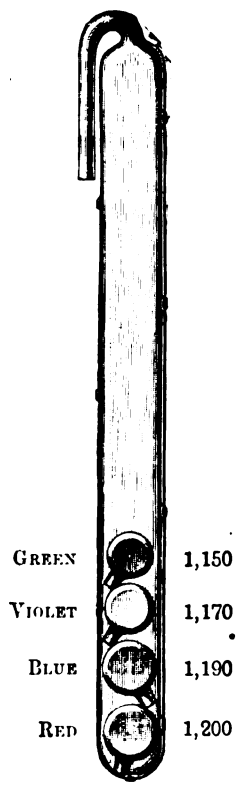
Thus we obtain finally

$$C = \frac{8 \cdot 452 \times 1 \cdot 0183 \times 32 \cdot 1 \times 11}{3 \cdot 1416 \times 102 \cdot 125 \times 10997 \cdot 062 \times 58 \cdot 44 \times 3} \text{ farads}$$

$$= \cdot 0000049127 \text{ farads} = 4 \cdot 9127 \text{ microfarads.}$$

THE HICKS GLASS-BEAD HYDROMETER.

The accompanying figure shows a new pattern hydrometer which has recently been brought out by Mr. J. Hicks (of 8, 9, and 10, Hatton-garden, E.C.), and which will be found to be well adapted for the



rapid testing of accumulator cells. Only a few words of description are needed. The hydrometer as seen in the figure consists of a glass tube pierced at the bottom and on the sides by several holes to admit the free access of the liquid. Within the tube are four small specific gravity bulbs of different colours, placed one above the other, and capable of freely rising and falling in the tube, which they nearly fit. The top bulb, which is coloured green, will float when the specific gravity reaches 1,150, the violet at 1,170, the blue at 1,190, and the red at 1,200. These figures are clearly marked on the back of the tube. Any ordinary workman can be entrusted with the use of this instrument where the reading of a scale might lead to errors.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *July 14th*, 1888.

There has been a great deal of talk in the papers during the past week or two as to the probability of a strike among the telegraph operators. The rumours are not confined to one city in particular, but appear to be afloat in Chicago and Philadelphia, as well as in New York and Boston. One of the prime movers in the agitation is said to be Mr. T. O'Reilly, a bright active man, and a leading spirit of the telegraphers' brotherhood. Mr. O'Reilly is said to enjoy the intimacy of Mr. Powderly, who is at the head of the vast organisation known as the Knights of Labour, with which the telegraphers' brotherhood is affiliated; and, undoubtedly, Mr. Powderly derived much of the material for his campaign in favour of Government telegraphs from Mr. O'Reilly himself. In some quarters it is thought that the present year will be a good one for the strike, from the fact that the Presidential fight, as it warms up, will require constant telegraphic service, and thus render the telegraph companies unwilling to run a risk in any way of losing the large addition to their income from this source. It has been noticed, too, that whenever there is a big strike the Western Union Company forfeits its dividends, and it is held that the company rather than go on doing this would make at least a temporary concession. On the whole the likelihood of a strike does not seem very great. It is true that the salaries of the operators for some time past have had a downward tendency; but the explanation of this is to be found in the fact that the ranks of the operators are overcrowded, and so long as there are large numbers outside the offices waiting for positions, it is not likely that those inside who have reasonable hopes of permanency are likely to chance losing everything. There is a probability that we shall see some agitation on the subject this summer, when the operators will probably try to secure shorter hours at better pay. It is possible that concessions may be made on both sides, as neither party is wishful to repeat the experience of five years ago.

In surveying the present situation in New York with regard to placing the arc light wires underground, one involuntarily ejaculates "Here's a state of things, here's a pretty how d'you do!" The controversy, so far from dying out, has become embittered, and now promises serious trouble. It will be remembered that the Board of Electrical Control forbade the contumacious United States Company to operate certain of its wires. Not satisfied with that, it has now joined hands with the Board of Aldermen in an effort to shut up the company altogether. It is alleged that the original franchise granted to the company did not contemplate overhead wires at all, but merely the laying of the wires underground in tubes. The Board of Electrical Control has further called the attention of the Attorney-General to the points in question, and has requested him to bring a suit to dissolve the United States Company on the ground of its unauthorised construction of its franchise. This means a fight if anything does, as the company will certainly resist such an attack to the bitter end, with all the influence and capital that it can bring to bear. In the meantime the Board has been adopting certain regulations on the advice of its expert, Mr. Wheeler, which will certainly tend to render the operation of overhead wires less dangerous. One of the rules provides that all circuits carrying a current exceeding 500 volts, between 9 a.m. and 4 p.m., must be painted red for a length of two feet at each insulator; and another rule provides that every electric light wire carried on poles shall be indicated by a number plainly marked on each cross arm under the insulator. It is also provided that every circuit must be tested at least once an hour when in operation. The Board has further adopted a form of notice to be affixed to poles, fixtures, &c., which contravene the regulations, giving warning that if they are not made to meet and conform to the rules immediately, the Department of Public Works will be requested to remove them.

In a recent letter I referred to the fact that considerable interest was being taken in the graphophone, and that the instrument, which was being brought forward quite prominently, was found to be very simple and efficient. Further information on the subject is now being contributed by Mr. Charles Sumner Tainter, in an elaborately illustrated article which is published this week by the *Electrical World*. It would appear from Mr. Tainter's statement that the credit of the development of the graphophone is largely his, and that the "improved" phonograph, as it is called, owes its better results in no inconsiderable degree to the adoption of improvements which belong specifically to the graphophone. Mr. Tainter claims, in fact, that at least twenty of the broad claims of the patents on the graphophone are infringed in the phonograph. The great and distinctive feature of the graphophone is that its record is cut or engraved in wax; whereas in the phonograph as brought out by Mr. Edison some ten years ago, and practically un-

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changed until within the last few months, the record is made by punching or indenting on a sheet of tin foil. While the record engraved on the wax is not susceptible of any change, the indenting method is open to grave criticism, on the ground that each new puncture made by the travelling stylus alters the shape of the one immediately preceding, so that the whole record from beginning to end is inevitably distorted. Mr. Tainter's work dates back to 1885, and his article makes reference to exhibitions of the machine as early as the fore part of 1886. He states that graphophones are now being used in both Houses of Congress at Washington, by the official stenographers as well as by members who dictate their correspondence. One of the machines was recently used in this city by an official stenographer attached to a special commission of inquiry, who immediately after each day's proceedings dictated his notes to the machine, and then left the waxen cylinders for his amanuensis to transcribe for him at leisure next day. It is, I suppose, from the fact that Mr. Tainter's claims to some of the most valuable improvements are justified that we owe the combination which has just been effected here between the phonograph and graphophone interests. It is said that the machines will be placed on the market in a couple of months, when I venture to predict that there will be a big rush for them, as one of the greatest curiosities, as well as one of the most remarkable time and labour-saving devices, of the age.

A great many electrical engineers are deeply interested in the news which reaches us from England as to the intention to make a start in the use of electric motors on the Underground Railway in London. It is believed that the change will effect an enormous improvement in the condition of the road and in the general efficiency of the service; but I hear a great many doubts expressed as to the advisability of adopting storage batteries for such a piece of work, and these doubts are expressed, too, by men who have the firmest belief in the general availability of the storage battery for such work. The great recommendation of the storage battery in connection with electromotive purposes has been that there were very objectionable features in the use of overhead wires or conduit conductors for city traffic, whereas each storage car was a self-contained unit, and did not depend on any external assistance; but in the case of the underground road, American engineers say, there is not the slightest reason why the overhead conductor or the third rail should not be used, and opinion here is generally in favour of the overhead conductor, which would be out of the reach of everybody on such a road, which, it is presumed, could be very effectually insulated. We shall watch this work with great interest, hoping that no irremediable mistake may be made, and that perhaps American electrical engineers may have a chance to lend a hand.

A new electric motor which has been introduced to public notice this week is that of Dr. O. Lugo, who utilises in his machine the maximum effects found in placing moving solenoids in proximity to fixed solenoids, in such a relation that as the armature coils move, the maximum number of lines of magnetic force is cut in the passage of each armature coil past each field coil, these effects being made successively, so that there is a continued application of them. In the motor brought out there are four similar bobbins attached to the shaft of the motor. The revolving armature coils are connected to the commutator fixed to the shaft, upon which bears a stationary brush; while the other side of the armature shaft carries a revolving brush, which bears against a fixed commutator, to which the ends of the field coils are connected. From this arrangement it appears that in every revolution of the armature shaft each armature coil is placed in circuit with each field coil, and there being four of one and five of the other, it follows that there are twenty successive pulls at as many radial positions of the shaft, each pair of coils being in circuit successively only during 1-20th of a revolution of the shaft.* By this arrangement, moreover, Dr. Lugo claims to avoid the evil effects due to self-induction, for the reason that only the minimum amount of effective wire is in circuit at any time. Another feature is that sparking at the commutator is avoided, from the fact that there is no magnetic lead in the field or armature, as the field travels round just in advance of the armature as each bobbin is cut in.

The seventh annual meeting of the Association of Railway Telegraph Superintendents has been held here this week. The object of this association is the promotion and advancement in general of the interests of the telegraphic department of railways, the duties of which, as the proceedings showed, tend every year to become more complex and comprehensive. The association has a membership of close upon 100, including all the leading railroads of the country, and the superintendents themselves are, generally speaking, a highly competent and intelligent class of men, in most cases graduates from the ranks of the operators. One of the subjects which came up for discussion was the distribution of standard time, on which an interesting address was made to the Association by Commander A. D. Brown, U.S.N., who is connected with the Naval Observatory at Washington, which furnishes correct time to all parts of the country. In connection with the distribution of time the observatory has adopted the Gardner system of controlling clocks; and Commander Brown states that they have a line from the observatory to various public buildings in the city of Washington upon which are no fewer than 225 clocks, or, including branch circuits, a total number in operation of about 400. This system has been in operation about four years. The clock is the ordinary eight-day clock, and contains its own motive power. The office of the electric signal is merely to set it, the connection being made by means of an attachment to the clock. When the signal passes the hour, minute and second hands move to zero; in other words, the clocks in Washington show twelve hours, no minutes and no seconds at the exact time that the same is shown by the observatory clock. The railroads have naturally had their attention called to this system, and it is now in use upon some of them, notably the Piedmont-Air line, as it is called.

As Commander Brown remarked, in explaining the details of the system, it must certainly be a great comfort for any superintendent to know that at the instant of noon by the clock of the observatory whence he derives his time, every train despatcher's clock shows the same hour, minute and second. Among the other subjects brought before the Association were the induction system of train telegraphy, electric welding for rails, and the use of the electric light in stations and train yards.

News has just reached this city as I close my letter of the death, at Rochester, N.Y., of Hiram Sibley, one of the fathers of the Western Union Company. Mr. Sibley was of English stock, and essentially a self-made man, starting with nothing, and dying with a fortune estimated at from 6 to 10 million dollars. His connection with the telegraphic business dates back to 1851, when he bought the House patents and built 100 miles of line. A few years later he joined hands with Ezra Cornell, who represented the Morse interests, and from the "pooling of the issues" resulted the Western Union Telegraph Company, which was incorporated under the laws of Wisconsin and New York in 1856. Mr. Sibley was early convinced of the feasibility of a line across the Continent to California, but when he first proposed the scheme to his associates he was met with discouragement, on the ground that failure would damage the new company, and that it was altogether beyond their financial resources. Mr. Sibley told his critics that if they would not join hands with him he would "go it alone;" and go it alone he did, till at last he secured an annual subsidy from Congress of $40,000, and the line was built and finished in 1861. The line immediately became profitable, and was the basis of several fortunes. Such a pronounced success naturally called attention to the work of building a line to connect America and Europe by way of Asia, across the Behring Straits. The plan was actually carried out in its earlierstages. Some $3,000,000 was spent in the enterprise, and it would undoubtedly have been carried through to success in all its ramifications but for the great achievements

* This seems to be a return to a form which has been several times tried and abandoned in this country, and has very little theoretically to commend it. The early forms of the Immisch motor embodied this principle. See *The Electrician*, October 22, 1886, p. 489.—Ed. *E.*]

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in submarine telegraphy which gave the United States far better connection with Europe by means of the Atlantic cables. Mr. Sibley remained active in the management of the Western Union Company until 1869, when he resigned office, but he has been engaged in business down to the present time, when, at the age of 81, he died full of honours. It will not be forgotten in the years to come that this shrewd, hard-headed business man was widely philanthropic and public spirited. To Cornell University he gave the Sibley College of Mechanical Arts, on which he spent $150,000; to the University of Rochester, N.Y., he gave the Sibley Hall, on which he spent $120,000; and other benefactions, to the extent of hundreds of thousands of dollars, might be easily recalled.

NOTES FROM VIENNA.

(FROM OUR CORRESPONDENT.)

The Telephone Company of Austria is sparing no pains to develop their business in Austria, and have succeeded in satisfying their subscribers and the Government.

They have increased their subscribers, including private lines to—

565 in Prag.	123 in Pilsen.
453 ,, Trieste.	269 ,, Reichenberg.
250 ,, Lemberg.	145 ,, Bielitz.
276 ,, Graz.	
112 ,, Czernowitz.	Total 2,191.

The wire run has increased to 4,628 kilometres, and the calls in the financial year 1887-1888 to 2,907,583. The service for receiving and transmitting telegrams by telephone has been much appreciated, as the following figures show, viz.: 50,905 transmitted and 23,179 received, total 74,084 during year 1887-88. The Government is also showing great activity in connecting up the various towns and opening exchanges where none had yet been opened.

They have connected Brünn with Vienna, also Baden, Voslau, Wiener-Neustadt, and Reichenau. They propose early in 1889 to run a special line of silicium bronze wire to Prag from Vienna; also to connect Buda Pesth, and perhaps Graz and Trieste. They have opened exchanges in Baden, Voslau, Wiener-Neustadt and Wansdorf, and are arranging the opening of further exchanges in Salzburg, Innsbruck, Karlsbad, Gablonz, and other towns, and have erected about twelve public call rooms in Vienna, where everyone can call up, upon payment of fixed rates per five minutes' conversation, the subscribers of the Vienna Company's exchanges in Vienna and Brünn, also those of the Government exchanges in Baden, Voslau, Wiener-Neustadt and Reichenau. The connection of numerous outlying places to the next telegraph station is proceeding at a rapid rate, thus extending the Austrian telegraph system without great cost.

The new switch-boards made by the Consolidated Construction and Maintenance Company (Limited) are proving very successful, and are largely used in Austria. The Consolidated telephones, as well as the Gower-Bell combination made by this company, have hitherto been unsurpassed for general exchange work, whereas the use of the Bell-Blake and others which have to be constantly regulated is rapidly diminishing. The Vienna Telephone Company is also increasing rapidly. During the last year they have connected up over 300 new subscribers, and are now laying cables for 600 to 700 more, which will cost them nearly £20,000.

Vienna is the only large city which has almost entirely underground cables in use, as Paris can hardly be counted, the cables there being placed in their wonderful system of subways. The Vienna Company had special difficulties to contend with owing to the great difficulty of obtaining way-leaves. Their new multiplex switch-board, made by Mr. Otto Schaffler, of Vienna, is at this moment probably the best in Europe. Although Austria cannot compare with the whole of Germany as regards the total number of subscribers, yet the towns, taken singly, compare very well with German towns of the same size. Germany has about five times as many large towns as Austria, which is a nearly purely agricultural country.

As regards the technical work, Austria is far ahead of Germany. The lines in Austria are all built of silicium bronze wire, in Germany of iron and steel. Austria has newer and better patterns of switch-boards, and far better telephonic apparatus. The German exchanges have lately got to be so bad that the German Goverment has been obliged to ask for a very large sum of money, said to be over £200,000, in order to reconstruct the Berlin and Hamburg exchanges.

All new trunk lines between towns in Austria are being run with silicum bronze wire on separate poles, it having been found that the Van Rysselberghe system does not give good telephonic connection, and spoils the telegraph work. In Germany, Belgium and France, the Van Rysselberghe system is being given up. Much expense would have been spared if Mr. W. H. Preece's advice had at once been taken. Mr. Preece was one of the first who set his face against the Van Rysselberghe's system, though acknowledging the service rendered by Van Rysselbergh to the understanding of various telephonic problems.

It was due to Mr. Preece that no money was wasted in England by trying to utilise this system.

NOTES FROM PARIS.

(FROM OUR OWN CORRESPONDENT.)

An important scheme has been laid before the Municipal Council for the construction of an undergound railway to be worked by electricity from the Bois de Boulogne to the Bois de Vincennes. The tunnel will be lined with an iron tube 5·6m. in diameter, and it is not proposed to open the surface of the ground at more than a few stated points. It is proposed to establish a two minutes' service of trains, and to maintain a maximum speed of 20 kilometres per hour. The estimated cost of the whole is 36 million francs, the construction of the tunnel and permanent way absorbing 22 millions of the total. If the concession is granted before the 1st October, the promoters of the scheme will be ready to guarantee the completion of the section between the Bois de Boulogne and the Place de la Concorde by the 1st July, 1889, as well as to extend a branch line to the Exhibition. The use of accumulators is not contemplated; the current will be taken off a central rail direct from the dynamos. Further technical details are not available at present, but the scheme seems to be a good one, and is in capable hands. The Municipality is merely asked to authorise the works, no financial assistance is requested, and it is not intended to seek a monopoly. But, even upon such terms as these the opponents of reform will certainly discover a thousand objections to the scheme, and for my own part I am not inclined to think hopefully of its prospects. France is sadly behindhand in the matter of electric traction, and I fear is likely to remain so.

Some further details respecting the Paris-Marseilles Telephone line have recently come to hand. The total length of wire out and home is 2,000 kilometres (1,250 miles); the conductor is of silicium bronze 4·5mm. in diameter, having a weight of 146 kilogrammes, and a resistance of 1·08 ohm per kilometre. Fortin-Hermann cables are used wherever it is necessary to run underground. In this cable the conductors are threaded at intervals through small cylinders of paraffined wood, several of these cylinders being then placed in a lead tube. The line has been constructed in lengths of 200 metres, the joints being made by the use of solder and special sleeves on the overhead line. The two wires are run one above another at a distance of ·5m on large double bell-shaped porcelain insulators. During some of the trials a strong north-west gale and the working Hughes' transmitter on adjacent lines gave rise to much rattling in the telephone receiver. Under favourable conditions, however, the transmission is good. The preliminary trials were made with various instruments, but it has been finally decided to use D'Arsonval transmitters and receivers.

NATIONAL TELEPHONE COMPANY.—A dividend for the six months ended June 30 last is announced at the rate of 6 per cent. per annum on the First and Second Preference Shares, and at the rate of 5 per cent. per annum on the Ordinary Shares, as against 4 per cent. for the corresponding period last year, and that of the remaining profits the sum of £2,500 should be added to the reserve fund, and the balance of £3,253 carried forward. The unaccrued revenue carried forward to the credit of the next account amounts to £58,495, as against £49,525 carried forward last year.

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CORRESPONDENCE.

THE ARC LIGHT AT EASTBOURNE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The letter published in your columns referring to "Search Lights on Yachts" reminds me that for 48 hours last month there was anchored off Eastbourne a private, large, three-masted screw steam yacht, from which at about ten o'clock each night there was displayed (for amusement, I presume) a most brilliant electric search light, which certainly dispelled any ideas I had formed as to what private enterprise could do in that direction, for I never saw a more brilliant beam nor one more dexterously manipulated in lighting up the desired objects on land or sea. I should think it must have convinced those who had before only seen the flickering arc lights along the parade of that town, that in electric lighting, as in most things, there are varieties of quality and kind. The parade lights always reminded me of some lines in the poem of "The Sacrilegious Gamesters"—

"It shed a restless, waving gleam
Through the gothic window pane;
And now it vanished for a space,
And now it came again."

"He stood, and thought it wondrous strange
That such a scene should be."

It also struck me that there is "in and out running" in other fields than those devoted to horse-racing.

I never saw the incandescent lamps which are used in many of the shops illuminated, but have been informed by those who complain of the unsteadiness of the parade arc lights that they are very steady and highly appreciated. That being so, if the parade lights are on the same circuit, the carbons or the mechanism which is supposed to regulate them must be in fault. Again, I am aware that the source of power is far from the arc lamps, necessitating long leads; but let the cause be what it may it should be remedied as quickly as possible, for as at present arranged it does not in my opinion tend to advance the success of electric lighting.—Yours, &c.,

July 22nd, 1888. WILLOUGHBY SMITH.

EDISON-SWAN *VERSUS* HOLLAND AND OTHERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I beg to inform you that, having been advised that the decision of Mr. Justice Kay is contrary to decisions in the Court of Appeal and House of Lords, the directors have instructed our solicitor to take the necessary steps for appealing against Mr. Justice Kay's judgment.—Yours, &c.,

S. FLOOD PAGE, Secretary.

The Edison and Swan United Electric Light Company,
London, July 19th, 1888.

UNIPOLAR INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In answer to Mr. N. G. Thompson's letter in your issue of the 13th inst., I would point out that there must necessarily be an increase or decrease in the number of lines of force passing through any area when more lines cross the boundary from outside to inside than from inside to outside, or *vice versâ*. In any case of so-called unipolar induction the number of lines of force passing through the circuit increases continuously at a rate proportional to the angular velocity of rotation. Consider, for example, the simple case of the terminals of a fixed circuit in contact with the central portion of the surface and the extremity of the axis respectively of a cylindrical magnet rotating about its axis. The circuit here increases in length at every revolution by the length of the path described by the centre terminal relatively to the magnet—that is to say, by a length equal to the circumference of a circular section of the magnet. Every line of force proceeding from the magnet will cut the area added to the circuit at each revolution once, and once only; so that the number of lines of force passing through any area bounded by the circuit will be increased at each revolution by the total number proceeding from the magnet.—Yours, &c.,

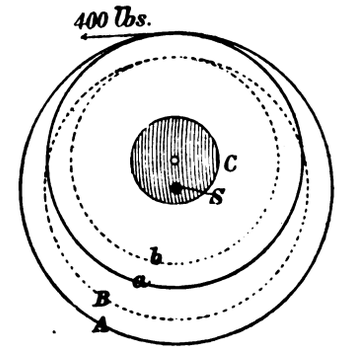
G. W. DE TUNZELMANN.

THE BEAUMONT EPICYCONOIDAL GEAR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I venture to trouble you with a few remarks on the Beaumont gear illustrated in your issue of the 29th ult., and designed with a view of facilitating the application of electricity to the working of tramways and railways. It is a very ingenious mechanical device, but I do not think it is suitable for the purpose in question.

In the invert wheels A and B and the pinion D carried by the excentric C I recognise all the essential features of an epicyclic train which was designed some time ago by Mr. R. H. Ridout and myself, for pretty much the same purpose as the Beaumont gear is intended for. The Beaumont gear, as you have illustrated and explained it, however, possesses a serious mechanical defect; if A and B are to have a different number of teeth, and still be concentric, and on one axis, they cannot both be made to work truly with the same pinion D; A and B must be wheels of different pitch diameters, and D must consist of two pinions of corresponding diameters, and bolted together so as to turn as one wheel. The combination is then in some respects equivalent to a train of four cog wheels, working together, and possessing a certain velocity ratio; but considered as a means of transmitting power rather than as a means of obtaining a certain change in velocity, the arrangement is by no means a good one. I shall perhaps best make this clear by taking an example.



Let the circle A represent the pitch line of one of the invert wheels, say the wheel driving the axle of the car, and B the pitch line of the controlling wheel; a and b the pitch lines of their corresponding planet wheels, which in the Beaumont gear are represented by the pinion D; the shaded circle C the the excentric carrying them; and the small black circle S the centre of the main driving axle or the armature spindle. As probable dimensions further suppose A = 12 inches radius, B = 11·2 inches, a = 8 inches, and b = 7·2 inches. From these dimensions, and B being fixed, we deduce the velocity ratio to be $\frac{1}{28}$, *i.e.*, B would make one revolution for every 28 revolutions of the armature spindle.

Now, suppose A is also the diameter of the pitch circle of the sprocket wheel driving a chain gearing with another sprocket wheel on the axle of the car, and, say, of a diameter equal to A. To keep a car weighing six tons in motion on an average tramway there will have to be a tension of, say, 400lb. maintained on the chain, and this will also be the pressure between the teeth of the wheels A and a, which gear together. To propel the car at eight miles an hour, A would probably have to make 70 revolutions a minute, and it would probably have about 50 teeth on its circumference. But if A is to make 70 revolutions a minute, the excentric carrying the planet a must make nearly 2,000 revolutions in the same time; and so we shall have nearly 100,000 teeth passing the line of centres every minute. The pressure upon them being 400lb., it would not be a difficult matter to work out the amount of energy absorbed in the friction, given the detail of the shape of the teeth, so that the amount of "slip" could be arrived at.

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Whatever amount of energy is wasted between this pair of wheels, rather more will be wasted between B and *b*, because with the dimensions assumed the pressure between their teeth will be about 440lb. instead of 400, and they move with practically the same velocity. The energy thus absorbed in friction would be greater than could be afforded from any electrical source of power.

Again, notice that, *neglecting the friction entirely*, the pressure to be kept up by the armature on the centre of the excentric carrying the planet wheels will be about 44lb. when the excentricity is 4in., as assumed above.

Now, compare these figures with what you would get in a simple train of wheels, say a pinion on the armature spindle gearing with a plain spur-wheel of 28 times its diameter, armature running at 2,000 revolutions, pinion 4in. diameter, with 10 teeth. If friction be neglected, the torque of the armature will be the same as before, 44lb. say, and we have $2,000 \times 10 = 20,000$ teeth passing the line of centres, as against nearly 10 times that number in the other case (*i.e.*, 100,000 twice over), and the pressure between them only about 90lb., instead of over 400. From these two sets of figures I think it may be fairly deduced that an enormous waste of power would ensue if the gearing in question were used to transmit anything like the power required on a tramway or railway.

A further very serious waste of power would be found to arise from the use of an excentric to carry the planet wheels *a* and *b*. The axle on which they turn should be as small as is possible consistent with adequate strength. The absolute *friction* between the rubbing surfaces may not be altered by increasing the size of the axle and converting it into an excentric (except in so far as it may be modified by the increased velocity between these surfaces), but the leverage at which this friction acts against the power overcoming it is increased, and so the power absorbed will be increased also.

As objections of another nature with which this gearing would have to contend may be mentioned the probable difficulty of lubricating the invert and planet wheels; of finding space for the apparatus underneath the floor of a tramcar; and, above all, the injurious effect upon it of the violent shaking about which it must get upon a tramway. Experience shows that machinery is far more difficult and expensive to keep in working order on a tramway than it is on a railway; this is partly due to the greater amonnt of dust and dirt to be contended with, and partly to the hard and rigid nature of the permanent way as compared with the permanent way of a railway.—Yours, &c. T. ARNALL.

Birmingham, 17th July, 1888.

PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

9,141. C. HUELSER, of the firm of Huelser and Co. London. A new or improved automatic electrifying apparatus (J. Müller, Germany). June 22, 1888.

9,171. W. E. LANGDON. Derby. Improvements in electric lighting as applied to railway trains. June 23, 1888.

9,206. C. LÜTKE and P. GEORGE. London. Improvements in galvanic elements or batteries. June 23, 1888.

9,224. G. HOOKHAM, Birmingham, and R. H. HOUSMAN, Bromsgrove. Improvements in the distribution of electric currents from central stations. June 25, 1888.

9,254. B. M. DRAKE, J. M. GORHAM, E. MANVILLE, and W. L. MADGEN. London. Controlling devices operated by means of the thermic effects of electric currents. June 25, 1888.

9,308. J. EDMONDSON. London. Improvements relating to dynamo-electric machines. June 26, 1888.

9,332. F. STITZEL and C. WEINEDEL. London. Improvements in electric connection of railroad rails. June 26, 1888.

9,333. H. PIDOT and H. PAUTIER. London. Improvements in and relating to electric arc lamps or lighting apparatus. June 26, 1888.

9,345. R. R. HUTCHINSON. London. Improvements in and relating to electrically propelled boats or vehicles for recreational purposes, and apparatus connected therewith, for use on water or land. June 27, 1888.

9,361. A. IMSCHENETZKY. London. Improvements in electric batteries. June 27, 1888.

9,405. R. F. YORKE. Redhill. A method to enable alternating currents of electricity to be utilised for charging electrical accumulators. June 28, 1888.

9,508. W. FRANCE and R. MORGAN. London. Improvements in and relating to telegraphing apparatus used on board ship. June 29, 1888.

9,547. R. R. HUTCHINSON. London. Improvements in electric motors and cars or carriages therefor. June 30, 1888.

9,553. A. L. FYFE and J. MAIN. London. Improvements in adjusting electrical lighting devices. June 30, 1888.

9,584. S. MILLER. London. Improvements in galvanic batteries for electric lighting and other purposes. July 2, 1888.

9,588. F. G. OBERDORFER and J. NEU. London. Improvements connected with electrical appliances for lighting trains with automatic connection between the carriages. July 2, 1888.

9,595. W. H. ALLEN and R. WRIGHT. London. Improvements in machinery or apparatus for generating electricity and in electro-motors. July 2, 1888.

9,615. G. H. RAYNER. London. Improvements in mounting incandescent electric lamps (J. Ragonet, Paris). July 2, 1888.

9,660. A. J. BOULT. London. Improvements in electric motors and dynamo machines (O. Lugo, United States). July 3, 1888.

9,661. A. J. BOULT. London. Improvements in telephone transmitters (J. Emmner, jun., United States). July 3, 1888.

9,662. A. J. BOULT. London. Improvements in or relating to electrical type writers (J. F. McLaughlin, United States). July 3, 1888.

9,672. G. P. LOWREY, G. F. SEWARD and T. L. WILLSON. London. Improvements in dynamo-electric machines and electro-motors. July 3, 1838.

9,686. H. H. LAKE. London. Improvements in and relating to electrical apparatus for forging, welding, and soldering metals, and to the manufacture of rings, links, and the like (E. Thomson, United States). July 3, 1888.

9,693. J. E. T. WOOD. London. Improvements in the manufacture of wire for telegraphic and other purposes. July 4, 1888.

9,708. G. HUCK. Burnley. The telephonograph. July 4, 1888.

9,730. W. H. AKESTER and G. HOPKINS. London. An improved cut-out for electric circuits. July 4, 1888.

9,745. E MANVILLE. London. An improved system for driving moving electric motors or locomotives in series. July 4, 1888.

9,747. L. W. WINNALL. London. Improvements in electric bells. July 4, 1838.

9,759. J. PAPIESZ. London. A self-acting dynamic machine. July 4, 1888.

9,808. J. P. BARRALET. London. Electrical fountains. July 5, 1888.

9,811. S. J. JONES and W. H. TASKER. London. Improvements in the production of blocks or masses of peroxide of lead, and in the production of elements for voltaic batteries, and in apparatus used in the production of such blocks or masses and elements. July 5, 1888.

9,817. G. KAPP, W. H. SNELL and J. M. V. MONEY-KENT. London. Improvements in the construction of transformers. July 5, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

June 30, 1888.

9,264. J. G. LORRAIN. London. Improvements in electric clocks. June 29, 1887.

10,199. H. C. BULL and Co. (Limited) and H. C. BULL. London. Improvements in electric metallurgical processes and apparatus therefor. July 21, 1887.

10,555. C. P. ELIESON. London. Improvements in electric batteries. July 29, 1887.

11,091. J. S. RAWORTH and H. M. SAYERS. London. Improvements in and connected with friction couplings governed by electricity. August 13, 1887.

11,704. W. E. LANGDON, J. C. FULLER and G. FULLER. London. An improvement in electrical insulators. August 29, 1887.

11,718. H. GLÄSER. London. Improvements in actuating mechanism for electrostatic generators. August 29, 1887.

11,776. W. H. BECK. London. New or improved system or apparatus for synchronising electric telegraph instruments (G. A. Cassagnes France). August 30, 1887.

14,270. B. J. B. MILLS. London. Improvements in means or apparatus to be employed in the production of sheet copper by electro deposition (E. Emerson, United States). October 20, 1887.

5,831. T. SCHÖNHERR-SCHÖNER. Leeds. Improvements in means or apparatus for lifting, lowering and regulating the height of the elements in electric batteries. April 19, 1888.

6,191. C. A. J. H. SCHROEDER. London. A mode of preparing carbons for electric arc lighting. April 26, 1888.

7,851. W. P. THOMPSON. Liverpool. Improvements in switches for electric circuits (G. Westinghouse, jun., United States). May 29, 1888.

7,853. W. P. THOMPSON. Liverpool. Improvements in or relating to storage batteries (C. D. P. Gibson, United States). May 29, 1888.

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July 7, 1888.

4,533. M. R. WARD. London. Improvements in electric locomotives and vehicles. March 26, 1887.

10,767. W. LOWRIE, C. J. HALL and H. W. KOLLE. London. Improvements in instruments for measuring electric currents, and for regulating and controlling dynamo-electric machines and prime movers. August 5, 1887.

11,751. A. E. NICHOLL. London. Improvements in electrical signalling apparatus for railways. August 30, 1887.

11,853. F. CAWS. London. Flexible supports for telegraph or other wires. September 1, 1887.

11,932. C. D. ABEL. London. Improved means for making or insulating the joints or connections of electrical conducting cables (Siemens and Halske, Germany). September 2, 1887.

11,960. J. S. ROSS and H. BAINES. London. Improvements in electrical telephones. September 3, 1887.

12,025. E. F. LAW. London. Improvements in apparatus for operating or controlling type-writers, type-setting machines and the like by the aid of electricity. September 5, 1887.

1,128. A. A. FORTIN. London. Improvements in galvanic batteries. January 25, 1888.

1,968. W. TILLEY. Brighton. Improved secondary battery or accumulator for the storage of electricity. February 9, 1888.

4,456. A. COLLINGRIDGE. London. An improved method of administering galvanic currents for curative purposes. March 23, 1888.

5,731. H. H. LAKE. London. Improvements in and relating to apparatus for measuring electric currents, which apparatus will also serve as a motor (E. Thomson, United States). April 17, 1888.

5,732. H. H. LAKE. London. Improvements in and relating to apparatus for measuring electric currents, which apparatus will also serve as a motor (E. Thomson, United States). April 17, 1888.

6,157. R. E. KEEN. London. Improvements in lanterns for electric arc lamps, and in posts or columns for supporting the same. April 25, 1888.

7,541. W. P. THOMPSON. Liverpool. Improvements in dynamo-electric generators or motors (H. W. Spang, United States). May 22, 1888.

7,551. J. KENDALL and O. COOPER. London. Improvements in coupling devices for electrical and other purposes, and in indicators to be used in conjunction therewith. May 22, 1888.

7,850. W. P. THOMPSON. Liverpool. Improvements in or relating to alternate current electric distribution (G. Westinghouse, jun., United States). May 29, 1888.

7,977. H. G. MORRIS and P. G. SALOM. London. Improvements in the mode of filling secondary battery plates. May 31, 1888.

8,171. J. J. GHEGAN. London. Improvements in magneto-electric liquid level indicators. June 5, 1888.

PATENTS SEALED.

June 29, 1888.

6,204. W. J. MULLER. London. Improvements in induction coils and transformers. April 28, 1887.

8,181. H. A. TAYLOR. London. Improvements in means or instruments for testing submarine electric telegraph cables or for analogous purposes. June 7, 1887.

8,708. J. OPPENHEIMER. Manchester. Improvements in apparatus for fixing telegraph posts. June 16, 1887.

8,710. T. NORDENFELT. London. Improvements in electrical apparatus to be used with ordnance to fire the charge. June 16, 1887.

8,855. E. JULIEN. Brussels, Belgium. Improvements in and appertaining to electric piles and plates therefor. June 20, 1887.

10,963. J. A. FLEMING and C. H. GIMINGHAM. London. Improvements in instruments for the measurement of electromotive force and power. August 10, 1887.

2,515. J. FEAVERGEAR. London. Improvements relating to dynamo-electric generators and motors. February 20, 1888.

3,835. H. P. COPELAND. United States. Improvements in telegraphic apparatus. March 13, 1888.

3,995. H. H. LAKE. London. Improvements in and relating to galvanic batteries (H. Walter, United States). March 15, 1888.

4,274. W. P. THOMPSON. Liverpool. Improvements in or relating to storage batteries (C. D. P. Gibson, United States). March 20, 1888.

4,275. W. P. THOMPSON. Liverpool. Improvements in or relating to storage batteries (C. D. P. Gibson, United States). March 20, 1888.

July 6, 1888.

1,333. W. WEBSTER, JUN. London. Improved means of oxydising and decomposing by electrical action organic matter and inorganic salts in sewage, water, and other liquids. January 27, 1887.

6,682. J. SWINBURNE. Chelmsford. Improvements in and connected with electrical distribution by means of direct or alternating currents, chiefly for lighting purposes, and in electrical measuring instruments which may be used therewith. May 6, 1887.

6,993. H. H. SLATER and A. S. NEWMAN. London. An improved apparatus for signalling by electricity. May 13, 1887.

7,078. P. WILLIAMS and W. POWLES. London. Improvements in electrical indicators for showing the rise and fall of gasholders and the quantity of gas therein, or water in reservoirs and the quantity therein, and for other similar purposes. May 14, 1887.

7,618. W. M. MORDEY and C. E. WEBBER. London. Improvements in electric transformers, induction coils, or inductional resistance coils. May 25, 1887.

7,857. H. TUDOR. Luxembourg. Improvements in registering meters for electric currents. May 31, 1887.

8,068. H. BAYLEY. Walsall. Improvements in holders for incandescent electric lamps. June 4, 1887.

8,284. S. P. THOMPSON. London. Improvements in the electro-deposition of the heavy metals. June 9, 1888.

8,380. A. L. LINEFF and W. JONES. London. Improvements in means for operating tramcars by electricity. June 10, 1887.

8,433. F. W. NEALE. Stoke-on-Trent. A telephone apparatus without a diaphragm. June 11, 1887.

9,011. E. JONES. Leeds. Improvements in the construction of dynamo-electric generators and motors. June 24, 1887.

14,622. E. E. VAUGHTON. Birmingham. An improved electric accumulator. October 27, 1887.

3,678. W. G. OLPHERTS. London. Improvements in and relating to electrical signalling on railways and in apparatus therefor. March 9, 1888.

SPECIFICATIONS PUBLISHED.

8,240, 1887. HARD, J. R., and WILSON, T. Galvanic batteries. (Price 8d.)

8,500, 1887. WARING, R. S. Conduits for electric wires. (Price 8d.)

8,701, 1887. ROSS, J. Producing electric energy for lighting, &c. (Price 8d.)

10,071, 1887. SAYERS, W. B., and STURGE, W. H. Electric incandescent lamps. (Price 8d.)

10,740, 1887. MATHIS, S. Regulators for electric lamps. (Price 8d.)

13,601, 1887. DAVIES, J. H., and THOMPSON, A. Automatic coin-freed electrical machines. (Price 11d.)

14,346. LUNDBERG, A. P. Bell push electric light switch. (Price 8d.)

15,703, 1887. COURT, J. Medical galvanic battery. (Price 8d.)

8,641, 1887. EDMUNDS, H. Supply of electricity for lighting, &c. (Price 1s. 1d.)

10,233, 1887. MAITLAND, M. Combined electrical vapour bath. (Price 8d.)

11,004, 1887. SMITH, M. H. Electrical propulsion of tramcars, &c. (Price 8d.)

16,473, 1887. BROMHEAD, S. S. (Street). Electrical railway signalling device. (Price 8d.)

1,932, 1888. ROYCE, F. H. Electrical contacts for switches. (Price 6d.)

4,673, 1888 JUSTICE, P. M. (Heisler). Dynamo electric machines, &c. (Price 1s. 1d.)

4,964, 1888. BOULT, A. J. (Doubrava). Transferring electric currents. (Price 6d.)

LEGAL INTELLIGENCE.

The Gaulard and Gibbs Patent.

In the Royal Courts of Justice (Chancery Division), before Mr. Justice Kekewich, the above case was mentioned on Tuesday morning, on an application to stay proceedings, judgment having been given on a former occasion against Messrs. Gaulard and Gibbs.

Mr. ASTON, Q.C. (who appeared for Messrs. Gaulard and Gibbs), said he was instructed to make a formal application to his lordship that the proceedings in this case might be stayed. He ought to say that upon his lordship's judgment, in his opinion, the plaintiff could go to the Registrar's Office and apply to have Gaulard and Gibbs's patent struck off the register. Of course, that would be a proceeding which might be very inconvenient to the parties. He will undertake to lodge the appeal at once.

Mr. JUSTICE KEKEWICH: Well, it cannot be heard under six months.

Mr. ASTON: I imagine not.

Mr. JUSTICE KEKEWICH: It does not seem to me to be a generous offer.

Mr. ASTON: I think that your lordship will remember the circumstances of the case. Our relations with the Grosvenor Gallery, who are practically the persons interested in this case, are of a very amicable character. I think that the proceedings should be stayed for a while.

Mr. Justice KEKEWICH: Can you suggest, Mr. Moulton, what is fair to both parties?

Mr. MOULTON: I certainly wish to give it as my opinion that your lordship's judgment is the revocation of the patent.

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Mr. Justice KEKEWICH: That I do not intend to go into. It is a new question which I am not called upon to decide. If I am bound to do so I shall not shirk it more than any other question.

Mr. MOULTON: Quite so. What I feel is that my learned friend is asking an indulgence which I cannot say has any very prejudicial effect upon my client, and at the same time I think that it ought to be granted, and that we, having obtained your lordship's judgment, should undertake not to take any actual steps with regard to doing anything at the Patent Office until the appeal is heard, provided that the appeal is lodged at once; but it should be on terms.

Mr. Justice KEKEWICH: They are cross undertakings. You are to appeal, and Mr. Moulton undertakes to do nothing.

The Simplex Electric Light and Plant Company (Limited) v. Cooper and Craig.

At the Manchester Assizes on Monday last this case came on for hearing. Mr. Bigham, Q.C., and Mr. Hopkinson were counsel for the plaintiff company, and the defendants were represented by Mr. Gully, Q.C., M.P., Mr. Yates, and Mr. Brierly. The action was brought, Mr. Bigham said, to recover the price of installing the electric light at the colliery of the defendants, in Staffordshire, and also to recover several items for goods supplied and work done. The defence, briefly stated, was that the plaintiffs did not do their work to the satisfaction of the defendants. After opening the case Mr. Bigham suggested that the better course would be to refer the matters in dispute to a practical electrical engineer.

The JUDGE said he did not like to shrink from any duty that was cast upon him, but in any event a considerable portion of the case must be referred, because, to some extent, the case was one of accounts, and under all the circumstances he thought the parties would be more likely to arrive at a satisfactory settlement by referring the disputed points.

After counsel and clients had consulted together,

Mr. GULLY announced that it had been decided to refer the case to a gentleman to be agreed upon between the parties. If the parties could not agree upon the referee, application would be made to his lordship to nominate a gentleman.

COMPANIES' MEETINGS & REPORTS.

Anglo-American Telegraph Company (Limited).

The ordinary general half-yearly meeting of the proprietors of this Company was held yesterday, at Winchester House, 50, Old Broad-street, the Most Hon. the Marquis of Tweeddale presiding.

The SECRETARY (Mr. T. H. Wells) read the notice convening the meeting, and the minutes of the last ordinary meeting, held on February 3rd, which were signed by the Chairman as correctly entered.

The Directors' report and statement of accounts were taken as read.

The CHAIRMAN: Gentlemen, it is now my duty to ask you to adopt the report and accounts, but before doing so I must be allowed to express my great regret, which I am sure will be shared by everyone present, that our worthy Chairman is unable to preside on this occasion. The indisposition which has prevented him from coming here is not of a very serious character, but his medical attendant insists on his remaining quiet at home. I am sure you will all join me in the hope that he will soon be restored to his usual health. Gentlemen, the report and accounts which have been in your hands for some days, which no doubt have been perused by you with the care and interest which they deserve, are so full and give you such ample information as to the proceedings of the past six months, that it will be wholly unnecessary for me to occupy your time at great length. At the same time, with your permission, I shall trouble you with a few observations on the more salient points. Turning, in the first instance, to the accounts, you will observe, no doubt with satisfaction, that the working expenses show a reduction of a little over £1,100. The repairs of cables are considerably less than they were at this time last year, the amount being £5,981, as against £9,858. This is accounted for by the fact that the expenses of the ship "Minia" have been charged to renewal fund, inasmuch as the ship was employed in renewing a very considerable portion of cable which had been destroyed. That item amounts to £15,485, which has been expended during the six months under notice. The repair was a very costly one, and was in connection with the Brest-St. Pierre cable, which was broken in three different places. One break was at a place no less than 2,000 fathoms in depth; the second was at 400 fathoms; and the third at 900 fathoms. The one at the depth of 2,000 fathoms has been successfully repaired, and the other at 400 fathoms has also been repaired, and the third, which is at the moderate depth of 900 fathoms, is in course of being repaired, and we have every reason to believe that news will reach us in a few days of the successful repair of that cable also; in fact, as far as we can make out, the delay is entirely due to a very thick fog which has been prevailing in the neighbourhood of Newfoundland. Those repairs have been costly, as might be expected; but fortunately we have a very valuable, I may say indispensable, fund to which we have been able to charge the cost of those repairs so far as we know the amount. That leads me to draw your attention to the fact that the renewal fund now amounts to the very handsome sum of £909,694, but in reality it is worth a great deal more. The securities in which your fund has been invested would yield now something like £50,000 over and above their cost price. Gentlemen, so far I think it must be admitted that the features of the report which I have dwelt upon are satisfactory. What is not quite so satisfactory is the reduction of our receipts, which, as the report informs you, amount to the sum of £19,635. The cause of this is explained in the report, and is due to the fact that the Commercial Cable Company, which charged a 1s. rate while we were charging the 6d. rate, altered it to 6d., thereby obtaining a considerable addition of traffic, or, rather, subtracting traffic from us which we had been enjoying before. The only observation that that seems to call for is that we must deem ourselves fortunate that they did not make the change at an earlier date. That brings me to the very important question of the tariff. You are aware that the 6d. tariff was adopted in the hope and belief that it would prove a remunerative tariff. It was hoped that so low a rate as 6d. would, in the course of time, augment the messages to such an extent that the 6d. tariff would become the tariff of the future. Well, gentlemen, the experiment has now extended over two years, and we, in common with all companies dealing with telegraph traffic across the Atlantic, have come unanimously to the conclusion that the 6d. tariff not only is not a remunerative tariff, but will not be so within any reasonable time; that I think we are all agreed upon. It is very much to be regretted that this is the case. For the first year the results were very promising. The increase amounted to something like 140 per cent., and if that increase had gone on at the same figure we probably should not have had to change the rate now. But, as the report informs you, the increase ceased about a year ago, and therefore we know pretty well the effect of the 6d. tariff upon our finances. The companies having come unanimously, I may say, to the conclusion that the 6d. tariff is not a paying one, nor is likely to be within any reasonable period, negotiations have been set on foot with the view of raising the rate. Those negotiations are proceeding at this moment, and I think I may say that there is a reasonable prospect of their being concluded in a satisfactory manner within a very short time. The negotiations are on the basis of a 1s. tariff. Now, gentlemen, if, as we believe, a 1s. tariff will not lead to any serious reduction in the number of messages, the revenue will benefit very considerably, and I need hardly add that we hope for a better dividend than it is my duty to recommend to you on this occasion. Most of you are aware with reference to our law suit with the French Company that it has been gained by us, and very large damages accrue in consequence of the decision in favour of this Company, and what I want to mention is that no credit has been taken for any portion of the damages which have been awarded to us. Therefore, if at any time any portion of these damages come into the exchequer of the Company so much the better will it be for the proprietors. I may also add with reference to the French Company that they have made claims which have delayed the negotiations somewhat—claims which we could not admit—and that is the reason that I am not able to report the conclusion of the negotiations to which I have referred. Gentlemen, with these observations I beg to move

"That the report of the Directors, with the accompanying statement of accounts to the 30th June, 1888, submitted to this meeting, be and the same are hereby received and adopted."

Sir JAMES ANDERSON seconded the motion.

Mr. SMITH said that he quite agreed with the noble Chairman's remarks that there had been a decrease in working expenses, but he thought that his lordship had made a mistake in the comparison. He (the speaker) made the saving of the present half year, compared with the last half year, £4,000.

The CHAIRMAN: £1,100.

Mr. SMITH (continuing) thought that very great credit was due to the Directors for the very able manner in which they had invested the proprietors' money. There was not the least doubt that their investments had increased in value by something like 13 or 14 per cent. Certainly the market value of their renewal fund had increased over 10 per cent., and seeing that the whole of the repairs would soon be completed, he thought the shareholders would agree with him that the time had now arrived for carrying out the understanding that they came to some time ago with their Directors, that the interest of the renewal should be used as revenue. He thought the whole of the interest of that fund should be now added to revenue. If they adopted that course it would increase in these hard times the dividend upon the Ordinary Stock by half per cent. He was sure that the shareholders had shown the greatest patience during the last two or three years by the very small amount of dividend which they had been satisfied with. He would move

"That the whole of the interest from the invested renewal fund accruing from 1st July, 1888, be carried to revenue account."

He did not think that anyone could object to that, and that, under present circumstances, it was a very reasonable resolution. Perhaps he might ask whether, in making the agreement with the other companies, it was merely a tentative agreement, and whether the Company would be bound by it for any fixed time. He supposed they would have the power, if the 1s. tariff did not work out to the satisfaction of themselves and the other companies, to advance the rate.

The CHAIRMAN desired to point out that the amendment was not an amendment on the report, because it dealt with the future. He would therefore suggest that the discussion on the report should be taken now, and Mr. Smith's motion afterwards.

Mr. GUESDON thought that the question of the agreement with the other companies should be left to the discretion of the Directors, who were much better qualified by their position than the shareholders to decide upon the conditions to be made with the other companies. He objected to any interference with the reserve fund. He believed in a strong reserve, and the Directors dealt with theirs in a perfectly sound and intelligible manner as business men. The amount of expenses to that account was £15,485, and it was credited with interest to the amount of £15,938, so that the one about balanced the other. He believed that was a sound way of dealing with it, and he would move as an amendment that the reserve

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fund be left entirely under the control of the Directors at present. Their first object was to establish the Company, and put it in such a position as to the reserve fund as would make it a terror to those men who would endeavour to injure it for their own selfish purposes. He believed a reserve fund was to an institution of this kind what a standing army was to a country. They could not afford to neglect their defences, and the best defence against attack was a fine reserve fund such as they had built up.

The CHAIRMAN repeated his request that the matter should be left until the report was passed.

Mr. HUMPHRIES objected to the form in which the accounts were made up. He protested against the repairs of the cable being put to the renewal fund, and not to the reserve account, making two accounts instead of one. If the whole of the expenses were put to the revenue account, it would increase the expenditure from £34,000 to £56,000.

Mr. JACKSON thought that paragraph 8 in the report wanted a little explanation, which, perhaps, his lordship would give in a definite form: "The attention of the public has been frequently drawn through the press to the large amount of the Company's capital, and this is alleged to be the sole reason why low rates cannot be made profitable upon the cables of this Company." He thought a great deal of emphasis was put upon the press as regarded the consideration of that question, and he wished to say a few words, if possible, to traverse that allegation, which he thought was totally unjustifiable. He contended that that seductive recommendation, that they should write down their capital, should be met as it was by Lord Monck eighteen months ago at their meeting in February, 1887. His lordship then laid it down clearly that it was no advantage to this Company to write down the capital to a nominal amount, and pay on £50 of their capital 5 per cent., which would be simply equivalent to 2½ per cent., which they might hope to get if the proposed alteration of tariff to a moderate amount was carried into effect. He thought the Directors ought to set their faces against creating a fictitious appearance of prosperity of that character. His experience of companies that had written down their capital was that they had done it because of their impecuniosity, and that they steadily declined in value. It was unsound finance. It was urged, why should they go on paying a dividend on a capital that did not exist? He contended that it did exist, and could easily be shown. It was just as reasonable for the press to say of railways that they should value their plant, their engine sheds, stations, and their land at its present depreciation, and then be content with a moderate dividend on that valuation. It was a monstrous absurdity. He wished to call the attention of the shareholders, and particularly of the press, to this extraordinary fact as regarded the Anglo-American Company, that for no less than 15 years not a pound of additional capital had been created. The capital account was closed in 1873, as could be learned from all their reports, and not a pound had been added to it; and therefore the proposition was a very insidious one. They could not allege that there had been extravagance on the Board. There had been want of care, perhaps, on the Board, and there had been no want of self-denial among the shareholders. What had been the result? For the last 10 years their dividend had not averaged 3 per cent. It was at the rate of 5s. 2d. for the last half-year and 6s. 3d. before, which was a little less than 11s. 6d. per annum for the important services they had rendered to the commercial and mercantile world. He maintained that they stood in a position unexampled, and that the shareholders would be most unwise and egregiously oblivious of the long sacrifice they had made to build up their renewal fund, out of which they had paid for their renewals and repairs without adding to their capital a single pound on which any dividend was to be paid, if they listened to such a proposition. He was grieved and surprised to find such a paragraph in the report, which he thought greatly affected their future. It was contended that they had "watered" their capital. He admitted that the original 1866 capital of the Anglo-American Company was doubled because it was an unexpected and wonderful success, two cables having been supposed to be utterly lost previously in the sea. What were the concessions obtained? First of all the shortest route in existence, by which a saving of 900 miles of ocean in the making of the cable was effected, and the land lines in Newfoundland were obtained, and the result was that the shareholders who, like himself, were in the 1865 cable company, that existed for 18 months, got for every £100 stock, on which he had paid a considerable premium, £42 in the new Company. Their 1874 cable had cost £475,000, and was paid out of renewal fund and out of reveuue. In 1880 another cable was laid down out of their hard savings and diminished dividends, at a cost of £330,000. He thought it hardly fair that the Board did not impress these facts on the outside world, the press particularly, who could not be supposed to be intimately acquainted with the history of the Company, extending over so many years. He did hope that they would stand by their capital. As to dividend, none of them expected, or ought to desire, anything but a moderate dividend from an international service, and under the circumstances they were entitled to it. He did not believe the press would urge the extension of great undertakings of the kind at the expense of the shareholders. He must demur to the statement of the Chairman that the sixpenny rate was ever expected to pay. He for one could never have believed it. As to the shilling rate, he was quite satisfied that no reasonable merchant, or any member of the Stock Exchange, would say that it was extravagant.

Mr. SEELY was surprised that the Board had been two years in finding out that the sixpenny rate could not pay. The Directors admitted, too, in the report that the rebound in the number of messages took place about twelve months back, and therefore it still was his conviction that it was really a fighting rate. The last speaker hoped that they were going back to a position where they might get a fair remuneration for the capital employed. The question was, What was a fair remuneration? Was 3 per cent. a fair return? If they went back before the war of rates they had not received more than 3 per cent. dividend for two or three years, and their rate was 2s. a word. It was not the first time that an unfortunate war of rates was tried. It was the second time, and the result had not been advantageous. They were only a commercial Company carrying messages, just in the same way as any form of trade might be carried on, and if other traders would start in opposition to them the best thing they could do was to arrange a tariff and work in harmony with them. He asked whether it was possible that the 1s. tariff could pay them 3 per cent.? They were working for two or three years at 2s., and they never exceeded 3 per cent even then. He therefore hoped that the Board, before they made any arrangements with other companies, would very seriously consider that question, and go on striving, with their miserable dividend, to force others to the same view as themselves upon the subject of the tariff.

The CHAIRMAN, in reply to Mr. Smith, said that he thought the terms of the agreement with the other companies might be safely left in the hands of those who were negotiating it. He was glad to hear such eloquent support of their policy with regard to the renewal fund from one so competent to speak on the subject as Mr. Guesdon. He must point out to the last speaker that there were many people of great knowledge of the subject who fully believed that within a reasonable time the sixpenny tariff would pay, on the same principle that lower rates had led to large increases of business in railway, omnibus, and other companies, not to speak of the great success which attended the Post Office reductions of rates. As he said in his opening speech, during the first year the augmentation of business was most encouraging, but it seemed a year ago to suddenly stop and go back. One advantage they gained by the low tariff was that they kept off competition, for, as would be remembered, one or two very serious attempts were made to obtain money from the public to lay cables across the Atlantic, and he was not at all sure if they were to raise the tariff beyond 1s. whether some such schemes might not crop up in the future, when they might be in a worse plight than they were in now. Mr. Jackson referred to the question of writing down the capital, but he (the speaker) could only say in reply to that, that the Directors had no intention of proposing anything of the sort, and therefore it was unnecessary for him to deal with the subject.

He then put the motion to the meeting and declared it carried unanimously.

Continuing, he said he wished to make one or two remarks upon the motion of which Mr. Smith had given notice. He was not sure it was a proper motion. He had no desire to do anything in the nature of stifling discussion, especially on so important and interesting a matter as the application of the interest on renewal fund. They must all know that the Board had every desire to give the shareholders the benefit of everything they thought could be given consistently with the interests of the Company. There was another objection to it, he would venture to mention, and it was that no notice of the proposal had reached the distant shareholders, and it was therefore impossible for them to know what might be the opinion of those shareholders on the matter. He had, as he said, no desire to stifle discussion, and if Mr. Smith would not object to put his proposal in a somewhat different form, he would then be very glad to take the sense of the meeting upon it. The suggestion that he would make would be that the motion should read

"*That in the opinion of the stockholders present at this meeting it is desirable that from 1st July, 1888, the whole of the interest arising from the investments of renewal fund be carried to revenue account.*"

Mr. SMITH accepted this, and said he saw no objection to put his motion in the form of a recommendation, repeating, however, his opinion that the time had now come when the interest on the renewal fund should be distributed as dividend.

Mr. JOHN NEWTON seconded the motion.

Mr. GUESDON again protested against any interference with the renewal fund. He did not pretend to be a large shareholder in the Company, but he held a sufficient stake in it to warrant him in expressing an opinion upon the question. He did not hold his shares for the value they might represent on the Stock Exchange, he held them as a source of revenue, and he wanted to see the Company occupy a permanent position of prosperity. He moved as an amendment

"*That the disposal of the interest of the investment of the renewal fund be left to the discretion of the Directors.*"

A SHAREHOLDER seconded the amendment.

Mr. JACKSON said he saw no difference between the motion and the amendment, Mr. Smith's motion being simply a recommendation to the Directors to consider the advisability, in the interests of the shareholders who were receiving no dividend from the earnings of the Company, of distributing the interest on the renewal fund. They did not want to force the hands of the Directors, but they said they were fairly entitled to the interest on that fund.

After a few more remarks from Mr. SEELY,

The CHAIRMAN said he wished to draw their attention to the agreement that was entered into by the shareholders with the Directors, Mr. Smith himself representing the shareholders. The agreement was that the Directors would stop further contributions to the renewal fund when that fund had amounted to £1,000 000. After that date the interest of the fund alone would be added to the principal. Therefore Mr. Smith's resolution was somewhat at variance with the agreement, and he must say that the Board were of opinion that a million was not too much for the renewal fund, and therefore Mr. Smith could not expect any support from the Directors, although it was only fair that it should be put to the meeting.

Mr. SMITH said the circumstances were not identical with those when the agreement was entered into.

The CHAIRMAN then put the amendment to the meeting, which he declared carried by a show of hands.

A vote of thanks was afterwards passed to the Chairman and Directors, and the proceedings terminated.

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The Direct United States Cable Company.

The twenty-second ordinary general meeting of this Company was held at Winchester House, 50, Old Broad-street, on July 20th, under the presidency of Sir John Pender, K.C.M.G.

The ACTING SECRETARY (Mr. T. Finnis) read the notice convening the meeting, and the minutes of the twenty-first ordinary general meeting, held on January 20th, which were signed by the Chairman as correctly entered. The report of the Directors was taken as read.

The CHAIRMAN then said: Gentlemen, before I move the resolution for its adoption I shall make, as usual, a few remarks upon the report, and also upon the present position of the Company. The revenue for the half-year (after deducting outpayments), and including income-tax refunded, amounted to £17,508, and the working and other expenses, including income tax, but exclusive of cost of repairs, absorb £15,277, leaving a balance of £2,231 as the net profit of the half year, making, with £9,911 (composed of £6,899 interest and profit, and £3,012 only of principal) transferred from the reserve fund account, a total of £12,142, which has been appropriated to the payment of the following dividends:—Interim dividend of 2s. per share for quarter ended 31st December, 1887, £6,071; interim dividend of 2s. per share for quarter ended 31st March last, £6,071—total, £12,142. A final payment of 2s. per share for the quarter ended 30th June is now proposed, making, with the three interim dividends already paid, a total of two per cent. for the financial year. The revenue, owing to the low rates current, shows a reduction of £6,C64 as compared with the corresponding period of last year. The expenses in London show a reduction of £583 in salaries, and an increase of £77 in stationery and printing, the remaining items being about the same as in last year. The expenses at stations show an increase of £60 in house allowances, £106 in maintenance, £45 in rent, £109 in travelling, and £59 in repairs, principally owing to outlay at Halifax station. The other items continue practically unaltered. In the further expenses directors' fees are reduced by £157, and use of patents by £126, and the half-year's income-tax is less by £286 than in the corresponding period. On the whole the expenses and other payments exhibit a reduction of £628. The cost of the current repairs amounted to £25,222 to 30th June. This sum is at present standing in the balance-sheet, but will be dealt with later on, together with the cost of completing the repairs. The investments continue worth much more than they cost the Company. These are figures which give you a thorough knowledge of the way your affairs have been dealt with during the past six months. When I last had the pleasure of addressing you I went fully into the details of the negotiations that were then going on with regard to raising the rates. As you are aware we have given the 6d. rate a thoroughly fair trial. We have been working at it for two years. Some of our friends were sanguine enough at one time, when they saw the traffic going up almost by leaps and bounds, to feel that the 6d. tariff might eventually be a tariff sufficient to enable us to pay a fair dividend. I confess I never believed a 6d. tariff would give us anything like a dividend. The result has been that for two years we have been, as you see we are to-day, paying a dividend, a portion of which comes from the actual working of our system, and the remainder principally from the interest on our invested reserve. Consequently we have been up to to-day in a position which I think is not creditable to business men. I expressed a very strong opinion when I last addressed you, and I said I thought the time would come when a conference ought to be held at which we should take into consideration the question of advancing the rate. At that time there were very considerable difficulties, and I saw clearly that to press anything like a conference wou'd do more harm than good. At the same time I saw that we had made an impression, that we had sown seed that was likely to fructify, and which would in time show good results. I am pleased to tell you to-day that those negotiations which have been going on more or less ever since our last general meeting have culminated now in the Anglo-American Company, the Western Union Company, the Mackay-Bennett Company, and the Direct Company seeing the folly of going on any longer at a 6d. rate. There is one exception to this, and that exception, I expect, will be dealt with on Monday—I refer to the French Company. About two years ago that company—it is probably a little less than two years ago—were most anxious that we should go back to the 1s. 8d. rate. There were very good reasons then why that could not be done. We had entered upon a policy of low rates, and we had to show how far the different parties were satisfied with the result of that. We have proved by going down to 6d. what a 6d. tariff can do, and that tariff is unsatisfactory. Representatives of the French Company, I expect, will be here on Monday, and I see no reason why they should not agree with us; in fact, I think I might almost assume that they will agree with us in putting up the rate, and, if they do the result will be that on the 15th August we shall be working at 1s. instead of 6d. Now, if the whole of the traffic at present carried at 6d. be maintained under the 1s. rate, the total receipts would be much about what they were when the rate was 2s., when we were paying you fair and respectable dividends, but the earnings of the pool would of course now be lessened by the proportion carried by the Commercial Company. If the public do not give us the same amount of support at 1s. as they do now at 6d., it will be for our consideration a year hence—as we shall give the 1s. rate a year's trial—whether we should not readjust the rate again. I hold that a concern is not managed fairly to the shareholders or to the public if it is worked under prime cost. We shall try during the year to do the best we can to develop the traffic and to serve our customers, and if we can establish a 1s. rate as a permanent rate we shall have done a good service to the shareholders and a very beneficial act for the telegraphing public. I have told you so far what is now before you, and I think you may look forward with perfect confidence to having the 1s. rate established, and that at a very early period indeed. Now, in regard to that part of the business—which I call a very important part, as it affects our dividend—I have given you all the information I am in possession of. I have kept nothing back, and I think the different parties interested are all entering into an honourable obligation, that there are to be no rebates and that the agreement is to be fairly and honourably conducted. If we find there is any departure from that I shall be the first to protest against it. I think, however, this arrangement which is now being entered into by the different telegraph companies will be carried on in a straightforward business way; and if it is carried on in that spirit I am sure that we shall benefit by it. Now, gentlemen, I had hoped to-day to give you a second budget of good news. I had hoped to be able to tell you that our cable was repaired, and in thorough working order, and I am enabled to tell you that we have taken out one of the most important faults in the cable. We have lifted the cable from over two thousand fathoms of water—two thousand two hundred—taken out the fault, and made the repair. That is a very great fact, and a very great feature in submarine telegraphy. To lift from 2,200 fathoms a cable that has been lying in the sea for nearly fourteen years is no small point at the present moment. It is one which scientific men must recognise as one of the great features of the times. It is one of those questions which those who are interested in submarine telegraphy must recognise as giving stability and character to their property, which, probably, some have not felt up to this time. To be able to repair a cable after fourteen years' submersion, and lift it from 2,200 fathoms of water, shows really that we have got such a knowledge of our business as will enable us to say with confidence that we possess something like a permanent property. The fact that you have not heard to-day of the completion of the repair is attributable, no doubt, to that which every one of us is complaining of at the present moment, that is the weather. I believe they are having very stormy weather in the Atlantic, and, as you know, it is impossible to repair a cable in a storm. We have to wait for calm quiet days, and in those calm quiet days we are able to carry on this important work. We believe that the ship is at the present moment within 600 miles of the Irish coast, in which position she has lifted and buoyed one end of the cable, and is only waiting for a spell of good weather which will enable us, we believe, to thoroughly repair the cable. The amount of cable put in will almost give us a new departure. We shall then be able to work our cable, and not only contribute our share to the pool, but we shall also be able to work our duplex system, which we have not been able to do on account of these faults. Therefore we shall take the position that we always desired to take in the pool—to do our full share, if not more than our proportion, of the work of Atlantic telegraphy. Now, I think I have pretty well told you the whole story of the Direct United States Cable in the last six months. I have shown you that we have done a bad business, which I am free to admit; but I have shown you that we have done a good business at the same time, in beginning—and I hope in quickening, to some degree—the conclusion of the 6d. rate. We have proved that that rate will never pay. It is impossible it can ever pay. We are therefore, I say, now taking a new departure, and that departure is likely to ensure us receiving better dividends than we have had in the past two years. With these remarks I move:—

"*That the report of the Directors, dated 6th July, 1888, together with the statement of accounts to 30th June, 1888, annexed thereto, be and the same are hereby received and adopted; and that a final dividend be now declared of 2s. per share, free of income-tax, making, with the interim dividends already paid, a total dividend of 2 per cent. for the year ended 30th June, 1888.*"

Mr. WM. FORD seconded the motion.

The CHAIRMAN having expressed his readiness to answer any questions,

Mr. GUESDON asked in regard to the negotiations with the cable companies, with the view of readjusting the rates, whether the arrangement come to was under a "pool," or whether the Commercial Company was to be in any distinct position from the other companies with respect to the working and profits of the cable. He was glad to hear the Chairman say that he hoped the 1s. rate would pay. Many years ago the Chairman expressed a strong conviction that a 1s. rate would not pay. He himself felt that a low rate would mean a large extension, and while the 6d. rate was insufficient to realise fair profits for the shareholders, it had developed one great fact—that low prices had increased to a larger extent than he had thought possible the use of the wires. He hoped, unless the traffic fell off very much, that they would be able to maintain a 1s. rate between the two great English speaking races. He was anxious to see submarine telegraph business carried on at a price favourable to all parties. He was not one who looked for 10 per cent. dividends, as those days were gone. He inquired why the cost of the patents had been less, and said he assumed, although it had not been stated, that the cost of the repairs to the cable would be charged to the reserve fund.

The CHAIRMAN, in reply, said that they had no "pooling" arrangement in regard to the raising of the rate. The old pool would continue, but the Mackay-Bennett Company would simply come into the arrangement to raise the rate, and they were particularly anxious that the rate should be raised. They, in fact, always desired that the rate should have been increased to 1s. 8d., not to 1s. It was the English companies who had fought for the 1s. rate, and they believed that if they got the same amount of traffic at 1s. which they had been getting at 6d., they would be brought into the position of paying fair and moderate dividends. He repeated what he had said before, that if they were to work at the 1s. rate with only the same amount of traffic which they had when they charged 2s. it would not pay, and he had not changed his opinion in that respect in any way. With regard to the less amount which had been paid for the use of patents, that was owing to their

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not paying for their patent rights during the interruption of the cable. They had contracted with the Telegraph Construction Company to carry out the repairs to the cable. He had satisfied himself by inquiring elsewhere that that company could do the work on better terms, and he had been fortified in that view by the opinion of their special advisers Messrs. Clark and Ford. They had to furnish 300 miles of cable for the repair, and that was an important work. Taking the matter all round—the cable, the ship, and the experience—they found that their interests would best be served by placing the contract in the hands of the Telegraph Construction Company. They could not specify that the work was to be done in a certain time; but they were paying for the cable, and they would pay so much a day for the ship; and it was therefore so much to the interest of the Telegraph Construction Company to show how quickly, cheaply, and efficiently they could effect the repair, for in that manner they would increase the high reputation which they already held. With regard to the reserve fund Mr. Guesdon was quite right. The cost of the repairs must be taken from that fund, on which they had had to draw to a small extent in order that the shareholders might have some return. They would like, however, to be able to add a little to that fund, so as to bring it up to its former amount, as he believed that the reserve fund was the backbone of a concern like theirs.

In reply to Mr. Jackson, the CHAIRMAN added that possibly the French Company, in order to acquiesce in the proposal for increasing the rate, might require a *quid pro quo*. As they were aware, a question was pending between them at the present moment. Probably the French Company had found out that they had made a mistake in raising that question; but that point was outside the question of raising the tariff. If the French Company did not agree to that they would pursue a policy different from what they had lately pursued, and a policy so inimical to the interest of the other companies that he believed they would be strong enough to carry their point.

Mr. JACKSON said he had been glad to hear of the proposal to increase the tariff. He thought the 6d. rate had lasted too long already.

The CHAIRMAN: Certainly.

Mr. JACKSON (continuing) drew attention to the large amount that would have to be paid for the repairs, an amount which he said would come to something like two years' dividends; and he thought that should serve as a warning to any future competing companies, letting them see, as it did, what risks they ran, and what their prospects were of profits. He thought their business would depend essentially on the energy with which it was conducted.

Mr. FRY asked whether the shareholders were to understand that the French Company were to come back into the pool, for that Company had treated them most unfairly, and in a most unbusinesslike manner.

The CHAIRMAN said that that was a matter that was in the hands of the lawyers at the present time. What would be decided in the matter he was not prepared to say, but he agreed that the French Company had acted very unfairly in leaving the pool; and their position was much weaker now than it would have been had they kept to the arrangement into which they entered. In further reply to Mr. John Newton, the Chairman said that the pooling question was not involved at all in the arrangement for raising the tariff to 1s.

Mr. NEWTON expressed great satisfaction at the Chairman's intimation as to lifting the cable from a depth of over two miles and successfully repairing it. He considered that that added to the stability of their position, and justified the view which he expressed some years ago that the Chairman was not entitled to state that the life of a cable was only 10 years. He (Mr. Newton) pointed out at the time that there was not sufficient experience to justify such a view, and that, on the contrary, the cable between England and France had been down for 21 years.

The CHAIRMAN said that there was a time when sound scientific men believed that it was impossible to lay a cable in the Atlantic. Other scientific men said that if a cable were laid it could never be picked up again. This view had been proved to be wrong, as the result of experience. He himself was certainly open to conviction, and when he saw a thing done he was only too glad, and did not in any way dislike it because it happened to disprove an opinion he had formerly expressed. Progress was being made and he accepted good things as they occurred.

Mr. WEATHERLEY thought the Board should forego some of their remuneration, and he maintained that the fact that the dividend was only 2 per cent., and that was being paid out of the reserve fund, showed that some alteration was necessary in the administration of their affairs.

The CHAIRMAN said that the Company was managed with complete efficiency, and Mr. Weatherley, in referring to this matter, had forgotten the fact that it had been the wish of the shareholders that they should adopt the 6d. rate and that something should be taken from the reserve fund account to supplement their dividend. In fact, everything had been done in accordance with the wishes of the shareholders.

Mr. HOOPER wished to know whether the interruption to the cable was attributable to any specific cause that was not likely to recur, or whether it was owing to decadence which was likely to cause the expenditure which they were now incurring to come upon them again. He also desired to know how much less they had received from the pool, owing to their inability to carry messages in the past half year.

Mr. UNDERDOWN observed that they had not lost anything.

The CHAIRMAN said that their arrangement in connection with the pool enabled them to go on for some time until they had effected their repair, receiving the same proportion of the revenue. They were, however, bound by their agreement to make their repair as speedily as possible. They made an important change in the position of the cable last year, removing it from a place called Brown's Bank, which was such an insecure place that they were frequently put to expense in repairs, and they had now placed the cable in a position of much greater security, and relieved themselves of the outlay which they had frequently been subjected to previously.

The motion was then put to the meeting and carried unanimously.

The CHAIRMAN then proposed the re-election of Mr. William Ford as a Director.

Mr. E. M. UNDERDOWN, Q.C., seconded the motion, which after some discussion was carried unanimously.

The CHAIRMAN then proposed the re-election of Mr. C. J. Günther as a Director.

Admiral R. C. MAYNE, C.B., M.P., seconded the motion, which was carried unanimously,

Mr. John G. Griffiths and Mr. John Sawyer were afterwards re-elected auditors.

Mr. NEWTON proposed a vote of thanks to the Chairman, who, he said, had answered all the questions which had been put to him in a straightforward manner. They obtained from Sir John Pender information which they never received from any other Chairman.

Mr. JACKSON seconded the motion, which was carried unanimously.

The CHAIRMAN having acknowledged the vote,

The proceedings then terminated.

Eastern Telegraph Company (Limited).

The thirty-second half-yearly ordinary general meeting of this Company was held on Thursday, the 19th July, 1888, at Winchester House, 50, Old Broad-street, Sir John Pender, K.C.M.G., in the chair.

The SECRETARY read the notice convening the meeting, and the minutes of the thirty-first half-yearly ordinary general meeting of the shareholders, held on the 19th January, 1888, which were signed by the Chairman; and the report having been, at the request of the meeting, taken as read,

The CHAIRMAN said: Gentlemen, before I ask you to approve of the resolution which I shall submit to you to-day I shall make, as usual, some remarks upon the report, so that we may give you the fullest possible information as to the working of this system during the last six months. Our revenue for the past half year amounted to £359,706, as against £331,862 in the same period of 1887, or an increase of £27,844. Included in these figures is an amount of £31,200 dividend on our investment in the Eastern and South African Telegraph Company, as compared with £23,400 last year, an increase of £7,800. As stated in the report, nearly all the shares in the Eastern and South African Telegraph Company belong to the Eastern Company. It is, therefore, most satisfactory that we should receive a dividend of 2 per cent. more than last year. The Black Sea Telegraph Company, owing to an interruption of the cable, shows a falling off of £1,300, this company having declared a smaller interim dividend than usual; but we are not without hope that the final dividend for the year will make up in some measure the lower interim distribution. Our investments in Direct Spanish Telegraph Company's Ordinary Shares give a return of £676, as against *nil* in the corresponding six months. The Direct Spanish Company, in which this Company has a controlling influence, has now turned the corner, and will, we expect, in future give a good dividend to its shareholders. The total working expenses amounted to £87,134, against £83,035, or an increase of £4,099. This is principally caused by the increase of work. The amount written off for depreciation of cable stores is £2,150 more, and we have also written off from the cost of electric lighting plant and tanks at stations £1,000 more this half year, and charged the cost of land lines at Cadiz and establishing station there, £195, to revenue. The general expenses in London were £8,333, and in 1887 they were £8,169. Some of the items under this head are more and some less, the net difference being an increase of £164. The working expenses at stations were £62,786 against £60,674, or an increase of £2,112. The principal increase under this head is maintenance and renewals of electrical instruments £1,093, and stationery and printing £660. The first increase is explained by a number of new instruments having been sent to Porthcurno, Suez, Aden, Bombay, and the Levant, and a larger amount of stationery was supplied owing to the increase in the number of messages and general business of the Company. I may also remark that we have opened a station at Cadiz, which involved some expense, but which will be a feeder to our general system. The expenses attending repairs and renewals of cables amounted to £38,412 against £43,903, or a decrease of £5,491, although we have charged under this head the whole cost of duplicating the Zante-Patras section, about sixty miles. Therefore, after charging all expenses, including income-tax, interest on the Debentures, Debenture Stock, and Preference Shares, we are able to pay a dividend of 5 per cent., and a bonus for the year of 1 per cent., making together 6 per cent. per annum, and carry to general reserve fund £75,000, carrying forward a small balance of £884 to the next account. It will be seen on reference to page 6 of the accounts that we have charged the whole cost of triplicating the Porthcurno-Malta cable and extension to Zante to the reserve fund, which is thus left at £342,338, which, with the special reserves stated in the balance-sheet, make the total amount of the reserves £362,606. We have also charged the amount expended on the new screw steamer "Amber" to the maintenance of ships fund. The issue of Four per Cent. Mortgage Debenture Stock to pay off the Five per Cent. Debentures is now complete, and the premium on the issue of the same, £2,366, has been credited to the reserve fund. The Five per Cent. Debentures were re-payable in 1887, amounting to £450,000. I think I need not say that that is a very remarkable instance of the strong position which our stocks hold on the London market, that we have been enabled to issue our Four per Cent. Debenture Stock practically at a premium, and it now stands at a considerable premium. That is the best evidence I can give you of the confidence on the part of the commercial community of London in this undertaking. It will be seen on reference to page 8 of the accounts that the total capital amounts to £5,900,000, and the capital expenditure to £5,965,000. We propose to make arrangements to dispose

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of the £62,000 Six per Cent. Debentures of the Direct Spanish Company, and when that is complete the capital and the capital expenditure will practically balance. We shall then be able to increase the investments on account of our reserve funds. I may say that all these extraordinary sums—taken partly from reserve and partly from revenue—enables us to keep down our capital expenditure, and I hope to maintain in future a very steady and respectable dividend, at the same time increasing our reserve fund, because that fund is most important in connection with such an institution as this. With a strong reserve fund at our backs our shares can be maintained in the market, and regarded as a good investment, and not as for speculative purposes. We find that men are coming in now and becoming proprietors who years ago would not have considered it an investment in which they could put either their own money or that of trustees. In conclusion, I may summarise the accounts as follows:—The gross revenue is £27,844 more; the balance brought forward from last half year was £16,306 more than in the corresponding period of 1887; and the total expenses, including ships and income-tax, are £3,341 less, so that we are able to place £27,000 more to reserve fund, and to pay £19,000 more (or half per cent. more) bonus than in the corresponding period of last year. Now, gentlemen, I think I have placed before you a most satisfactory statement. Just before coming into the room I referred to the remarks that I made at the last half-yearly meeting. That was one of those pleasant meetings which I personally must remember as long as I live. Very kind remarks were made on that occasion by shareholders at the honour which had been conferred upon me—an honour which I accepted as being connected with the institution by which you have all so long stood I see, referring to the report of the last meeting, that I made certain prophecies. I told you that in all probability, at the pace that we were going, we should be able to pay you the 1 per cent. bonus. That bonus had been taken away for a time on account of the large deductions that had been made in our rates at the Berlin Telegraph Conference. We were forced to reduce our rates. We have, however, recovered our position, and we are able to declare to-day our regular 5 per cent. dividend, with a bonus of 1 per cent. for the year, bringing you back to the point where you stood before we went to Berlin. I think you must regard that as a very satisfactory position to be in. During the last year, too, we have added increased strength to our system by the laying of a third line from Porthcurno to Lisbon, Gibraltar, Malta, and Zante, giving us another important cable; and that makes us independent of the French line through France. While, however, it makes us independent of that line, and we can work without it, we are so anxious to have our work done in a thoroughly efficient and prompt manner that we are still desirous of having that line through France. We have been negotiating for a considerable time with the French Government, but there have been difficulties in the way—difficulties connected with the Channel cable. It was only the other day, I think last month, that the whole of those agreements were settled, and now the Submarine Company's system is merged into the Government system. By that we shall practically benefit to some extent, but it will leave the French people free to deal with us in regard to this line through France. If we can get it on such terms as will be a great aid to us, and facilitate our work, we shall have it; but having laid down this third line that I have mentioned we are made perfectly independent, whether France agrees or not. I think, however, that a spirit is abroad among nations that this great system is now more or less international; while they contribute nothing, they receive the same benefit that England receives from this system. I think that that view is gaining ground so far that I am hopeful in the future that we shall find less difficulty in negotiating with foreign Governments than we did in the early days of this work. We have further evidence of that at this moment in Portugal, where there is a disposition to meet us, and a fair disposition, too. We shall encourage that as far as possible; and you can easily understand that the more feeders we can secure, the more other nations interest themselves in our system, the better for the shareholders. I think I have now pretty nearly told you the whole of our position excepting this: I have told you in my written remarks that we are doing a most satisfactory business at the Cape, but we feel that that system is not as perfect, not as secure, as we should desire it to be. We have only duplicated up to Aden, and a very small portion of our line is duplicated between Aden and the Cape. We are now about completing arrangements whereby we shall secure an alternative route to the Cape, joining our system at St. Vincent, utilising the line lately laid along the West Coast of Africa, giving us an alternate line, and securing a permanency to our Cape traffic, meeting a requirement of the Government, and, in other words, giving us such an independent position that will very materially indeed strengthen the Eastern Company. The Eastern Company is the parent company, and is the owner of a large portion of the South African Company and African Direct Company's shares. The Eastern Company will, to a large extent, control this new system, and when I tell you that Sir James Anderson and one or two others connected with this system will control that system, you will see that it places you in a stronger position than I have ever been able to tell you of at any previous meeting. I may say this, just to show you how rapidly these matters are dealt with. We work in connection with the Eastern Extension Company. They are a large feeder to us homewards, we are large feeders to them outwards. Three weeks ago both cables, which is very remarkable, ceased to speak at the same moment. That was to us an extraordinary event. However, we did not hesitate to take steps at once to have the cables repaired; and I am glad to say that the interruption is now tided over, because one of the cables is repaired, and we expect to hear of the other repair being effected. The Eastern Extension Company took steps and chartered a vessel; in short, the time of interruption and difficulty was met in such a way that the whole thing was put right in the short space of three weeks, and that almost at the other side of the globe. That work was done by the Eastern Extension Company, which is our ally; and of that Company, as you are aware, I am also Chairman. The advantage of working the two companies together is so immense to us both that I mention this circumstance, because if there had been opposing interests we could not have done the work in anything like the time I have mentioned. I think I may now conclude by repeating what I said before—that we have strengthened our position in every way. We have increased our reserve fund, we have paid a large sum towards increasing our cable power, and we have also given you to-day, with all that extra expenditure, a fulfilment of our promise by giving you the bonus of 1 per cent. With these remarks I beg to move:—

"*That the printed report and accounts of the Directors to the 31st of March, 1888, submitted to this meeting, be and the same are hereby received and adopted. That a dividend on the Preference Shares of the Company to the 30th of June, 1888, at the rate of 6 per cent. per annum, be paid, less income-tax, and that, in accordance with the Directors' recommendation, a dividend be and is now declared of 2s. 6d. per share, with a bonus of 2s. per share, both free of income-tax, on the Ordinary Shares of the Company, making, with previous payments by way of dividend on account, a total payment of 6 per cent. on those shares for the year ended 31st March, 1888.*"

The VICE-CHAIRMAN (the Marquis of Tweeddale): I beg to second that.

The CHAIRMAN: If any gentleman has any remarks to make before I put the motion, I shall be glad if he will speak now.

Captain GOODSALL: On which coast is the Bombay cable down? You say in paragraph 6: "The several sections of this Company's cables are in good working order, with the exception of the Aden-Bombay cable."

The CHAIRMAN: I should have mentioned in my remarks that the shore end of one of our Bombay cables has been interrupted. When I say "interrupted," it is limping, it is not working as it ought to work; but we expect when the ship gets to the spot it will be repaired speedily. Meantime, it does not interfere with our traffic except to the extent that we have one cable less.

Captain GOODSALL: Will you inform me the length of cable between Porthcurno and Zante, *vid* Malta, for which you are paying £315,000?

The CHAIRMAN: Will you please finish, and I will answer the questions altogether?

Captain GOODSALL: I should like to know the price you are paying for the "Amber" out of the ships' maintenance fund. You mix it up altogether. That is all that I have to say.

The CHAIRMAN: The distance is 2,728 miles from Porthcurno to Zante. The "Amber" is chargeable to our maintenance ships' reserve fund, and the amount expended to 31st March last was £29,000 odd.

Captain GOODSALL: Thank you.

The CHAIRMAN: The resolution has been moved and seconded; those in favour of it please hold up their hands. To the contrary. Carried unanimously. That is the only resolution I have to put to you to-day, and I am pleased to find that you are so well satisfied with it.

Mr. NICHOLSON: Before we separate I think we may pass what with us is not a formal vote—a vote of thanks to the Chairman, Directors, and staff for the very able way in which the affairs of our Company have been conducted. That resolution requires no recommendation from me, and I beg to move it.

Mr. HURST: I have great pleasure in seconding that, because I think the report of the Directors and the explanation of the Chairman are extremely satisfactory. Everything we have heard to-day should make us thoroughly pleased with our property. There was one remark in particular that I wish to note that is equally satisfactory—that is, when he spoke of these shares being held very much now as an investment. It would appear that the idea of speculation attaching to the shares is passing away, and that our undertaking is now regarded as a positive and sound security.

The SOLICITOR (Mr. Burt): I will put that to the meeting:—

"*That the best thanks of the meeting be given to the Chairman, the Board of Directors, and the staff for their able and successful conduct of the Company's business during the past year.*"

Those in favour of that please signify the same in the usual manner. To the contrary, if any. Carried unanimously.

The CHAIRMAN: On behalf of my colleagues and myself I have the greatest possible pleasure in returning thanks. As to our staff, it has always been our pleasure—and not only our pleasure, but our duty—to have on our staff the very best men we can find to do the work. We have treated those men generously, and we have had many acknowledgments of that. It will always be our duty to maintain on our staff men of the highest qualifications to fulfil the very onerous duties entrusted to them. On behalf of my colleagues and myself, and the staff, I beg again to return you my best thanks.

The proceedings then terminated.

The Globe Telegraph and Trust Company (Limited).

Report of the Directors to be presented to the fifteenth ordinary general meeting to be held this day (Friday), at 2 p.m., at Winchester House, 50, Old Broad-street, London, E.C.

2. The net revenue of the Company for the year, after deduction of expenses, amounts to £168,053. 13s. 2d., which, with the balance of £1,442. 6s. 8d. brought forward, make a total of £169,485. 19s. 10d. From this amount there has been distributed the sum of £114,023. 14s. 9d. in interim dividends, leaving an available balance of £55,472. 5s. 1d.

3. The Directors recommend payment of a final dividend for the year of 3s. per share on the Preference Shares, and of 3s. per share on the Ordinary Shares, making, with the former distributions, a total dividend for the year of 6 per cent., less income-tax, upon the Preference and 3½ per

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cent. net upon the Ordinary Shares (against 2½ per cent. for the preceding year), and carrying forward a balance of £2,107. 1s. 3d.

4. The Directors hope that before long an arrangement will be made whereby a remunerative tariff may be established for Atlantic messages.

5. The Imperial German Government having acquired the lines of the German Union Telegraph Company of Berlin, the German Union Telegraph and Trust Company will cease to exist at about the end of the present year. This is a measure in furtherance of the acquirement of the Channel cables by the Governments. The Board have reason to believe that the return on the capital of the German Union Telegraph and Trust Company, in which this Company holds largely, will be about par, while on the Preference Shares of the German Union Telegraph Company of Berlin held by this Company there will be a profit on capital account of about 20 per cent.

6. In pursuance of agreements made between the Western and Brazilian Telegraph Company and the London Platino Brazilian Telegraph Company, the shares of the latter Company have been exchanged for an equivalent in the Western and Brazilian Telegraph Company's Shares. The Board hope that the revenue on this item in their accounts will be augmented in the future.

7. During the past financial year a further quantity of 2,000 Ordinary Shares of £15 each of the Western and Brazilian Telegraph Company Shares have been acquired in exchange for Preference and Ordinary Shares of this Company.

8. Fifty-nine shares of the German Norwegian Telegraph Company have been drawn for amortisation, and paid off at par, less exchange.

9. In conformity with the Articles of Association, the Marquis of Tweeddale and Henry Daniel Gooch, Esq., two of the Directors, retire, but, being eligible, offer themselves for re-election.

10. The auditors, Mr. John George Griffiths, F.C.A. (Messrs. Deloitte, Dever, Griffiths and Co.), and Mr. William Griffith, B.A., barrister-at-law, also retire at the meeting, and offer themselves for re-election.

NEW COMPANIES REGISTERED.

THE SUBMARINE MINING AND TORPEDO EXPLOSIVES COMPANY (LIMITED).—Registered by Saunders, Hawksford, Bennett and Co., 68, Coleman-street, E.C. Capital £30,000, divided into 30,000 shares of £1 each. Object, to acquire from Messrs. Gibbons and Fox all patent and other rights belonging to them in torpedoes and submarine mines, under an agreement dated July 10, 1888, and made between Charles J. Fox of the first part, Joseph Pannell Gibbins of the second part, and Alfred Wright, as trustee for the company, of the third part; to carry on the trade or business of manufacturers of torpedoes, and all materials, substances and things incidental to the manufacture of torpedoes and submarine mines, or the packing and storing, firing, and carrying on the disposition thereof. The first subscribers are:—

	Shares.
F. Thorn, 8, Addington-road, W.	1
T. Heyworth, Newport	1
H. D. Sandeman, Fernlee, Worlingham, Kent	1
J. W. Baine, Howard House, Harrow	1
W. H. Amos, 124, Burrage road, Plumstead	1
J. S. Anderson, 36, Wellesley-road, Croydon	1
T. Large, 8, Coburg-road, Teddington	1

The first directors shall be Frederick Thorn, L. Heyworth, H. D. Sandeman, and J. W. Paine. The qualification shall be the holding of not less than 250 shares in the capital of the company. The remuneration to directors shall be the sum of £500 per annum, with an additional sum of £150 to the chairman.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended July 20th, 1888, amounted to £4,633.

CUBA SUBMARINE TELEGRAPH COMPANY.—After providing for the dividend on the Preference Shares, and placing £6,000 to the reserve fund, a dividend on the Ordinary Shares at the rate of 9 per cent. per annum is proposed, leaving £1,195 to be carried forward to the current half year's account. A year ago the dividend was at the rate of 8 per cent.

SUBMARINE TELEGRAPH COMPANY.—The accounts of this company for the half year ended June 30th, 1888, submitted to the Board, show a balance, subject to audit, which enables the directors, after adding 15 per cent. of the gross receipts to the reserve fund, to recommend a dividend at the rate of 13½ per cent. per annum.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended July 20th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £3,924.

CRICKET.

Eastern Telegraph Company v. Kenneth Anderson and Company.

This match was played at Beaufort House on Saturday, the 14th inst. The Eastern won the toss, and commenced to bat in a very bad light; but notwithstanding this they knocked up the very creditable total of 126. Penney and Wells both batted well for 34 and 31 runs respectively, while Richardson played a dashing 17 (not out). Gurney bowled very steadily, his analysis being five wickets for 36 runs. Messrs. Anderson's representatives then wielded the willow, but were all dismissed for the small total of 19, and consequently had to follow on. Their second venture realised 39 runs, leaving the Eastern Company victorious by an innings and 68 runs. For the Eastern, M'Millan obtained 7 wickets for 6 runs, and Chisholm 3 wickets for 11 runs. Great zest was given to the game by Mr. Kenneth Anderson presenting a handsome bat for the highest score in the match, and a ball for the best bowling analysis. The former was won by A. O. Penney, and the latter by J. G. M'Millan, both of the Eastern team.

Mr. Hibberdine acted as captain for the winners, and Mr. Alex. Jack for the losing team. Scores:—

EASTERN.—J. G. M'Millan, b Jack, 8; Chisholm, c Gardiner, b Gurney, 8; S. Wells, c Jack, b Gardiner, 31; A. O. Penney, b Gurney, 34; W. Macdonald, b Gurney, 12; T. Richardson, not out, 17; E. D. Payne, c Granger, b Gurney, 2; Lacy, b Launders, 0; J. Wells, b Gurney, 0; A. W. Donaldson, b Launders, 1; W. Hibberdine, run out, 4; extras, 9—Total, 126.

KENNETH ANDERSON AND CO.—First Innings: G. C. Hawes, b M'Millan, 0; A. Gardener, c Richardson, b Chisholm, 3; A. Jack, b M'Millan, 1; H. Gurney, b Chisholm, 0; Major Granger, c Richardson, b M'Millan, 4; C. Job, b M'Millan, 0; Gowenlock, b Chisholm, 7; A. J. Launders, b M'Millan, 0; J. Lang, b M'Millan, 1; J. Strudwick, not out, 0; E. Smith, b M'Millan, 1; extras, 2—Total, 19. Second Innings: G. C. Hawes, b Chisholm, 0; A. Gardener, b Chisholm, 9; A. Jack, c Penny, b Chisholm, 3; H. Gurney, c Chisholm, b M'Millan, 0; Major Granger, b Penney, 0; C. Job, c Chisholm, b M'Millan, 2; Gowenlock, c Chisholm, b M'Millan, 11; A. J. Launders, b M'Millan, 8; J. Lang, b M'Millan, 0; J. Strudwick, b Chisholm, 0; E. Smith, not out, 3; extras, 3—Total, 39.

PATENT

SILICIUM BRONZE AND SILICIUM COPPER WIRE.

The best for overhead Telephone and Telegraph Lines,

AND ALL ELECTRICAL PURPOSES.

Hard Drawn High Conductivity Copper Wire.

ROLLED AND DRAWN

PHOSPHOR BRONZE.

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BEARINGS, BUSHES,

AND OTHER PARTS OF

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WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, July 25, 1888.		Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending July 25, 1888.	
£			**TELEGRAPHS.**			£. s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American	41	42	3 5 6	Jan., Apr., July, Oct.	41⅞	40
2,614,820	Stock	20/0	Do. Preferred	68⅛	69⅛	3 19 2	,, ,,	69⅛	66⅛
2,614,820	Stock	nil.	Do. Deferred	13⅝	14¼	...	February	14¼	13¼
130,000	£10	3/0	Brazilian Submarine	12⅛	12⅜	5 9 10	Mar., June, Oct., Dec.	12⅜	12⅛
16,000	10	8/0	Cuba Submarine	13⅞	14	5 14 4	February and August	13⅞	...
6,000	10	10/0	Do. Preference	18½	19½	5 2 6	,, ,,	...	...
12,931	5	4%'87	Direct Spanish (£4 paid)	3½	4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference	9⅞	10⅛	4 15 3	April and October	9	...
60,710	20	2/0	Direct United States	9⅝	9⅞	4 5 4	Jan., Apr., July, Oct.	9⅞	9
380,000	10	2/6	Eastern	12⅛	12⅜	4 8 11	,, ,,	12 5/16	12⅛
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜	15¼	3 19 0	,, ,,	15¼	14⅜
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	3 16 3	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅜	13	5 0 0	Jan., Apr., July, Oct.	13	12⅜
22,050	10	5/9	German Union Telegraph and Trust	9	9⅛	7 7 4	January and March	...	...
179,177	10	1/6	Globe Telegraph and Trust	6⅝	6⅞	4 10 10	Jan., Apr., July, Oct.	6 1/16	6⅝
178,992	10	3/0	Do. 6 per Cent. Preference	14	14¼	4 4 3	,, ,,	14¼	14 1/16
150,000	10	5%	Great Northern	13⅜	14¼	5 5 3	Jan., July, and April	14⅛	14
17,000	25	5/0	Indo-European	36	38	6 11 9	April and October	...	...
38,348	10	3%	London Platino Brazilian	5⅞	6¼	...	May and November	...	...
9,000	8	4/0	Reuter's	7⅛	8	5 0 0	April and October	7 9/16	...
338,225	Stock	12%	Submarine	140	150	9 3 4	February & August	...	...
30,000	10	6/0	West Coast of America	6½	7	7 2 10	January and July	6⅞	6½
150,000	100	8%	Do. Debentures	110	115	6 19 2	June and December	...	...
88,321	10	nil.	West India and Panama	⅞	1⅛	...	...	...	...
34,563	10	9/0	Do. 1st Preference	10⅝	11¼	...	April and October	...	...
45,181	15	3/9	Western Brazilian	10	10¼	6 5 0	March & September	10 3/16	10
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118	123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	102	104	5 15 5	March & September	...	...
			TELEPHONES.						
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	8	8⅜	5 0 0	Yearly	8	...
220,000	£1	2½%'87	Oriental (11s. paid)	⅞	⅞	3 13 6	...	...	...
80,000	5	5/0	United	12¼	13	5 15 5	June and December	13⅛	12⅞
50,000	5	2/6	United River Plate	5⅓	6	...	April and October	...	...
			ELECTRIC LIGHT.						
24,357	5	1/2 Feb.'86	Anglo-American Brush (£4 paid)	2½	3	...	...	2⅝	2½
23,692	5	nil.	Do. (fully paid)	3½	4	...	February & August	3½	3⅜
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅛	2⅜	...	...	2 1/16	2⅛
312,000	¼	0/1¼d '86	Maxim-Weston	1/16	3/16	...	February	...	...
			MISCELLANEOUS.						
37,350	12	12/0	Telegraph Construction and Maintenance	39	40	5 19 11	March and July	39⅜	39
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	17½	18½	5 9 7	February & August	18⅛	17⅝

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000

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The principal objects of the Corporation are:—

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2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the duties of the family solicitor.

The Corporation acts as Trustees for the Debenture Holders in Public Companies.

For terms, &c., application should be made to the General Manager at the Company's Office.

GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 533.—Vol. XXI. FRIDAY, AUGUST 3, 1888. Price 4d.

NOTES.

We are glad to announce that the Organising Committees of Sections A and G of the British Association have arranged a joint discussion on "Lightning Conductors," to be held at the Bath meeting, in September. Mr. W. H. Preece, F.R.S., will open the discussion, and Prof. Oliver J. Lodge, D.Sc., F.R.S., will defend the position he advocated this year before the Society of Arts. The occasion will be looked forward to with the greatest interest, and we anticipate a very instructive debate.

The Metropolitan Electric Supply Company, to which we drew attention last week, closes its lists to-day. Besides the influential names which we then gave as connected with the scheme, the directorate consists of a number of gentlemen who have been associated with electrical industry almost from its infancy. It will be seen by the prospectus that this company is not committed to any particular patents or systems, but leaves itself free to adopt any which promise favourable results. Under such management, and with such a programme, the success of the undertaking is well assured.

The Chelsea Electricity Supply Company, which has also just closed its subscription list, has a healthy appearance which it affords us much pleasure to recognise. Launched under the auspices of three leading electrical firms (the E.P.S. Company, the Anglo-American Brush Company, and Callender's Bitumen Telegraph Company), with directors from each of these companies on its own Board, and with a committee of consultation consisting of Messrs. Callender, King and Raworth, it is at least certain that the management will know thoroughly well what it is about, and will be quite competent to select the most suitable means of doing it. From a technical point of view the enterprise presents many features of considerable interest. The system to be adopted is that of battery transformers in sub-stations, with the automatic charging and discharging switch designed by the engineers of the E.P.S. Company. Save for the ill-fated Colchester enterprise—which was altogether before its time—this will be the first occasion on which the battery sub-station method of distribution has received a fair trial, and we shall look forward to it as affording a crucial test of the capabilities of the system. If it cannot be made to succeed in the present hands, it must clearly be useless for anyone else to try it for a long while to come. However, there is every reason to anticipate that the Chelsea Electricity Supply Company will be a thoroughly successful enterprise.

By a singular coincidence the same week which has witnessed the public advent of two of the most extensive and most promising electric lighting schemes that have yet been launched has witnessed also the final obsequies of a pair of those wild and worthless ventures which marked the period of inflation of six or seven years ago. The total loss of capital in these two concerns alone amounted to no less than £97,049. Compared with the mechanical skill and knowledge of the science which is now brought to bear upon the problem, the companies which were to have illuminated the world in 1883 may practically be said to have possessed not a single qualification for commercial success. Their untoward fate, it is to be hoped, will act as a warning to any rash and ignorant speculators who may be tempted into the field by the recent successes of better informed and more competent undertakers.

Referring again to the Metropolitan Railway project, and on the principle of *audi alteri partem*, we have pleasure in publishing the opinion of the secretary of the New England Western Electric Light Company, which we find in a letter addressed to our Boston contemporary, *Modern Light and Heat*, especially as this is the first occasion in which we have met with any criticism favourable to the scheme coming from a technical quarter. After referring to the severe handling which it appears that the proposals have received from the *Boston Herald* (surely a competent critic!), the writer proceeds, in somewhat questionable English, as follows:—"The sole reason is because no one has been able to put into use with accumulators a motor of sufficient economy to do its work effectually, with the small current the batteries could give off without damage to themselves, they [query, who?] did not propose to condemn their motors and so did condemn the accumulators. The New England Western Electric Light Company has been running for more than a year a car at Cambridge with 120 cells of accumulators, making 12 miles an hour on levels and three to five up the steepest grades, and never drawing over the 35 amperes, the limit of the batteries without heating, and the cells are as perfect to-day as when first put in, and this at a cost of $3 for 80 miles run, this sum including 10 per cent. on the whole charging and motor plant. These are facts that can be proved; the storage system is a success in this instance and as cheap a method as has been devised and all overhead, underground connections are unnecessary, it can be put in any present well equipped horse railroad.

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If the tracks are in poor condition they should be made strong and that is wise even with horses. There is lots of dust thrown into the air to cover incompetency."

Now, in spite of its batteries which "do not heat," its general incoherency, and total irrelevance to the question of the Underground Railway traffic, we nevertheless find something of distinct value in this communication. So far as we are aware, this is the first record of twelve months' service with accumulators used for traction in which it has been possible to claim that the cells have stood the test triumphantly, and have come out "as perfect as when first put in." Then as to the price! *C'est magnifique, mais ce n'est pas le commerce;* at least we know that it cannot be done in this country, if that is any criterion. One penny three farthings per car-mile (including 10 per cent. depreciation on the plant) would make even a North Metropolitan Tramway director's mouth water. Seriously, however, we are pleased to learn that some financial success has been attained with the battery system in the States, and we shall be glad to have authentic details.

In our issue of June 29th, under the title of "Delany's Improvements in Cable Telegraphy," we described an ingenious modification of the Morse key designed for transmitting dot and dash signals at the ordinary rate of hand signalling over long cables. A fortnight later Mr. F. Higgins pointed out in our correspondence columns that twenty years ago Sir Charles Wheatstone and Mr. Augustus Stroh had designed a key of the same description, and that it had been successfully employed upon the Amsterdam cable. We have since ascertained the date of the patent specification in which this invention is described, and we now publish an extract (with illustrations) in another column, from which it seems sufficiently clear that Mr. Delany's idea belongs to the extensive category of "re-inventions." Whether it is actually possible to increase the carrying capacity of a long cable by substituting this method of working for the Thomson recorder, is, perhaps, open to question. Seeing that the technical officers of the cable companies can hardly fail to have been acquainted with the Wheatstone and Stroh patent, the device, if really efficient, would almost certainly have been in use long ago.

The remarkable experiments with high tension electricity described by M. Gaston Planté in a fascinating book which we review in this issue, recalls to our recollection an experiment which we once saw Mr. Mordey perform at the Brush Company's works. This consisted in obtaining an arc between the surface of a solution of common salt placed in a basin and a carbon electrode brought immediately over it. The experiment is a very brilliant one, the evolved gases recombining in the form of vivid flames, which are of course coloured an intense yellow by the sodium. We do not, however, recollect that the arc assumed the globular form described by M. Planté in similar experiments.

Our New York letter discloses the fact that the battle of Alternating *versus* Direct Currents is being fought out in that city with the utmost determination. The threatened invasion of the Westinghouse forces has evidently aroused the direst apprehensions on the part of the companies who at present hold the field. It is no longer a question of discussing the *pros* and *cons* in amicable conclave, but of fighting tooth and nail for the favour of the Board of Electrical Control. At the special meeting of the Board held to consider the question a formidable array of testimony was adduced in support of the assertion that the prevalent apprehension of a special danger attaching to alternating currents is entirely without foundation. The simple fact that in all the eighty-two stations now operating this system in the United States no fatal accident has yet occurred affords in itself a remarkably strong presumption in favour of this view, and, moreover, the Westinghouse Company were able to bring evidence of a positive as well as a negative character. No decision has yet been pronounced by the Board, and apparently the opposition has yet to deliver its reply. For our own part, we have become convinced—and we know many electrical engineers who adopt the same view—that if any difference in the degree of danger to life exists, it is the continuous current which is the more dangerous of the two.

Nothing transpired at the half-yearly meeting of the Submarine Telegraph Company with regard to the impending purchase, except that the chairman spoke of its transfer to the "Governments of the countries" in the plural; from which it may be inferred that the British Government will not alone become the possessor of the company's cables. No hint as to the price to be paid was let fall; but it is gratifying to note that a very valuable property is to be bequeathed to the company's successors, and that the company itself is retiring with golden laurels. Thirteen and a-half per cent. dividend, with fifteen per cent. added to the reserve fund, and a balance carried over, is a very respectable ending to a long and prosperous career.

Some of our excellent American contemporaries have recently taken to printing short and pithy extracts from the sayings or writings of leading men in the electrical world, under the generic and expressive title of "Pointers." As examples of the method we may take this of Gisbert Kapp:—"If secondary batteries were good enough, I should never dream of putting down alternating transformers, but I have never seen a good battery;" or that other of Thomas D. Lockwood (of Telephonic fame)—"What possible avail can it be, if the right thing is not done in the right way, by the right man at the right time?" And again, a Pointer from W. M. Mordey, "We seem to make all the improvements, but the Americans make all the money"; or, yet once more, J. Swinburne's wise saying, "Inaccurate calibration is a much more common fault in measuring instruments than bad design." Lastly, we will wind up with this of Francis B. Crocker—"It is well enough, perhaps, to designate volts obtained by chemical action as equi-volts, but I do not know any reason for it. Really, these equi-volts are just plain, ordinary, North American volts." On this we are constrained to remark that Mr. J. T. Sprague says that the "equi-volt" is not a common or garden volt, but a unit of energy, and we think that Mr. Sprague ought to know, if any one does.

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The Lighting of the City.—We understand that at an early date the question of lighting the City by electricity will again come before the Commissioners of Sewers.

The Graphophone.—We hear that Mr. Henry Edmunds (of the Cadogan Electric Light Company) is bringing some graphophones back from the States, and will probably read a paper on the graphophone before the British Association at Bath.

A Telegraph Wire Struck by Lightning.—A wire of the Exchange Telephone Company's system at Bow was struck by lightning and fused in the centre of a span, during a thunderstorm on Monday afternoon last. The conductor was of copper, ·083in. in diameter.

Photographs of Lightning—M. Trouvelot has secured a photograph of a remarkable lightning flash which occurred on the 24th June. The principal flash divided itself into four branches, and these again are subdivided into no less than thirty-seven distinct streams.

The Chilian Telegraph Service.—In the address of President Balmaceda, at the opening of the Chilian Congress, reference is made to the introduction of a new measure, by which it is proposed to organise the postal and telegraph services under one board of management.

Metropolitan Electric Supply Company (Limited).—It will be seen by our advertising columns that the above-named company has issued its prospectus, the leading features of which we foreshadowed in an editorial note last week. The subscription lists open and close this day (Friday).

Athens.—The Edison Continental Company has undertaken the electric lighting of the forthcoming Exhibition at Athens, at which the exhibits destined for the Paris Exhibition of 1889 will be shown. The installation will comprise two 300 ampere dynamos, 50 arc lamps, and a few incandescent lamps.

Lubricators.—We learn that the Dee Oil Company, of London and Saltney, have secured the whole of the Admiralty contract for cylinder oil, 1888-1889. This contract is the largest ever given out for high-class oil for internal lubrication by the Lords' Commissioners.

Electric Light on a Swedish Railway.—Electric lighting has been successfully tried on the Skane-Holland Railway, in Sweden. The lamps are fed from an accumulator in the luggage van. The installation has been effected by Messrs. Edwin Audrén and Co., Gothenburg, and it is intended to fit all the express trains between Christiania and Helsingborg.

The Burman Land Lines.—The *Indian Engineer* says that the telegraph line from Yunan to Moulmein will soon be completed, the constructors and materials having reached the latter place with a view to working backwards. When this is done, about 80 miles more in a straight line will connect the Chinese Government telegraphs with the Indian Government telegraphs.

Paris.—Our Paris correspondent informs us that the Municipal Council has voted funds for the creation of a municipal central lighting station at the Halles Centrales. The examination of the proposals for establishing central stations in different quarters of the town, which have been received from several electrical firms, has been postponed in each case until October next.

The 1889 International Congress of Electricians.—The Comité d'Organisation of this Congress met for the first time on Tuesday, 24th July, and elected an Executive Committee. The following officers were nominated:—President, M. Mascart; vice-presidents, MM. Gariel, Fontaine, and Lippmann; treasurer, M. Lemonnier; secretaries, MM. Hospitalier de Nerville, Hillairet.

Crompton and Co. (Limited).—The conversion of the well-known firm of R. E. Crompton and Co. into a limited liability company is announced this week, with a capital of £140,000. We understand that the issue of a prospectus will not at present take place, but we are informed that a large amount of the capital has already been privately subscribed by the directors and their friends.

The City Commission of Sewers.—At the last meeting of the Commission of Sewers, notices were received from the Metropolitan Electric Supply Company, and from the London Electric Supply Corporation, giving notice of an application to the Board of Trade in the ensuing Session, for a provisional order for power to supply electricity for lighting and other purposes within the city.

Birmingham Central Electric Light and Power Station.—Messrs. Chamberlain and Hookham have appointed Mr. Norman T. Gray engineer to this scheme. The price at which the electricity is proposed to be supplied has now been fixed at 8d. per unit, which is equal to a little less than ½d. per hour for incandescent lamps of 18 candle-power, and about 4d. per hour for arc lamps of 2,000 candle-power.

The Waterhouse Arc Light System.—We learn that this system, which is well known in the United States, is being introduced into England by Messrs. Shippey Brothers (Limited), who have been appointed agents for the Waterhouse Company, whose works are situated at Hartford, Conn., U.S A. The company guarantees to light ninety 1,700 candle-power lamps, 2,000 candle-power nominal, with an expenditure of 50 horse-power.

A Chapel Collection on Behalf of the Electric Light.—The *St. Pancras Gazette* says that the Rev. F. B. Meyer, B.A., minister of Regent's Park Chapel, Park-square East, at the close of his discourse on Sunday evening, made an appeal for funds to light the church with the electric light during the winter months. The building was thronged with the usual large congregation, and the response to the preacher's appeal was a very liberal one.

The German Union Telegraph Company of Berlin.—The German Government have exercised the option which they reserved to themselves under their agreement of assuming the property of the line on and from 1st July. The effect of this will be to give to the shareholders an adequate return, because it is on the basis of their best half-year's receipts. The line is now administered by the German officials. It is expected that the return of the capital will be paid part in January and the balance shortly after.

The Great Western Railway Electric Lights.—The members of the Inventors' Institute paid a visit on Saturday last to the Great Western Electric Lighting Station at Paddington, under the guidance of Mr. Spagnoletti. This plant now comprises 4,000 incandescent and 100 arc lights. Mr. Spagnoletti said that the electric lighting had put an end to the very frequent accidents which formerly occurred to the shunters and goodsmen and also to a large amount of damage to the company's trucks and rolling stock, everything being now accomplished at night with as much precision as in the day time.

Wellington. N.Z.—The Corporation of Wellington, New Zealand, have accepted the tender of the Gülcher Company to light that city by electricity. It is proposed to use incandescent lamps and to drive the machinery by water power obtained from the city waterworks. The contract is for 480 Edison-Swan lamps

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of 20 candle-power each, each lamp to be lit from dark to dawn. The price is £1,750 per annum for the first five years, the company offering to run the undertaking for a further period of five years at £1,600 per annum if the council decide not to purchase the plant at the end of the first period.

The Wells Light.—Our readers will be somewhat disappointed to learn that the works of the Manchester Ship Canal are not to be illuminated by electric light. Its place has been taken by the "Wells Light," in which ordinary mineral oils are burnt, but which seems to be an improvement upon the Lucigen light. If the improvement be of a substantial character, and the cost as little as is claimed by the inventor, it is probable that the Wells light will prove a formidable competitor for the lighting of contractors' works and outdoor spaces where the heat and dirt of a naked flame is permissible.

Valencia, Spain.—Spanish advices refer to the early inauguration in Valencia of an important central station for the supply of electric light. The installation is to consist of 16 steam engines of 100 horse-power each, 16 dynamos for 1,200 lamps of 10 candle-power, 12 multitubular boilers of 108 horse-power, three pumps for raising water, and 12 small pumps for feeding the boilers. The Spanish paper from which we take the information does not mention the name of the contractors, but from the nature of the facts stated the installation looks very much like one we referred to as being under consideration some time ago.

Bournemouth.—At the last meeting of the Bournemouth Town Council an application from the local electric light company was read, asking permission to erect in the borough iron standards similar to those erected by the telephone company in Bournemouth, which, the application stated, "had a nice appearance, and were only four inches at the base, not so wide as an ordinary lamp-post." The town clerk suggested that the matter should be allowed to stand over until the quarterly meeting of the Council in August, and, in view of the fact that the Electric Light Company are going to send in a tender for lighting the town by electricity, this was agreed to.

Mexican Telegraph (Cable) Company.—Advices from the City of Mexico state that the half-yearly report of this company—that is to say, for the six months ended June 30th—shows operating expenses 17½ per cent., against 23½ per cent. in the first half of 1887. The figures compare as follows :—

	1st January to June 30.		
	1888.	1887.	Inc. or Dec.
Earnings	$168,582 ...	$130,173 ...	+ $38,409
Expenses	29,694 ...	30,704 ...	- 1,010
Surplus	$138,888 ...	$99,469 ...	+ $39,419

A quarterly dividend of 2½ per cent. was declared in June.

The Cost of Copper in the Edison System.—In a recent Paper by Mr. G. H. Bliss, read before the Chicago Electric Club, the following illustrations of the cost of copper per lamp in the Edison system are given :—"I will give one or two examples of what the actual cost is for copper in a couple of Edison stations now in process of installation. For one installation which provides 100 street lamps scattered over an area of 1½ mile square, and 500 lights for stores, residences, and churches in a mile square, the entire cost of copper, at 20 cents per pound, is $3,000, or $5 per lamp. For another installation where 100 street lamps are scattered in one area two miles square and 800 inside lights in an area about a mile square the entire cost of copper, at 20 cents a pound, is $3,102, or $3.44 per lamp."

Hastings.—The *Hastings News* says :—"The local electric light company is steadily pushing ahead and extending its business. Much more could be done if the townsfolk would encourage the company by putting more capital into the concern and adopting the electric light for private houses, workshops, and other places. Nearly all the hotels are now supplied with the incandescent lamps, and the Alexandra Hotel will increase its improvements by having about one hundred lights on the circuit. Some of the larger boarding houses in the town are also trying the new illuminant. Considering how healthy and clean and comparatively cheap the electric light is, it is somewhat surprisising it is not more used in large establishments."

Presentation to Mr. J. T. Crowe, of the Eastern Telegraph Company's Staff.—In view of the approaching marriage of Mr. J. T. Crowe, of the head office staff of the Eastern Telegraph Company, his friends at Winchester House, Old Broad-street, took the opportunity of showing their regard by presenting him with a handsome silver-plated tea and coffee service with salver to match. The latter bore the following inscription :—"To John Tudor Crowe, Esq., on the occasion of his marriage, August 16th, 1888. Presented by the head office staff of the Eastern Telegraph Company, London." Mr. W. T. Ansell in making the presentation expressed in a few appropriate words the hopes of those present for Mr. and Mrs. Crowe's future welfare and happiness.

The Telephone in the West of England.—The Western Counties and South Wales Telephone Company are about to embrace in their wide spreading net another group of Devonshire towns, including Torquay, Paignton, Newton Abbot, Totnes, Ivybridge, Tavistock, and Horrabridge; and to establish in each of those places call offices. These lines will also be placed in connection with the existing exchanges at Plymouth, Stonehouse, Devonport, Mutley, Plympton, and Marsh Mills. This is a bold experiment, for it involves a large expenditure, and the population of the district is not remarkably dense. But it will enormously increase the value of the Plymouth exchanges to business men, and we trust that it will result in a very considerable increase in the number of subscribers.

Bath.—At a meeting of the Surveying Committee of the Bath Town Council, this week, the Clerk reported the receipt of a letter from the Town Clerk officially stating that the Council had resolved to light certain streets of the city by electricity, and that the arrangements were left with the Surveying Committee. The Mayor suggested that a special Electric Lighting Committee should be appointed. He thought it would be best that no gentleman should be placed upon it who had any pecuniary interest in the gas company or the electric lighting company. Mr. Sturges submitted a list of names, but it was pointed out that several of them were not on the Surveying Committee, and that, therefore, that meeting could not appoint them. Mr. Sturges then proposed the following names :—The Mayor, Alderman Gibbs, Captain Franklin, Messrs. Moger, Collins, Ricketts, and Sturges.

Science Schools.—On Friday last Mr. A. Acland asked the Chancellor of the Exchequer whether the Treasury would be willing to sanction the removal of the restriction on building grants for science schools which made it one of the conditions of grants in aid to such schools that they should be built in connection with a school of art, aided by a Department building grant.—The Chancellor of the Exchequer said he must at present answer the question in the negative. Great expenditure was being pressed upon the Government in connection with technical schools, grants for colleges, and for the development of scientific and technical education. The Government was in sympathy with the movement, but it was necessary to

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look at the question as a whole and to bring all these schemes together, and then to see in what order and to what extent these claims could be met.

Important Installation at Birmingham.—The Birmingham Corporation Street Estate Company, who are building a large block of shops and offices in Corporation-street and Martineau-street, have decided to light their new buildings with electric light. There will be twenty shops and sixty-four offices in the block, which will be fitted with incandescent lamps, and the tower will be surmounted with a powerful arc light. The dynamos and the electric fittings are being supplied by Messrs. Ellwell-Parker, of Wolverhampton, and the engines, which are compound and of a semi-portable make, are being built by Messrs. John Fowler and Co., of Leeds. The whole of the electric machinery and fittings are being erected under the supervision of Mr. T. C. Sharp. We understand that provision will also be made to supply the electric light to some of the adjoining business premises.

Electric Light Signals.—The Conz system of incandescent lamp signals has recently been tried on the U.S.S. "Atalanta," at Annapolis. Three pairs of lamps, 500 candle-power Edison incandescent, each pair white and red, were secured in sockets on the sides of a block of wood; the three blocks were then screwed on a 12ft. piece of moulding and hoisted aloft. The lamps are capable of fourteen different combinations of signals, no two lights in any one of the three pairs being alight at the same time. The lights are manipulated from a switch-box in the pilot house. This switch-box is a brass cylinder 5in. in diameter, with fourteen glass discs on the dial face corresponding to the fourteen signals. An index moves round the dial face, and when it is over the desired disc a handle in the centre is pulled and the circuit closed through the proper lamps. The box also has an offset to contain an electric lamp to illuminate the discs from within.

The Electrolytic Production of Magnesium.—M. de Mongelas has lately devised a process for obtaining magnesium by electrolysis. An alloy of magnesium is first obtained in the form of an electrolytic deposit. The bath consists of a concentrated solution of chloride of magnesium, combined with an equally concentrated solution of the chloride of any other metal except aluminium. The solution preferred is one part of chloride of zinc and two parts of chloride of magnesium. The two solutions mark 18° on the Beaumé scale. Good results are obtained by using the electrolytic bath as the battery. The external jar contains the double chloride solution and the copper cathode, the amalgamated zinc anode is placed in dilute sulphuric acid. The zinc is deposited in a "spicular" or "arborescent" form, and the magnesium in granular crystals. This alloy is then washed, dried, and crushed, and finally melted in a crucible containing chloride of sodium. The zinc volatilises and leaves pure magnesium.

The Westinghouse Machine Company in Italy.—The Westinghouse Machine Company of Pittsburg, U.S.A., is endeavouring to extend its operations in Italy in machinery for driving electric light dynamos. The company, which was founded in the year 1881, has an agency in Paris, and has upwards of forty engines already in work in France. In Italy the company has not hitherto been directly represented; but a Paris correspondent informs us of the arrival last week of Mr. J. B. Thomas, a representative of the company, who is *en route* for Italy for the purpose of founding agencies of the company. In an interview with Mr. Thomas our correspondent learned that that gentleman's operations will in the first place be principally confined to Rome and Turin. As the object of the company is to extend the employment of the Westinghouse machine for electrical installations in Italy, we may state that, according to our Paris correspondent, the company has made up to the present time about 4,000 engines, of an average of 45 horse-power. The company has 13 sizes of standard engines, varying from 5 horse-power to 250 horse-power, and is now developing the manufacture of compound engines from 6 horse-power up to 600 horse-power. Compound engines of 150 horse-power are already at work.

Gas Pipes Damaged by Lightning.—Mr. J. Best writes to the *Journal of Gas Lighting* as follows:—"A singular occurrence took place at St. Ives (Hunts) on Wednesday last. A thunderstorm passed over the town, and the lightning struck the premises of Messrs. Coote and Sons, coal merchants. Their spacious office is lighted by copper ventilating Argand gas-pendants; the products of combustion being conveyed through the ceiling into the roof. The electric current descended the ventilating shaft of the gas-burner over the desk of the cashier (who was fortunately absent at the time), and made its exit by the office door, which was open. No damage was done here. The adjoining house is occupied by one of the clerks; and there a gas-pipe was melted and the gas ignited. From an inspection made here, the electric current was conveyed into the roof of the dwelling house by the spouting, which is coupled up by a zinc pipe to convey the rain water to a tank under the roof. A ¾-inch lead pipe is brought from the tank down through a bed room and into the scullery, and carried partly round the scullery near the ceiling, crossing at right angles, and so as to touch a ½-inch composition pipe which conveys gas to a bracket. Here the gas pipe was fused, and the gas ignited. There is no chimney in the scullery or in the bed room above. No other damages to the premises could be traced. I shall be glad to learn whether any of your readers have had similar experiences."

The Copper Market.—We take the following from the *Daily News* of yesterday:—"At last the copper syndicate has the satisfaction of observing that the deliveries in France and England are on the increase. Last month the deliveries, according to Messrs. Merton's statistics, were 9,766 tons, having been little over an average of 5,500 tons per month during the previous six months. Earlier in the year the rise in the price of copper had its natural effect of causing consumers to hold off from the market as long and as much as possible. At length, however, deliveries have got back to a normal rate, and even somewhat beyond. For the past twelve months the average monthly deliveries of copper in France and England has been 8,031 tons, while for the previous two years the monthly average was about 7,750 tons, so that the deliveries last month were large and not small by comparison. At the same time stocks in England and France and on passage from Chili and Australia are put at 75,412 tons, being nearly half as much again as at this time last year, and about 15,000 more than the average stock in the year 1886. During the last seven months the stock has been increasing at the rate of five thousand tons per month, and unless the deliveries are maintained at something like the rate reported for July, the syndicate may be in trouble either next year or soon afterwards. It is remarkable that, notwithstanding the increased consumption of copper during July, the visible supply increased by 3,169 tons for the month."

Electric Traction on the North Metropolitan Tramway.—At the 37th half-yearly general meeting of the North Metropolitan Tramways Company, held on Wednesday, at the Cannon-street Hotel, Mr. George Richardson, who presided, stated that the Directors had for some time had under their

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consideration the adoption of some motive power for propelling the company's cars. Five years ago electricity was proposed to them by a company, who forwarded them an engine, but it proved unsuccessful. The next attempt was made two years ago, when the Elieson Company brought their system to the notice of the company, and an arrangement had been made with that company for working cars on the Romford road. Six engines had been made by that company at the shed which had been set apart for the purpose by the North Metropolitan Company; but more room had now been given by them elsewhere to the Elieson Company, in order that their system might be brought more fully into use. The price at which they had contracted was 4½d. a mile, whereas it cost them 5d. a mile with horse-power. They had also arranged with the Electric Traction Company for working their electric combined engine on the Barking-road. The trial had proved satisfactory, and their engine had been approved by the Board of Trade. The charge was also 4½d. a mile. They hoped that electricity would prove as satisfactory as had been expected. In the United States there were 60 street electric tramways.

Electric Traction on the Metropolitan Railway.—At the half-yearly general meeting of the proprietors of the Metropolitan Railway Company on Friday last, Sir E. W. Watkin said that "one interesting feature of the half year had been the progress that had been made in preparing for the construction of a locomotive engine which will go by electricity. When the engine was completed they proposed to try it on the northern parts of the line if they found it to answer. The conditions were that the locomotive shall be worked as economically and, to use a mechanical term, have a life as long as the ordinary locomotive. These conditions fulfilled, they proposed to substitute gradually a locomotive that made no sulphur, no steam, no smoke, for what would then be the old-fashioned locomotive engine. Now, he knew that people, he would not say had chaffed, but had rather smiled at him when he told proprietors that he thought it their duty to try this experiment; but the experiment had been at the expense of the Electric Traction Company. It was rather a hard bargain for them, but if there was success it would, no doubt, be an immense advantage to this and all underground railways. With regard to the power itself, Mr. Richardson, chairman of the North Metropolitan Tramways Company, had said that the experiments had shown that the motive power of the Electric Traction Company was the best traction power that had been brought before the public. He (the chairman) was told that practically the same words were used—of course, not officially—by General Hutchinson, the distinguished railway inspector to the Board of Trade."

The Electric Lighting Question and the Paddington Vestry. We extract the following sensible letter from the *Paddington Mercury*:—"Gentlemen: I am glad that at last you are moving in the matter of the electric light question. I cannot understand why you have not moved a good deal sooner. It seems to me a pity that you should be so slow to take action in matters affecting the public welfare and convenience, and so quick in those things which bring but little public advantage and less public credit upon your body. In a rich borough like Paddington there must be numbers of residents who would be glad to have the advantages of the electric light, if it could be supplied to them without the enormous cost of putting down plant to produce it. My right hon. friends, Lord Randolph Churchill and Lord ——, I mean Mr. John Aird, members for the borough, both have this luxury in their homes, and I do not see why 'Reuben' should not have it brought to his door as well. And perhaps some of the parsons may be inclined to get it laid on to their churches and chapels if you begin to distribute it. I imagine it would be a great boon in some of those places. In those churches which are empty it might act as a sort of advertisement, and would be a good 'draw.' But in those which are crowded it would be a boon in preventing them getting so overbearingly hot as a few of them now do. My neighbours and friends, Dr. Clifford and the Rev. Chas. Leach, the ever popular Radical parsons, enjoy the luxury of full conventicles. These July days and August days the soft, cool, clear electric light would be a great blessing both to them and to their people. I have often seen the parson sweltering away trying to make an impression upon the people in a foul and over-heated atmosphere. And more than once I have seen the people boiling away as if they were in a Turkish bath. The new light might help to keep the people awake and the parson cool, and thus give the sermon a chance. I am glad on every ground that you are taking action if only to make inquiry. I shall await report with considerable interest. In the meantime I trust you may enjoy your holidays and keep good tempered.—Your neighbour, REUBEN RUFUS."

A New Electrical Deep Sea Sounding Apparatus.—A party of engineers from London have recently been making a series of experiments in Oban Bay and in Loch Linnhe, for the purpose of testing an electrical apparatus for taking deep sea soundings recently invented by Messrs. Cooper and Wigzell, of London. According to the *Engineer and Iron Trades Advertiser*, Mr. Ogilvie, of Barcaldine, placed his yacht at their disposal, and Councillor Munro accompanied the party to verify the soundings taken from the charts. The apparatus consists of three principal parts connected together electrically by conducting wires. The sounder is a heavy bar about five feet long, having a water-tight cavity at the upper end, which contains special mechanism actuated by the pressure of the water, and at the bottom it is fitted with a grip which, when it strikes the bottom, closes suddenly and secures a specimen, which it brings up. The sounder weighs 26lb. or 40lb., the weight depending upon whether it is required for deep or shallow soundings, and is connected with a strong cast-iron winch, on which the wire is wound, and through which the electrical current passes. This sounding line, which takes the place of the deep sea lead line, is made of galvanised steel wire, and is strong enough to bear a strain of half a ton. Insulated wires connect the winch with the recording instruments, which may be placed in the chart room or any other convenient part of the ship. The indicator of this recording instrument marks the depth as the sounding-bar descends, and becomes stationary at the greatest depth attained by it or on reaching the bottom. Thus it is not necessary to wait until the sounder is wound in again in order to know the depth, and valuable time is saved. The depth recorded is absolutely according to hydrostatic pressure, due to the vertical height of water over the sounder at the time. If there is a swell or high sea running the figures will indicate the depth from the top of the wave in most instances, while soundings can be taken either when the ship is in motion or stopped, a speed of 20 knots an hour making no difference in the results obtained. The experiments tried at Oban Bay were for the purpose of testing some improvements which have just been effected on the apparatus, and the locality was chosen owing to there being, at a convenient distance, some of the deepest water around the British Isles. The results obtained were highly satisfactory, and were found to coincide with the Government charts. The deepest sounding taken, 118 fathoms, was in Loch Linnhe, at the south end of Kerarra.

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ALTERNATE-CURRENT ELECTROLYSIS.*

BY MM. J. CHAPPUIS AND G. MANEUVRIER.

The impossibility of producing electrolytic decomposition of sulphate of copper by an alternating current is generally supposed to be an established fact. The absence of all electrolytic phenomena is explained by the assumption that the copper deposited by one current is immediately removed by the other. This negative result is even brought forward as a proof of the exact equality of the two currents. We, however, have been able to justify this explanation by rendering visible the electrolysis of the sulphate, as we have already done in the case of acidulated water.† The experiment is, however, somewhat more complex and more difficult to effect. If a concentrated solution of copper sulphate is placed in a voltameter with platinum electrodes, currents having an average strength of 2·5 amperes (which in the case of acidulated water produce an abundant evolution of explosive gas) give rise in sulphate of copper to nothing more than a considerable heating effect. But if the size of the electrodes is reduced to about 6 sq. mm. (0·1mm. diameter, 20mm. long), there is both evolution of gas and deposition of copper. Electrolysis succeeds equally well with copper electrodes of the same size. As soon as the circuit is closed, a column of minute gas bubbles instantly ascends amidst a cloud of red-brown powdery copper, whilst the electrodes soon assume the appearance of the freshly reduced spongy metal.

Taking all our experiments together, they seem to show that it is possible to establish a sort of equilibrium between the rate of decomposition and the rate of recombination of the constituents of the electrolyte. Once this equilibrium is attained, there seems to be no further electrolysis, properly speaking. Hence, all things which tend to make the rate of the former predominate over that of the latter will cause the reappearance of electrolytic phenomena, whilst those conditions which tend to make the rate of recombination predominant will cause these phenomena to disappear.

Current density is one of the principal things which tend to accelerate electrolysis. It is evident that if on the one hand we increase the quantity of electricity traversing the electrolyte, while on the other we diminish the surface of the electrodes, we shall cause the rate of decomposition to gain on that of recombination, and tend to produce electrolytic action. It is also easy to understand that both electrodes and electrolyte may greatly affect the rate of recombination by virtue of their chemical and physical properties. Hence the tendency to electrolysis depends upon the nature of electrodes and electrolyte, as shown by our previous experiments. Lastly, it can be foreseen that, all things being equal, the rate of alternation will play an important part in these phenomena. For supposing that the rate of alternation becomes so slow that the electrolytic products of one current have time to disappear, either by direct disengagement or by diffusion, before the products of the opposite current appear, it is obvious that no recombination is possible. In this case each current acts like a continuous current of short duration; thus, the slower the rate of alternation the greater the probability of electrolytic effects, all things being equal, and *vice versâ*. We have been able to verify this theory by actual experiment. Employing, as we did, a separately-excited machine, we were able to vary the rate of alternation without affecting the average strength, and, consequently, the average density of the current. We altered the speed of the machine from 1,500 to 2,600 revolutions a minute, thus raising the number of alternations per second from 100 to 173, and by regulating the strength of the current flowing round the field magnets we were able to maintain a constant current. Under these conditions we carried out the two following experiments.

With the machine running at its proper speed of 2,000 revolutions a minute (133 alternations per second), we regulated the strength of the current so as to obtain a state of equilibrium, *i.e.*, a state in which no gas would be evolved in an ordinary water voltameter. We then lowered the speed to 1,500 revolutions (100 alternations a second), and gas was freely evolved at the electrodes. Next with the machine running at 2,000 revolutions and the current regulated so as to produce a remarkable and regular evolution of gas, we increased the speed to 2,600 revolutions (173 alternations a second), and the evolution of gas was immediately arrested. In either case it is possible to counteract the effect of this variation of speed by a proper modification of the current density. Thus, in the first experiment the gases were made to disappear again by increasing the surface of the electrodes; whilst in the second experiment the gas was made to reappear by reducing their surface.

We thus see that speed of alternation and density of current affect the question of electrolysis inversely, so that currents of medium density may give rise to electrolytic effects, provided the alternations are slow enough. It was owing to this that in 1837 de la Rive was able to decompose acidulated water by means of alternate-currents from the then recently invented magneto-electric machines. He was able to get explosive gas on large platinum electrodes of 8 square centimetres surface, so that the difficulty in his case was to get rid of the gases, while in our case the difficulty was to make them appear. This difference arises from the fact that the machine used by de la Rive gave at the most 50 alternations per second, whilst ours gave at least 100 alternations. From these experiments we shall be able to deduce the numerical laws of the several phenomena and the general rules which ought to guide the use of these currents for this purpose.

In a subsequent communication (*Comptes Rendus*, Vol. CVII., No. 2) MM. Chappuis and Maneuvrier give an account of their investigations into the causes of the spontaneous explosions of the mixed gases given off by alternate-current electrolysis, and the means by which they were enabled to avoid this dangerous occurrence. The following is an abstract of this interesting Paper:—

If a voltameter of the ordinary pattern is used in alternate-current electrolysis experiments an explosion inevitably occurs when all the liquid has been nearly expelled from the collecting tubes, and it was only after we had taken special preventive measures that we were able to continue our researches. This phenomena was observed by de la Rive as long ago as the year 1837, and also by Bertin in 1857. De la Rive passed alternate currents from an electro-magnetic machine through an ordinary water voltameter, and noticed that the platinum electrodes became coated with a powdery platinum film, and that if they were then introduced into a vessel containing explosive gases an explosion resulted. From this de la Rive concluded that the phenomenon was due to the so-called catalytic action. Bertin decomposed acidulated water by a continuous current from a battery of 50 Bunsen cells, and collected the evolved gases in the same receiver. He observed that the gases exploded as soon as the receiver became nearly full, both when platinum was used for either electrode and when platinum was used as the positive and iron as the negative electrode. With platinum and copper, or with platinum as the negative and some oxydisible metal as the positive electrode, no explosion took place. Bertin attributed the phenomenon neither to catalysis nor heating, but to the "polarisation of the electrodes" [an explanation which seems to leave a good deal to be explained]. Neither of these theories suffices to account for the facts as observed by us. Like de la Rive we observed the black film, but it has nothing to do with the detonation of the gases, since this often takes place long before the appearance of the film and when using perfectly new electrodes. Like Bertin, we produced explosions with other metals than platinum; but, unlike him, we came to the conclusion that polarisation had nothing whatever to do with the phenomenon. For take a new electrode and fill a bell-glass with the mixed gases, then substitute another new electrode; the gases explode the moment the current is put on, provided only that the electrode is sufficiently well out of the water. We attribute these explosions to the electrodes becoming incandescent by reason of their progressive emersion from the liquid, increasing as it does the current density and the resistance, and diminishing the cooling effect due to contact with the solution. We have been able to make this incandescence actually visible.

We take electrodes of platinum, which are placed in a bent tube. One end of the platinum is soldered to the copper wire conveying the current, the other end is soldered to the glass. We have noticed that the end soldered to the glass becomes incandescent at the moment of detonation. One of the electrodes having been broken, an almost invisible point projected out of the glass, and the moment the current was started this projection became incandescent, exploding the gas bubbles as soon as they

* Translation of a Paper by MM. J. Chappuis and G. Maneuvrier, read before the Académie des Sciences. (*Comptes Rendus*, Vol. CVII., No. 1.)

† See *The Electrician*, 29th June, p. 237.

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came in contact with it. Again, if only the tips of the electrodes are allowed to dip into the liquid, incandescence and detonation are the immediate result.

It follows from this that all circumstances which tend to increase the heating effect, such as increase of current density and diminution of electrode surface, tend to accelerate explosion. Thus, with a ·5mm. wire, detonation did not occur until the gas had pushed down the liquid to within 5mm. of the end of the electrode. On the other hand, with a 2mm wire, the explosion took place when the liquid was still 25mm. from the end. To prevent explosion we keep the electrodes always well immersed in the solution by enclosing them in a conical or cylindrical funnel, at the top of which there is a small straight tube, which carries off the gases to a receiving vessel. This, or any other similar arrangement, is well adapted to obviate all danger in the manipulation of the explosive gases given off in alternate-current electrolysis.

WHEATSTONE AND STROH'S SUBMARINE CABLE KEY FOR MORSE SIGNALS.

In connection with the article which appeared in this journal on June 29th, p. 242, under the title of "Delany's Improvements in Submarine Cable Telegraphy," the following extract, taken from a patent issued to C. Wheatstone and J. A. Stroh in the year 1870, is of considerable interest. On comparing the two descriptions it is impossible to doubt that they are substantially identical:—

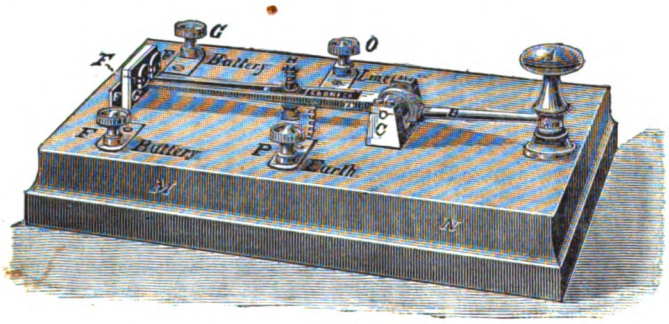

Fig. 1.

"*Simple Reversing Key.*—Our fourth improvement is a method of constructing a manipulating key for directing into the telegraphic circuit alternately inverted currents from a voltaic battery, which last only during the upward and downward motions of the lever; the separation of the battery from the line and the connection of the latter with earth being effected when the lever reaches the two limits of its motion.

"On the insulated stand, M, N (Fig. 1), is mounted the manipulating lever A, B, with its bearing at C. Upon the back of the lever are prolongations formed by two metallic blades D and E, which are permanently in connection through spiral wires—one with line through the binding screw O, the other with earth through the screw P. The extreme ends of these blades press against the sides of small curved blocks of ebonite, so shaped that when the key is depressed the blades ascend on the right-hand sides, and when it is elevated they descend on the left-hand sides of the blocks. On each side of each of these curved blocks is inserted a small piece of metal flush with the side face of the ebonite, against which the metallic blades rub and make contact in their passage up or down. The two pieces of metal which face each other on the inner sides of the curved blocks are connected to the zinc pole of the battery through the binding screw G. The two metallic contact pieces on the outer sides of the blocks are permanently connected with the copper pole through the binding screw F. By this arrangement when the key is depressed a current is sent into the line in one direction, and while it is being released a current in the opposite direction is transmitted. Between the terminal screws O and P is a vertical metallic pillar, H, provided with flanges with which the blades D and E make contact at their extreme points of elevation or depression, so that during each ascent or descent before the extreme ends of the blades leave the ebonite blocks they are put into contact with each other, and the line put for an instant into contact with the earth and discharged.

"*Reversing Key with Fly.*—Our fifth improvement consists of an inverting key by which the battery is cut off the moment after its inversion, enabling currents of equal duration to be transmitted into the line independently both of the time the key is allowed to rest at either of its limits and of the rate at which it is moved.

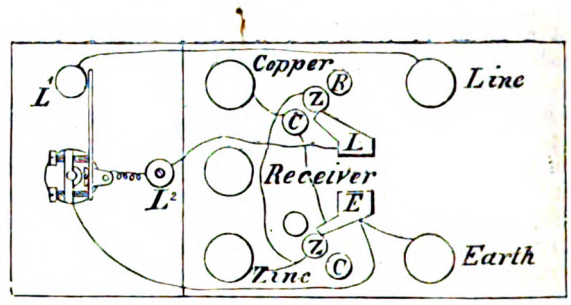

Fig. 3.

"The first part of the instrument consists of an inverting key, which may be of the ordinary construction, and is provided with the usual commutating contacts for inverting the battery between the earth and line terminals. The second part of the instrument consists of a mechanical interruptor, which is inserted in the line circuit, and whose velocity of motion determines the duration of the current sent by the key. The inverting key is shown in perspective in Fig. 2, and a diagrammatic view of the connections in Fig. 3. It consists of a lever K, K, provided at the back with a spring prolongation A upon which on opposite sides are fixed two metallic blades E and L, the former being permanently connected through the spiral wire E^1 with earth, the latter being permanently connected through the spiral wire L^1 with the mechanical interruptor, and thence with the line terminal. The metallic blades play between

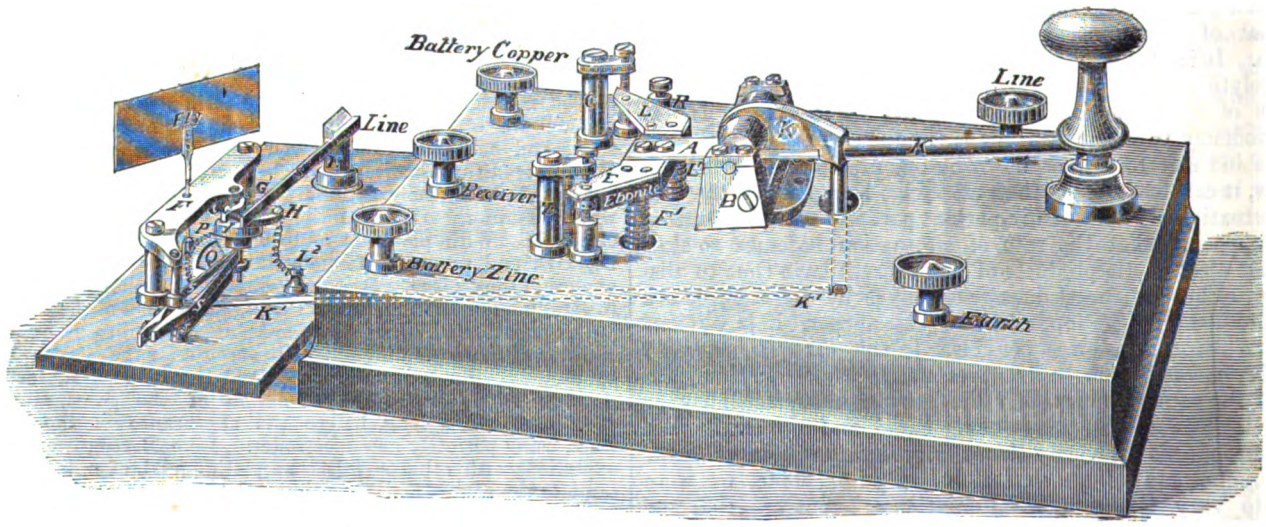

Fig. 2.

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four contact anvils upon the pillars Z and C and the studs z and c. The pillar C and stud c are connected with the copper pole of the battery, whilst the pillar Z and stud z are connected with the zinc pole. Thus when the blades are elevated against C and Z, zinc is to earth and copper to line; whereas when the key is in its position of rest, as shown in the drawing, copper is to earth and zinc to line. This portion of the apparatus, therefore, forms a double current or reversing key, which may also be of the usual construction.

"The second part of the instrument is connected with the key by a rod, K^1, attached to the vertical prolongation of the lever K. This rod, K^1, is coupled to an arm, J, attached rigidly to a vertical arbor pivoted in a suitable frame, F. Attached to a collar on this arbor are two adjustable parallel blade springs, s, s^1, the further ends of which embrace two pins, one upon the arm J, and the other upon one side of the oscillating system G H I. This oscillating system is carried upon a vertical arbor, upon the lower part of which the quadrant (Q) of a spur wheel engages with a pinion, P, the shaft of which carries a fly above it. Half-way up is a block of ebonite, I, carrying a small triangular metal slab, H, in connection with the blade L of the key, through the spiral wire and screw L_2. At the top of the oscillating arbor is a small cross with two contact screws, G, G^1, both of which are to earth through the arbor and frame. The slab H is provided with a vertical pin, which, when the system oscillates, rubs against the face of a spring, s^{11}, which is connected electrically with the line terminal of the key. The line circuit between the blade L and the line terminal is therefore made and interrupted between the pin on H and the spring s^{11}. When the key is at rest the rod K^1 draws the arm J forwards, and keeps the left-hand spring s pressed against the pin upon the quadrant Q; the oscillating system is therefore held at rest, as is shown in the drawing, the line spring s^{11} being pressed from contact with the pin upon H by the front contact screw G, and the line is therefore to earth. When the knob D of the key is depressed, the blades E and L being raised to the upper anvils C and Z, the direction of the current is reversed. At the same time the rod K^1 is thrust back, causing the right-hand spring s^1 to press against the pin upon the quadrant Q and make the system rotate as fast as the fly will allow it to. In rotating, the screw G (earth) leaves the spring s^{11}, which falls for an instant upon the pin upon H, thereby completing the line circuit with L_2 and L and allowing a current to pass into the line. This is, however, immediately afterwards interrupted again by the further screw G^1, which as it comes round forces the spring s^{11} from the contact pin. When the key is released again the rod K^1 pulls the spring s against the pin of the oscillating system, causing the quadrant and fly to rotate in the opposite direction, and the current (inverted by the blades L and E) to be transmitted in the opposite direction for an instant as the contact pin of H passes by the spring s^{11}. When the key is not in use for transmitting signals it is placed in its position for receiving. For this purpose the metal block B carrying the bearings of the lever K is made turnable about a vertical pin. When receiving, therefore, the knob of the lever is drawn towards the left by which the blade L is brought to rest upon a stud, R, connected with the receiving instrument. The horizontal movement of the lever also has the effect of relieving the tension of both the springs s, s^1, of the interruptor, so as to allow the oscillating system to assume a central position, and the pin upon H to rest in contact with the line spring s^{11}. Currents therefore arriving at the station pass from the line terminal over s^{11}, pin on H, L_2, spiral wire L_1, blade L, and stud R to the receiving instrument."

REVIEWS.

Phenomenes Electrique de l'Atmosphere. By GASTON PLANTÉ. (Paris: Baillière et Fils, 1888.)

The present year of grace is likely to be long remembered for the abnormal frequency of thunderstorms and other atmospherical disturbances. It may also be distinguished as the year in which two valuable memoirs, dealing more or less directly with the *experimental* investigation of electric meteorology, have seen the light. The lectures of Dr. Oliver Lodge have quite recently been reprinted in this journal; and we have now before us a volume by M. Gaston Planté, containing an account of researches in the same direction. The book covers, however, wider ground than that recently taken up by Dr. Lodge, and amidst much that is new and valuable we find a good deal which has already been published by the author in his earlier memoirs; some things also we find to which we are unable to yield entire assent.

The author is of opinion that the origin of atmospheric electricity is to be found not in any meteorological process, but in "a primitive charge of positive sign, belonging to the earth as a whole," and which is undergoing a very gradual secular diminution. As all our measurements of potential are relative, there can be nothing intrinsically improbable in this assumption. In place of seeking for a constant source of generation to account for the observed differences of potential between the surface of the earth and the regions of the atmosphere, we should have to explain the causes of the varying distribution of electrical density. It would seem worth while to pursue the suggestion beyond the point where M. Planté leaves it.

The chief interest of the work does not, however, lie in the theorising, but in the numerous and ingenious experiments by which M. Planté has sought to reproduce, upon the scale of the laboratory, the electrical phenomena of the heavens. Whether the analogy between the experimental and the natural phenomena is in every case as close as the author supposes is open to question, but it is at least certain that we have here described a series of brilliant and striking experiments which will be to most of our readers as novel as they are interesting.

Most of these experiments were carried out by means of M. Planté's great secondary battery, which now consists of 1,600 cells, giving him, therefore, the command of nearly 4,000 volts. Unfortunately, the author has not thought it necessary to give any measurements of current or resistance. We read of 400, 800, and 1,600 cells, discharged "in quantity" or "in tension," but we have no clue as to the current or the energy actually employed in any case. In some cases the "rheostatic machine" is used.

We shall proceed to quote some of these experiments, beginning with a simple case, in which the analogy appears to be successfully established. The phenomenon in question has only once been observed in nature, probably because the necessary conditions are not often present. This is a case in which a lightning conductor had an earth connection carried underground and terminating in the middle of a pond. The conductor was seen to receive a flash, and at the same moment a jet of water spurted into the air from the midst of the pond. By means of a powerful static discharge taken into a basin of water this is easily imitated, and is very likely due to a sudden generation of steam at the end of the conductor.

A well-authenticated case occurred in Germany in 1884, in which a flash of lightning struck a building and appeared to make its exit through a window, leaving a jagged hole in the glass. The next instant a powerful jet of water rose from the soil, came straight through the same hole, and struck against the ceiling of the room, almost deluging the house. This case seems more difficult to account for than that last mentioned; and it is, perhaps, a little doubtful whether the experiment offered by M. Planté is quite analogous. A fine wire is passed through a glass tube of small diameter, and an inch or so at the end is allowed to dip into a basin of salt water. A current "of high tension" sent through the circuit thus formed causes the water to rise in the tube to the height of 25 or 30cm. The upper surface of the water becomes luminous, and gives off jets of steam. The experiment is in any case a pretty one.

These, however, are instances of rare and, so to speak, accidental phenomena, and the investigation of the more regular electrical manifestations is even more interesting. In order to imitate the fall of hail, M. Planté has devised a very ingenious experiment. A saturated solution of potassium nitrate, or other suitable salt, is placed in a shallow vessel, into which dips an electrode connected with a secondary battery of 400 cells. The extremity of the conductor connected to the other end of the battery is wrapped round with moistened paper, so as to present a considerable surface. When the conductor so prepared touches the surface of the liquid an extraordinary effect occurs. An arc of the so-called "semi-incandescent" type is formed, jets of steam spurt from the surface, and at the same time large drops are projected into the air in all directions. Since these drops consist of a saturated solution they solidify as they fall, producing a "hail" of saltpetre. M. Planté concedes the difficulty of finding an atmospheric analogy for the

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saturated liquid, but, if we understand him aright, he suggests that if an electric discharge takes place amongst cirrus clouds floating—as is frequently the case—at such heights that their particles consist of very minute ice crystals, then the following series of results ensue:—First, the heat developed by this or by an immediately preceding discharge liquefies the ice particles; next, the resulting liquid is scattered in large drops, as in the experiment shown; and lastly, the drops are again congealed as they fall, and so reach the surface of the earth in the form of hail. Without offering any opinion as to the exact degree of analogy here presented, we would remark that the origin of hail has long been a *crux* to the meteorologists, and the suggested explanation should not be dismissed merely because it is somewhat complex.

The remarkable phenomenon known as "globular" or "ball" lightning has long been a favourite subject with M. Planté, and in an appendix at the end of this work he collects quite a large number of well-authenticated instances. The attention of the scientific world was first drawn to the subject by Arago, in the year 1838. The descent of globes of fire from the clouds had long been a popular belief, but the "thunderbolt" superstition with which it appeared to be intimately associated had tended to discredit the facts in scientific circles. The existence of the phenomenon is now, however, perfectly well established, and certainly admits of no doubt in the mind of the present writer, who has himself been privileged to witness a display of this character at rather uncomfortably close quarters. This instance has already been related in *The Electrician*,* and the general impression left on the writer's mind is closely in accord with many of the stories related by M. Planté. In the case alluded to, a fiery globe, coming apparently from the fire-place, moved with a gentle undulating motion around the room, finally disappearing, without explosion, by the way it came. M. Planté speaks of this slow, wavy motion as characteristic, and he also gives more than one instance in which the ball passed up the chimney of a dwelling-house. In *The Electrician* of Sept. 3, 1886, p. 333, a case is recorded which is similar in this detail; but the globe coming in contact with the body of a man killed him on the spot, although without detonation. Arago notices that some balls disappear with and others without explosion. Planté records instances in which the ball was of an ovoid shape, and others in which it seemed to rotate with great rapidity. In one case, where the aperture of a disused stove pipe had been covered by wall paper, the ball tore away the paper, and disappeared up the pipe. In the earliest case quoted by M. Planté, which occurred at Stralsund in 1670, the apparition of a single ball was accompanied by a succession of detonations. He also quotes from this journal an account of a "beaded" flash which broke up into a great number of fire balls. This occurred at Westminster during the great storm of August 16th last year.

M. Planté has carried out a great many experiments in order to imitate these phenomena. An arc discharge taking place between a metallic electrode and a basin of distilled water, with 4,000 volts in circuit, takes the form of a globe of fire when the arc is extended to its greatest limit, and by causing the electrode to swing to and fro over the surface M. Planté gets an effect which, in the dark, closely resembles in appearance the globe discharge. But it is scarcely possible that these phenomena are really identical. In the *Comptes Rendus* of 19th August, 1878, the author published the description of an experiment with a plate of mica formed into a condenser by coating each side with tinfoil. When charged up to about 2,000 volts, the mica gives way at the weakest part, and a little detached globule of incandescent tin starting at this point makes its way by an irregular or sinuous course all over the surface of the plate, cutting a narrow groove or trace in the mica. In 1877 M. Planté improved upon this by using an air condenser in which the metallic plates were covered with paper and moistened with distilled water; an E.M.F. of 4,000 volts was used in this case, and the wandering globule consisted of water vapour, air, and hydrogen.

It is worth while to mention here an experiment originally due to Mr. T. Blakesley (M. Planté attributes it, in a footnote, to M. C. Moussette, by whom it was no doubt independently discovered). If a photographic dry plate after development be placed between the poles of a Holtz or Wimshurst machine, an E.M.F. insufficient to strike across the plate will start a wandering spark, which moves irregularly to and fro upon the surface.

M. Planté's experiment with the moistened coatings is perhaps as near an approach as can be made to the actual meteorological conditions. In order to apply this to the explanation of the natural phenomena he assumes that between the thundercloud and the earth there is formed "a column or funnel of damp air strongly electrified, visible or invisible, which serves as an electrode, through which a continuous discharge takes place, manifesting itself at the lower extremity as a ball of fire."

The limit of our space will not allow us to quote the interesting series of experiments by which M. Planté endeavours to support this explanation. For our own part we are unable to feel that the phenomenon has yet been elucidated to a thoroughly satisfactory extent, although the beauty and originality of M. Planté's work none the less deserves the fullest recognition. We have left ourselves no room to speak of the miniature cyclones, water-spouts, and auroras which M. Planté has produced in his laboratory; but we may, perhaps, return to this part of the subject on a future occasion.

* See *The Electrician*, August 20th, 1886, p. 294.

"Electro-plating." 2nd Edition. By J. W. URQUHART. (Crosby Lockwood and Son, London, 1888.)

This book has a great excellency and a great defect; it is simply and clearly written, but it is deficient in the scientific foundation of the subject. In nearly all the details of the art it is very explicit.

In the preface, the author states "that without much rule of thumb any ordinarily intelligent man may become an expert in electro-deposition with a very little science indeed." This appears to us to be a very misleading statement, because a man can only become an expert in electro-plating, either by means of "rule of thumb" experience, or by means of scientific knowledge; if he is without either he must fail. There is no short-cut or royal road to excellence in electro-plating, any more than in any other pursuit; and a combination of scientific knowledge and "rule of thumb" is, in our opinion, the most certain means of success. It is further stated in the preface:—"This work has been prepared for the benefit of that numerous portion of the community who have not the advantage of books, and who could with difficulty understand them if they had." And on page 7 the author says, "that this treatise is written for those who know nothing of chemical or electrical science," and "the reader is assured that the practice of electro-deposition may be carried on with only a modicum of scientific knowledge." It is rarely the case that a thoroughly informed author of a scientific book speaks in favour of "a modicum of scientific knowledge" relating to his subject. On p. 62, the writer remarks that "the worker himself cannot be expected to be a trained chemist or electrician, and give, as he does, his services for a small wage weekly." This statement is reasonable; but there is a very wide difference between "a trained chemist or electrician" and a man "who knows nothing of chemical or electrical science," and is therefore ignorant of the fundamental principles which govern his work. As the author assures the reader "that the practice of electro-deposition may be carried on with only a modicum of scientific knowledge," we are not surprised to find a deficiency of such knowledge and of preparatory chemical and electrolytic information in his book. From this deficiency of scientific principles, and from the above statements and others in his book, we conclude that the author considers such knowledge to be of a kind which may be omitted both by the teacher and learner. He, however, admits, on p. 37, that "a knowledge of the subject of electrolysis would prevent a great many failures."

Plainly speaking, the book appears to be intended to enable a man to work successfully at electro-plating "with a very

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little science indeed." This is exceedingly plausible and tempting to an uneducated workman possessing but little money, and it may induce him to buy the book; but we consider it to be false economy, very risky, and generally disastrous. For his own self-improvement, and for his ultimate success, irrespective of an immediate and direct increase of wages, we would recommend the workman not to be satisfied with "a modicum of scientific knowledge" relating to his employment, but to continually add to his stock of information respecting it, and certainly to learn the fundamental principles, and acquire the preparatory knowledge which illuminate his entire working.

As an example of the effect of carrying on the practice of electro-deposition "with a very little science indeed," we find on page 118, in both editions of the book, instructions given for making the double sulphite of sodium and silver-plating solution, by passing "sulphuretted hydrogen (*see* process, p. 44)," made "from sulphide of iron with diluted sulphuric acid," through a solution of washing soda until the solution is neutral, and then adding a saturated solution of silver nitrate, "as long as the solution re-dissolves the silver" precipitate. No one possessing even a modicum of chemical knowledge would attempt to use "sulphuretted hydrogen gas" for such a purpose—first, because it would not produce the substance wanted, but quite a different one, viz., sulphide of silver; and second, because it would not re-dissolve the sulphide of silver precipitate. The solution mentioned is prepared, not with "sulphuretted hydrogen," but with sulphurous anhydride gas, and the way to make the latter is not described in either edition of the book. A very moderate amount of preparatory chemical knowledge would have prevented the author from giving these erroneous instructions. It is only fair to say that we have observed no other serious error in the book. Notwithstanding its fundamental deficiencies, however, the book is full of details of useful instructions in electro-plating, described in the simplest language, and it will prove of great service to ordinary electro-platers, especially to those who have acquired suitable preparatory knowledge of the principles of chemical and electrical science.

Short Lectures to Electrical Artisans; being a Course of Experimental Lectures Delivered to a Practical Audience. By J. A. Fleming, M.A., D.Sc. (Lond.) Second Edition. (E. and F. N. Spon, London, 1888.)

We think it a matter for considerable satisfaction that a second edition of these Short Lectures has already been demanded. This book is one which we shall hope to see run through many more editions yet. There are many persons not strictly belonging to the artisan class who would derive much advantage from the study of this work. We are frequently asked to recommend suitable books to people who possess some general knowledge of electricity, but who wish to obtain a firmer grasp of the principles of electrical engineering. This is one of the books which in such cases we most strongly recommend.

ON THE ELECTRIFICATION OF METAL PLATES BY IRRADIATION WITH ELECTRICAL LIGHT.

The July number of the *Phil. Mag.* contains the following translation of a Paper, by William Hallwachs, which originally appeared in the *Göttinger Nachrichten*:—At the close of an article recently published in Wiedemann's *Annalen*, Vol. XXXIII., p. 301, I had mentioned that, to judge from preliminary experiments, metal plates become electrostatically charged when irradiated with the electrical light. It could be seen from the outset that we were not dealing here with charges at potentials that could be measured by a gold-leaf electroscope. In order to ascertain whether a charge measurable with sensitive electrometers could not be obtained, the final experiments were made as follows:—The circular metal plate, 8 centim. in diameter, to be illuminated was suspended by an insulated wire in the centre of a cylindrical sheet-iron vessel, 50 centim. in length and 37 centim. in diameter, which lay with its axis horizontal. The surface of the metal plate was coated with rust, but one portion of the surface was brightly polished and was put to earth. The wire by which the plate was suspended passed through, but insulated from, an earth-connected brass tube, to a Hankel's electrometer, which was chosen for these experiments on account of its small capacity. In the lid of the metal cylinder was a circular aperture of about 8 centim. diameter, which transmitted the rays of the arc lamp to the plate hanging inside. This aperture was covered by a piece of wire gauze, in order to prevent any appreciable induction of the lamp on the plate to be irradiated, without excluding the action of the luminous rays on it. From former experiments (loc. cit., p. 305) this latter phenomenon was to be expected, and was confirmed by the present experiments. The luminous arc was at a distance of 45 centim. from the plate, the rays coming from it passed through a diaphragm 6 centim. in diameter before entering the metal case. The case was of rusty iron, so that the contact potential against the plates to be suspended was always negative. In this case only could the rises of potential indicated by the electrometer be indubitably explained. For if the plate had been negative to the case, a rise of potential would have occurred due to the transport of negative electricity by the illumination. If the plate, however, was positive towards the case, and therefore possessed a positive charge, an increase of potential could only be due to the fact that positive electricity was produced on the plate by irradiation. The determination of a difference of potential due to contact by a method formerly described in Wiedemann's *Annalen*, Vol. XXIX., p. 7 (1886), gave for rusty iron towards brightly-polished zinc 1·2 volt. If, now, the aperture in the diaphragm through which the rays of light could fall on the plate was closed by a mica plate, the electrometer was at rest when the arc was produced. When the mica was replaced by a far thicker plate of selenite, the galvanometer gave a gradually increasing deflection indicating positive electricity. This at once ceased to increase when the mica again replaced the selenite. The rise of potential cannot therefore be due to an inductive action, nor can it be referred to the action of heat. The complete absorption of the action by mica, and the great transmissibility of selenite are here as prominent as in the action of light on electrostatically charged bodies, so that the excitation of electricity is probaby due to the same rays as that phenomenon. The metals which have been used for the experiments just described were zinc, brass, and aluminium. In all three positive electricity occurred on irradiation with brightly-polished surfaces. Old surfaces no longer show the phenomenon. The radiation itself lowers the potential to which the plates can be electrified, so that with any succeeding experiment made with the same surface the potential obtained is lower, while the rise to it takes place more rapidly, and the decrease is greater than when for the same interval of time between the experiments the plate was not illumined. The maximum potential with zinc amounts to over a volt, with brass to about 1 volt, and with aluminium to 0·5 volt. These values are the highest which have as yet been obtained, as the maximum values change with the condition of the surface. As I have had to interrupt these experiments I have ventured meanwhile to communicate the chief results. Whether the excitation of electricity by radiation with electric light is in direct connection with the loss of electricity by electrostatically-charged bodies when irradiated I cannot state, as it has hitherto been impossible for me to make any experiments in this direction.

BOOKS, &c., RECEIVED.

"Über Molekularphysik." By F. Lindemann. Separate Impression from the *Transactions* of the Physico-Economic Society of Königsberg.

"*Journal* of the Society of Telegraph-Engineers and Electricians." Vol. XVII., No. 74. (London: E. and F. N. Spon).

"The Inventor's Manual." A handbook of practical information. By J. C. Chapman, A.M.I.C.E., Fel. Inst. Patent Agents. (2nd Edition.) (London, 1888.)

Fortschritte der Elektrotechnik. A Quarterly Review of Electricity. 1. Year, Part IV. (Berlin: Julius Springer.)

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SPECIAL NOTICE.

"The Electrical World" *for July 21 issues a* Special Supplement, *containing Mr. Sprague's Paper on "The Solution of the Municipal Transit Problem." This Supplement is issued* Gratis.

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THE ATLANTIC CABLE RATES.

We are glad to be able to announce this week that the war of rates between the several Atlantic Telegraph Cable Companies has virtually ceased, and that on the first of next month the charge by any of their lines will be a uniform one of 1s. per word. It is curious to note that, according to the statement of the Chairman of one of the English companies, the American companies, which were primarily responsible for the destructive rates prevailing since May, 1886, are now quite ready, and even anxious, to place them on a friendly and more profitable footing. Only one company, the French Atlantic, held back from the rest until the last moment; but after a show of resistance, and a consultation with the French Government, this company also has given in its adhesion, and there is now a combination of the five companies to work their cables henceforth at a rate which, while it may not be too low to yield

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a reasonable profit to them all, will not be so high as to invite any new competitor. The parties to this prolonged dispute have, in fact, arrived at the conclusion that the experiment of competition has been sufficiently exhaustive, not to say exhausting, and that it has furnished them with trustworthy data on which alone they can base a commercially sound tariff of charges.

The history of the conflict, not less than the outcome of it, in its bearings upon the commercial aspect of submarine telegraphy, may be usefully studied at the present moment. More than two years ago the English companies, owing to the laying of a new and quite superfluous cable from the other side of the Atlantic, were compelled to reduce their word-rate from 2s. to 6d. We say compelled, because the intruding cable started with a rate of 1s. 8d., and unless the existing companies were content to acquiesce in this reduction—in other words, to condone the competition—they were bound to retaliate by reducing their own rates to a much lower figure. With some advantages on its side the Commercial Company then reduced its rate to 1s., while the other four companies were running at sixpence; but it was obvious from the first that this state of affairs could not last, and in the autumn of 1887 the Commercial Company reduced its rates to the level of the rest. Eighteen months' trial of an artificial rate was evidently not a success, and since last September the whole of the cables have been working at a uniform rate of sixpence a word. By that time, however, it had become plain that the sixpenny rate could not pay any of the companies; and, if possible, this fact became plainer when the new company entered into competition on equal terms. From that moment the sixpenny tariff was doomed, for if a shilling tariff would not pay, worked independently, certainly a sixpenny tariff would not. It did not, apparently, take long to convince the proprietors that competition, except on purely philanthropic lines, was no longer practicable, and that an amicable alliance with the other cables was the only basis on which its own could ever hope to earn a fair profit.

This stage being arrived at, the next step necessary was the fixing of a tariff on which all the parties would be willing to work. One or two of the companies wished to return to the 1s. 8d. rate of 1886; but this has been overruled, and we think wisely. The sixpenny rate, although in itself unprofitable, has greatly developed the traffic, both in area and in bulk; and whatever may come of the increased rate now adopted, the ground on which it will begin is far superior to that on which the higher tariff was worked three years ago. The English companies believe that there will be no serious falling off in business under the increased rate; but, be that as it may, the maintenance of the sixpenny rate for two years and three months has made the experiment of a shilling rate a possibility which otherwise probably would not have been entertained.

On this result at least the public are to be congratulated. They have enjoyed for a considerable period the advantage of a very low tariff, and are now to have a tariff much lower than it would have been but for that advantage. Some of the companies' shareholders urged the adoption of the 1s. 8d., or even a 2s. rate; and, in view of the losses they have sustained, they were entitled to make this demand. But at present it is wiser to be content with the directors' proposal, or at all events to give it a fair trial. What the companies have now to do is to work for profit, not for each other's destruction; secondly, to provide themselves with an adequate reserve fund; and lastly, to prevent the possibility of any fresh competition arising.

The companies themselves, as well as the public, have reason to be satisfied with the prospects now before them. Not only have they worked up an immense field for telegraphic business, but they have disarmed the hostility of their customers. The 6d. tariff has been borne patiently and tested to the uttermost that could be reasonably expected. The diminished dividends have spoken eloquently even to a public not over inquisitive as to profits so long as prices rule low; and the result has been, so far, that no outcry has been heard against a rise in prices which a few years ago would have been hailed with a storm of indignation. Only in one quarter have we noticed a mild protest on the ground, apparently, that as the traffic has increased 140 per cent. under the 6d. tariff, therefore it ought to be remunerative. But the fact that it is not remunerative is not disputed, and, on the whole, is accepted as a justifiable reason for increasing it. The decrease in the rate was in much greater proportion; and, as the phenomenon of working expenses increasing considerably with augmented traffic has lately been demonstrated in the Postal Telegraph Service of this country, the general public are prepared to view the situation with unaccustomed reasonableness. Of course there is the usual talk about the hundreds of thousands of people on both sides of the Atlantic panting to send cablegrams to each other, and waiting only for the rates to be lowered; but it is not likely the *Daily Telegraph* will succeed in this line of argument where Mr. Henniker Heaton has failed. It may be true, and we hope it is, that "Transatlantic telegraphy is at present, as regards bulk, nearly in its infancy;" but as it brings us no nearer finding capital to provide the full-grown child with more cables, the proposition does not call for serious discussion. Similarly, except as a sample of popular misconception, we need not give greater publicity to the speculation that Mr. Edison's "perfected phonograph" may "aid in recovering the lost sixpenny tariff." Whatever its inventor may expect, or the *Daily Telegraph* may predict of it, the phonograph has at present about as much relation to submarine telegraphy as the sewing-machine has to steam locomotion. Just now, therefore, we have only to deal with the facts as they are; and among several foolish things in the article from which we have just quoted there is one passage of sense and reason on which the Atlantic cable companies might rest their whole case, namely, that private enterprise is not expected to make sacrifices out of revenue in order to "do good" to the public.

THE SPRAGUE ELECTRIC TRAMWAY AT RICHMOND, VIRGINIA.

Under the title of "The Solution of the Municipal Transit Problem," a Paper which has attracted much attention in the United States was read on June 17th, before the American Institute of Engineers, by Mr. F. J. Sprague. The Paper is of very considerable length, and deals in the first place with the general question of the tramway service in large cities, and proves from authentic statistics that while the working cost of the cable system of traction is from 50 to 70 per cent. that of horses, the cost of the electric system does not exceed 40 per cent. After giving numerous details relating to the running of the Sprague motors, the author describes the difficult character of the street lines in Richmond, where gradients of 1 in 10, and curves of 27ft., 30ft. and 40ft. radius are frequent. He then proceeds as follows:—

The power house is situated two blocks away from the nearest point of the line, and is almost equi-distant from its extremities. As a distributing point, it is, therefore, both theoretically and practically, a central station. In the construction no expense has been spared, and the performance of the station has justified it. The battery consists of three cylindrical return tubular boilers of the latest pattern, mounted on a Jarvis patent furnace, their capacity being 125 horse-power each. The water is taken from the city mains or from a well. All feed-water connections are of brass pipe. From the pumps the water passes first through the feed-water heater, where it is heated to from 150 to 200 degrees Fah. From there it goes to the filter. The draft in the furnaces is regulated by an automatic steam damper regulator, which, with anything like regular firing, keeps a pressure within two pounds of that for which the regulator is set.

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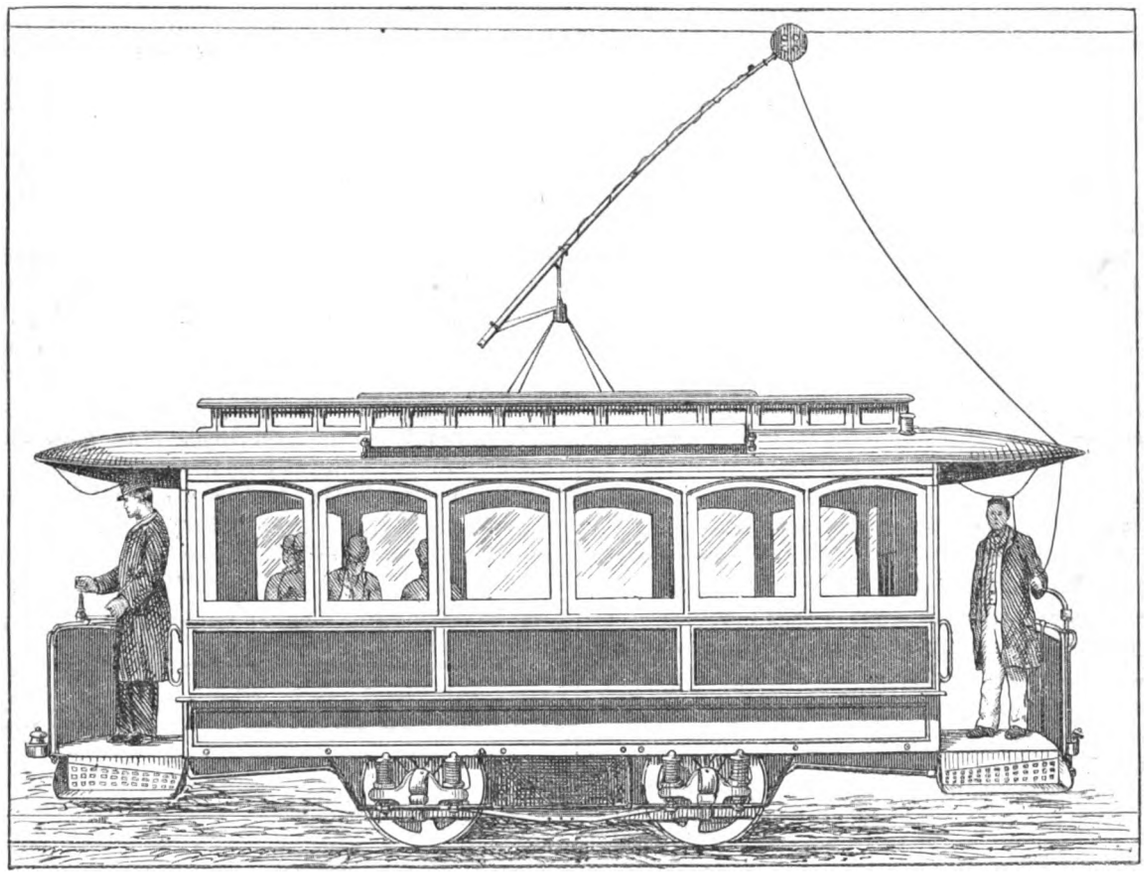
The boilers all feed into one main feed steam pipe, which in turn leads to a separator, a large iron cylinder into which the steam passes, the water falling to the bottom and the dry steam being carried off at the top. All live steam pipes in the boiler room are covered with magnesia.

The present battery occupies less than half the available space in the boiler room, so that four more boilers can easily be put up when it becomes necessary to enlarge the plant. Two more have just been added. An important feature of these boilers, which are the source of power of the whole system, should not be overlooked—that is, the quantity of coal burned. Where a very perfect combustion is obtained a grade of coal can be used which would be impracticable in an ordinary furnace; the mixture at present being used is two parts screenings to one part bituminous, costing from 1·75dol. to 2dols. per ton delivered. As the station is only three hundred feet distant from the depots of three railroads, coal can be obtained almost at the door. From the boiler room, both the steam and exhaust pipes run in an underground, mineral wool-packed trench to the engine room.

The railroad engines, of which there are at present three, are of the Armington and Sims high-speed type, and develop when running at full load 125 horse-power each at 250 revolutions.



The Sprague Electric Tramway at Richmond, U.S.A.

Each engine drives two special Edison dynamos of 40,000 watts capacity each, wound for 500 volts maximum pressure. The dynamos feed into copper "bus" bars, supported on the walls by porcelain insulators.

Each machine has its independent ampere meter, and in addition there is a general ampere meter at the end of the positive "bus" bar. From this bar the current passes to four snap switches, each switch being connected through a three-plug safety switch-block to one of the feeders supplying current to the main-line wire. These four-feeder wires tap into the line wire at different points, thus maintaining the pressure approximately equal all along the line. At the ends of one of the feeders in the central station pressure indicators are to be attached which will indicate the voltage at the junction of one of these feeders with the main-current wire, and this will serve as a guide.

The electric circuit consists of two parts—the overhead and the ground circuit, each being of compound character. Along the kerb stones, at distances of 135ft., are 30ft. poles, inserted into the ground at a distance of 5ft. Great difficulty was experienced at first on account of the clayey character of the soil, and it became necessary at the corners to put in very heavy poles, which were embedded in concrete and stones to prevent settling out of place after heavy rains. These poles carry the main circuit, which extends throughout the entire length of the road, and is a copper wire three-sixteenths of an inch in diameter; this is called the main conductor, for on it depends the operation of the road in case of accidents or repairs to the contact wire.

This main conductor is supplied at widely separated points by feeders, which come from the main supply at the central station. Without the use of these feeders, which can also be reinforced if necessary, the size and cost of the overhead conductors would be very largely increased. The curves are formed of a series of short chords, which approximate the central line of curvature.

The current is taken from this working conductor by a light structure on top of the car (see Figure). This consists of a low skeleton framework which carries an adjustable swivelling trunnion, having at its upper end a jaw in which is suspended a counter-balanced trolley pole, having at its extension a grooved wheel held by a spring against, and making running flexible contact with, the under side of the working conductor. The flexibility of this arrangement is very great, it being able to follow with perfect facility variations of the trolley wire two or three feet in either horizontal or vertical direction, at any speed, and around any curve. What is all important, it relieves the line of strain instead of adding to it. When getting at the end of the track this trolley trunnion is swung around so as to trend in a proper direction abaft the centre of the car. If off the line it can be replaced from the car quickly and easily in the darkest night. From the trolley the current passes through a protected wire to the lightning arrester and thence to two switches one at each end of the car, whence, after whatever commutation is necessary, it goes to the motor circuits, and thence to the wheel frame.

The return circuit is through the track, and thence by both metallic and ground circuits to the station. Each section of rail is joined to a copper ground wire, which runs throughout the length of the road underneath or alongside the stringer pieces, which is done to prevent appreciable differences of potential existing between the rails. As a further precaution, at intervals of 500ft., this ground wire is connected to an earth-plate, and at seven points widely distributed these ground plates are supplemented by heavy iron pipes sunk into iron ore, or 12in. water wells, about 25ft. deep. The ground wire is connected to the station, and there is also a main ground connection made there in a 30ft. well through a large zinc plate, and another to the entire water-works system. Some modifications of the overhead system are now being made

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which will make it impossible for any accident to one section of the line to disable the remainder ; will enable the different sections to be operated independently ; and, in case of a fire which may necessitate the blocking or temporary disabling of one part of the line, will allow this section of the line to be cut out of action either automatically or at will.

Each car is fitted with a duplicate and very powerful motor equipment. This is carried entirely beneath the car body, is very compact, out of sight, and necessitates no radical change in the construction of the car. The body had to be stiffened a little and 3in. steel axles put in. One of the great objections which have been met with in applying motors, whether steam, electrical or of any other character, to the propulsion of street railways, has been the difficulty of getting sufficient track adhesion to operate the car under all conditions of track, loads and grades. Especially was this objection true in Richmond, where it was manifest that no application of a motor system could be fully successful unless the entire weight of the car and its contents were made available for traction.

One of the manifest reasons is, of course, the slippery character of the track under many conditions. Another thing should also be noted, and that is that it is almost impossible in practice to cast all wheels of exactly the same circumference, or at least so that the paths described by the lines of contact shall be the same. Moreover, on curves the wheels are all travelling over paths of different lengths. Theoretically, the wheels should be independently driven, but since this is not possible it follows that the next best thing is to drive each pair of wheels independently. It is a fact which admits of no dipute that there are conditions of track which will not permit of a car being driven from one pair of wheels only, and this difficulty is often augmented by the fact that if one pair of wheels only is used they will sometimes be leading, sometimes following ; on heavy grades, with one platform reserved for the driver, there is a very serious displacement of the centre of gravity, and there may be very much more weight upon one pair of wheels than on the other. The whole experience in Richmond has been to emphasise the value and necessity of independently driven axles.

To accomplish this, one motor is centred upon each axle, and to allow the required freedom of motion, and at the same time to preserve perfect parallelism in the meshing of the gears, and also for taking part of the weight of the motor off the body of the axle and to throw it on to the journals, one end of the motor is supported by double compression springs playing upon a loosely suspended bolt, which is supported from a cross girder in the bottom of the car.

The motors are, then, so to speak weighed or flexibly supported from the car body, and the motion of the armatures is transmitted to the axles through intermediate gearing, of compact form and great strength, so that whenever the axles are in motion there is a spring touch of the pinions upon the gears. Barring friction a single pound pressure exerted in either direction would lift or depress the motor a slight amount, and no matter how sudden the strain, whether because of a variation of load or speed, or a reversal of direction of rotation, it is impossible to strip the gears unless the steady strain exceeds the strength of the iron, the pressure on the gears always being a progressive one. The motor armature makes nearly twelve revolutions to each revolution of the car axle.

The motors, although in one sense independent, are connected with duplicate switches at either end of the car which afford simultaneous control of both machines. These motors, which are of normal capacity of 7½ horse-power each, can for a short time work up to 30 horse-power, and are capable of producing a tractive effort of over three thousand pounds at 50 per cent. efficiency.

The machines are controlled by a single movement switch, which effects the various commutations and reversals. They run with fixed brushes in both directions and under all loads. They are run without any covering, and I have no doubt of having street car motors in such condition soon that the cars will be run over a pit, and the machines washed down with a hose.

The cars can be run at widely different speeds, varying from the slowest crawl to twelve or more miles per hour. They can be started and stopped without the use of brakes in the space of three or four inches, and when making the normal running speed can, in an emergency, be stopped and reversed without brakes within less than a quarter of a car length. The starting, although prompt, is easy and without shock or jar.

Emergencies sometimes bring out qualities of motors which are unexpected, or which, at least, if counted on are rarely ever brought into play. On one occasion a man was descending a six per cent. grade with a heavy load when his brake chain parted. Seeing a sharp curve right ahead of him which he knew he would leave if he struck it at the speed he was running, he instantly reversed his machines and brought his car to a standstill, and on the rest of his trip handled his machines entirely with the motors. On another occasion a man, pssing from behind one car directly in front of another, was struck and knocked down by the dash-board. Although the car was moving at a lively gait, the machines were reversed and the wheels stopped within a foot of the man. By any other method of propulsion he would have been killed. Frequently on a ten per cent. grade, with a loaded car, the brakes have been thrown off, the machines reversed, the car stopped and started backward up hill within less than one-half of its length, a test of the most remarkable severity.

In noting the control of the car, one is struck at the remarkable character of the traction, and cannot help wondering where it comes from. Unquestionably it is in a large measure due to the fact that every pound of weight is available for traction, and that the two axles, being independently driven, can take their own speed, and each pair get the best grip.

Another thing to be noted, where the ground circuit is used, is the increase of traction due to the passage of the current from the wheels into the rails. Exactly what molecular action takes place has not been ascertained ; it may be simply heating at the contact surface, but the fact remains that the traction is very largely increased. The magnetic condition of the wheels and tracks also has some function in this increase of traction. The wheels and axles are magnetised by the method of motor construction and mounting, and also by the passage of the current through them ; the tracks are likewise magnetised by the current passing through them, and also by the rolling contact of the wheels. Yet, admitting all these aids, the results have been extraordinary.

Sixteen-foot closed cars, carrying picked loads of fifty-five to sixty passengers, and having a total weight of 15,000 pounds, are operated on the 10 per cent. grade, often with a slippery and slimy rail, and on 27-foot curves, without the use of sand or extra help.

These same grades and curves have been ascended without sand after one of the worst sleet storms which has visited this section for years. Various tests under the most unfavourable conditions have been made, cars often being required to cut their way through clay, snow, and ice when the tracks were out of sight. No severer test could have been made, and the power and tractive effort developed have exceeded the most sanguine expectations.

Cars have often been stopped and started on the heaviest grades, and in the sharpest curves. One motor has propelled two cars around sharp curves and up six per cent. grades. One car has pushed another of greater weight around the sharpest curves and up seven and eight per cent. grades both straight and combined.

I have no hesitation in saying that with a clean track, and with proper gearing, these cars could mount a 15 per cent. grade, depending on adhesion alone. During the four months' operation, although there have been troubles and changes have been made while the cars were running commercially, no car has been pulled a foot by animal power ; if any accident has occurred to a motor the car has gone along with one machine, oftentimes with heavy loads and on heavy grades, or in some cases has gone home in company with another car. One hundred and forty men, who did not know the difference between a motor and a hand-saw, have been broken in to handling these cars ; oftentimes with remarkably short training. Up to Saturday, May 4, the number of regular cars on duty had not succeeded twenty. On that day, at 4 p.m., the hour when traffic becomes exceptionally heavy, we began putting out ten open cars, starting them from the eastern car-house alternating with the closed cars, but finally banking them all up at the Old Reservoir. At 6 p.m. they were started home, and shortly afterwards these ten open cars, headed by a closed car, were all run at full speed close together down the east-bound track of Clay-street. At one time fourteen cars were on the line between Clay and Hancock-streets and the Old Reservoir, and shortly before 7 o'clock there were about twenty-two cars on the line between Capitol-square and the Old Reservoir, and at 7 o'clock thirty cars were on the line, the closed cars being very heavily loaded, many of the cars being run with two-minute intervals. The three boilers, whose capacity is 375 horse-power, were then supplying three Armington and Sims engines of 125 horse-power capacity, which were driving the six railroad dynamos, and two Westinghouse engines of 110 horse-power capacity, which were driving two alternating-current dynamos and exciters, with an equivalent load of 1,060 incandescent lamps. The mixture was enriched, and the firing of boilers became pretty active, there being, in addition to the thirty cars badly banked, about 110 horse-power taken for lighting.

The highest reading, however, on the line was less than three-quarters of the normal capacity of the dynamos, which were originally intended only for thirty cars, and the average reading for this number was only a trifle over half the normal capacity.

The figures which follow, being based upon an actual service increasing from eight to thirty cars, and extending over a period of four months under the most trying circumstances, and at the most critical and care-requiring period of the enterprise's existence, will give street railway men the most careful and liberal estimate of every possible expense attending the operation of the road which is in any way dependent upon its electrical features. The operating expenses are given under two heads—First, the central station operating expenses, and second, the road operating expenses ; the

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two constituting the total cost of motive power. These are given in detail, and they will probably be found to cover every expense, although in some small ways the distribution of these expenses may be found to be changed by several months' longer running. The fuel and other incidental expenses of the station are from the engineer's record, and checked by the readings of the electrical instruments.

For thirty cars running on a double track the central station expenses are about as follows :—

52 42-100 cwt. coal, at 10 cents	$5.84	
113 70-100 cwt. screenings, at 7 cent.	7.96	
5 pints cylinder oil, at 75 cents per gallon	.47	
5 pints dynamo oil, at 30 cents per gallon	.18	
3 pounds waste, at 10 cents	.30	
Water at current rates	3.00	
Fuel, &c.		$17.75
1 day engineer	$3.00	
1 night engineer	2.25	
4 firemen	6.00	
1 cleaner	1.50	
2 dynamo men	3.50	
1 electrician	4.00	
Labour		$20.25
Lighting	.50	
Depreciation and repairs on dynamos, 3 per cent.	1.50	
Depreciation and repairs on engine and boilers 10 per cent.	4.38	
Total central station expenses		$44.38

or $1.48 per car making 80 miles.

[The central station being operated for twenty-four hours for lighting and power purposes, the lighting company has now assumed charge and rents the power to the cars at $1.60 per day.]

In estimating the road expenses, more than liberal allowance is made, but in a new enterprise it is safe to err on this side rather than attempt to claim for a system advantages which will not in practice be borne out. The expenses are then as follows :—

Oil, grease, and waste	$4.50	
Brushes	3.00	
Trolleys	2.00	
Material		$9.50
Three mechanics and one helper for thoroughly overhauling motors once a week, making repairs, adjusting brakes, &c.	7.90	
Four inspectors, two day and two night, for oiling machines and looking after brushes	7.50	
Two night inspectors, to thoroughly inspect motors after cars are laid up and see that all bolts, nuts, and connections are tight, and that everything is in good working order for the morning run	4.00	
One winder and helper for making any repairs which may be necessary and any testing which is required	3.50	
Two linemen	5.00	
Labour		$27.90
Depreciation on car work at 15 per cent.	18.00	
Depreciation on line work at 10 per cent.	4.00	
Depreciation		22.00
Total road operating expenses		$59.40

or $1.98 per car making 80 miles.

The total motive power expenses both in the central station and out on the road would not then exceed 3.46dols. per car making eighty miles, or 4.32dols. per car mile, and this includes everything except the executive and salary expenses, taxes and insurance, and is less than 40 per cent. of the cost of operation by horses with the same number of cars and under the same conditions.

But the showing is even better than this, for another fact is to be noticed, and it is an important one from an economical point of view. For example, twenty cars on duty for about eighteen hours make a mileage of from 1,500 to 1,800 per day, and if it were not for the fact that the schedule requires them to operate part of the time on a single track with insufficient turn-outs they could make 1,800 or 1,900 steadily. This, notwithstanding the fact that the speed is limited by municipal regulations. Many of the cars often run 90 to 100 miles. The same mileage and intervals made by twenty electric cars could not, under the circumstances, be made by anything less than twenty-five horse cars of the same size, and the electric cars probably carry in the aggregate just as many passengers. It follows that to get the same service with horses not only would the number of cars have to be increased, but likewise the number of horses, conductors, and drivers. The same mileage performed by horses without these cars and grades would require a stable equipment of not less than 300 horses.

With the mileage which is now made, there is an actual saving of about 125dols. per day in the motive power expenses as against operations by horses. It is hardly necessary to point out that this would pay a good interest on a pretty large investment. The capacity of the road to economically carry passengers has been made so apparent that the old City Railway, which was operated by mules, and has about thirty miles of track and fifty cars, has been bought up, and is to be equipped with motors operated from the same central station. A third line will probably be added, and in the near future every street car, to the number of one hundred, in Richmond and Manchester, will be electrically operated from one station.

MR. VERNON HARCOURT'S NEW PHOTOMETER.

The holophotometer has been designed in order to get rid of two difficulties connected with other methods of attaining the same object, viz., to measure the light emitted in every

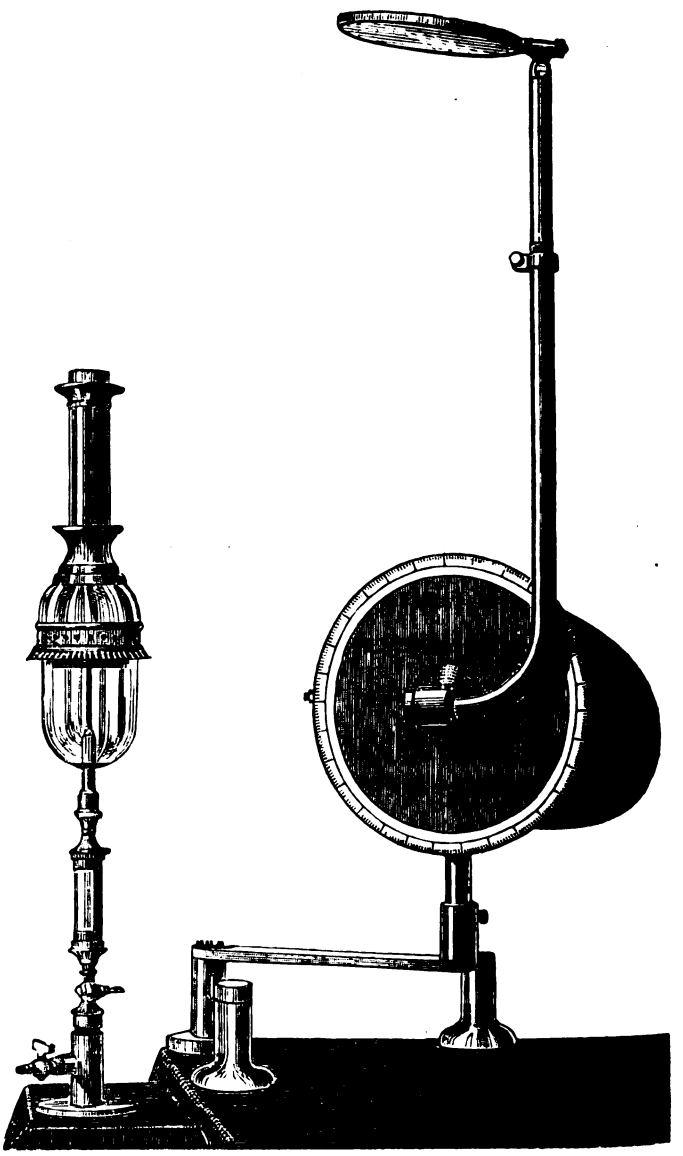

FIG. 1.

direction by any luminous source. These difficulties are:— (1) The movement of the light to be measured or of the standard lamp, neither of which is desirable. (2) The errors caused in the measurement of lamps provided with reflecting fittings, by the assumption that the flame is the zero point from which measurements should be made, whereas, strictly speaking, the principal focus formed by the reflectors should be taken as the zero point. Inasmuch, then, as this focus may be several inches away from the flame, and as the length of bar usually employed is 60in., it is evident that serious errors may be introduced by the difference between the real and the

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assumed zero points. To establish the existence of such an error, and to eliminate it, two things are necessary, viz., that readings should be taken with bars of various lengths, and that the length of the bar should be very great compared with that between the real source of light and the focus formed by the reflector. Both these points are secured by the use of the holophotometer. The instrument is mounted upon a table capable of being moved nearer to or further from a fixed table containing a graduated bar, with a movable disc (say, of the Letheby pattern), and having a standard lamp fixed at the zero of the bar. The lamp to be measured is mounted upon, or is in rigid connection with, the movable table, and is therefore not moved during a series of readings.

The holophotometer consists of an axis working friction-tight in a collar supported by a vertical pillar. The axis is accurately fixed at the same height, and in a line with the centre of the disc. At the end nearest to the disc is placed a large mirror with its centre concentric with the axis, but so arranged that the plane of the mirror may be inclined and clamped at any angle to the axis. At the other end of the axis is fixed a telescopic arm carrying a smaller mirror, which is capable of being turned into any required position. The arm being rigidly fixed to the rotating axis of the instrument, to which is also attached the larger mirror, it follows that the rotatory motions of the mirrors about the axis are identical. The angles of rotation are measured by the indications upon a divided circle attached to the moving axis, which are shown by a pointer fixed to the upright support.

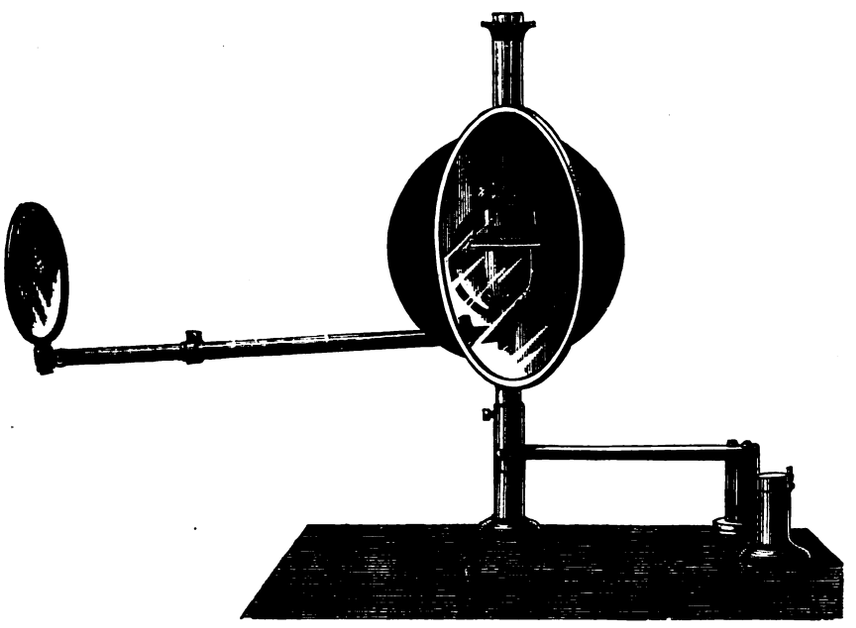

FIG. 2.

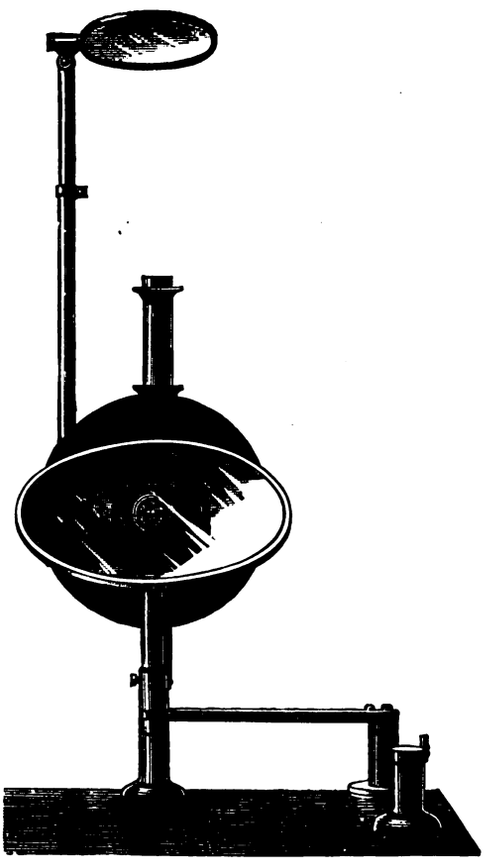

FIG. 3.

The mirrors are adjusted in such a way that the light from the lamp to be measured falls upon the smaller mirror, thence is reflected on to the larger one, and finally along the axial line of the photometer disc. As both mirrors rotate together it follows that if a horizontal beam is reflected correctly all other beams will find their way along the axis of the photometer. If, therefore, the arm carrying the small mirror be moved through various angles, it will receive the light emitted from the lamp at those angles, and the light will at every angle be transmitted along the axis of the photometer. The divided circle is made large enough to serve as a complete screen of all direct light, and only the light falling on the small mirror can find its way to the disc. In order that absolute, as well as comparative, tests may be carried out, only one additional measurement need be made. The direct horizontal light is measured without the interposition of the holophotometer (which is mounted so as to be easily moved out of the direct line); then the mirrors are interposed, and a new measurement made. The additional path travelled by the light is allowed for in calculation; and thus the absorption of the mirrors is found once for all for the particular character of light under measurement. It is only necessary afterwards to multiply subsequent values by this coefficient of absorption in order to obtain absolute measurements at various angles.

The employment of mirrors in photometry has sometimes led to serious errors; but it will be seen by the foregoing description that inasmuch as the relative angle of the mirrors is never changed, and as their absorption is easily calculated and allowed for, the only objections to their use have been guarded against and avoided.

In order to eliminate the second source of error mentioned above, viz., that arising from the formation of a principal focus, it is only necessary to take a series of readings with the table in one position, and then move it to a greater distance and take another series. If a focus is formed at a sufficient distance to produce an appreciable error, it will clearly appear in the difference between the readings at the two distances, and then it is only necessary to wheel the table to such a distance that the discrepancy is inappreciable. In other words, this is equivalent to using a bar of sufficient length to make it practically infinite compared with the distance between the focus and the real source of light.

The instrument has been designed specially for use in light-house work, where it becomes of the highest importance to measure accurately the total light given by any lamp, and not only that emitted in any one direction which may or may not be the maximum.

Preliminary experiments made with the instrument by Mr. Stepney Rawson, at the works of the Woodhouse and Rawson Electric Manufacturing Company, have shown what a valuable instrument it is for the determination of the commercial value of various lamps, as well as for assisting in the many difficult problems of the diffusion and reflection of light. The absorption of the two mirrors used is, as already mentioned, stated to be only 1·8 per cent., but a series of experiments are to be made upon this point.

We show here three views of the instrument:—

(I.) As seen from behind, showing the divided scale.

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(II.) Looking from the photometer disc, showing how the horizontal light from the lamp is transmitted to the disc.

(III.) Looking from the photometer disc, showing how the vertical light would be transmitted to the disc.

The instrument is supplied by the Woodhouse and Rawson Electric Supply Company, 11, Queen Victoria-street, E.C.

RANSOMES, SIMS AND JEFFERIES' ENGINES.

Messrs. Ransomes, Sims and Jefferies (Limited), Orwell Works, Ipswich, have recently brought out two portable engines of 6 and

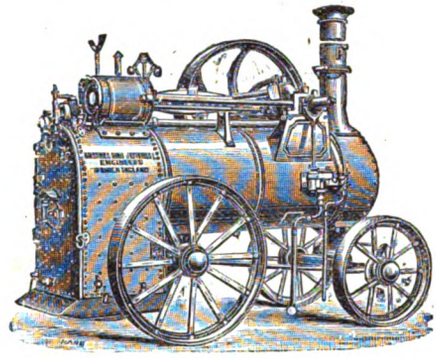

FIG. 1.

8 horse-power respectively, of new design, which possess several noteworthy features. The cylinders are of increased diameter, steam jacketed, and lagged to prevent condensation and radiation of heat. The crank shafts are supported upon wrought-iron brackets riveted to the boiler, and the bearings on each side are provided with vertical and lateral adjustments; the governors are of the high-speed class, very sensitive, in direct communication with a double-beat piston valve, and have complete control over the engines, maintaining a regular speed. The boilers have raised-top fire-boxes, giving ample steam space, and a large manhole in the side of the fire-boxes gives great facility for cleaning. Many of these portable engines have been used for small or temporary electric light installations. This engine is illustrated in Fig. 1.

Messrs. Ransomes' 20 horse-power compound undertype engine is a fine specimen of workmanship and finish, and where economy of fuel is a consideration will be found exceedingly valuable. The cylinder and working parts are mounted on a strong wrought-iron girder frame; the boiler is placed over the engine on the same frame, resting at the smoke-box end on the cylinder, the frame being extended beyond the crank shaft to form an ash pit for the fire-box.

These engines are specially adapted for export, not only on account of the ease with which they are fixed, but as the boiler can be detached from the engine and the girder frame taken to pieces, the weight of the packages may be considerably reduced so as to facilitate transport. This is a matter of the utmost importance in many countries. Another advantage of this type of engine is that it occupies very little space and requires no expensive foundations.

Messrs. Ransomes also supply compound engines of the same type with separate or detached boilers, as shown by our illustration (Fig. 2), two boilers often being found more convenient than one larger boiler on account of the greater facility in transport already referred to. They are made of mild steel plates throughout, and the fire-boxes when desired may be of extra large dimensions for burning every description of inferior fuel.

The 8 horse-power short stroke stationary engine shown in Fig. 3 has the bed-plate, cross-head guides and plummer-blocks for crank

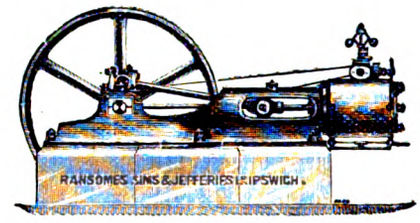

FIG. 3.

shaft all cast in one piece, the cylinder, with its valve-chest, being bolted to the end of the engine frame. This design is very strong, neat and compact, and well suited for electric light work.

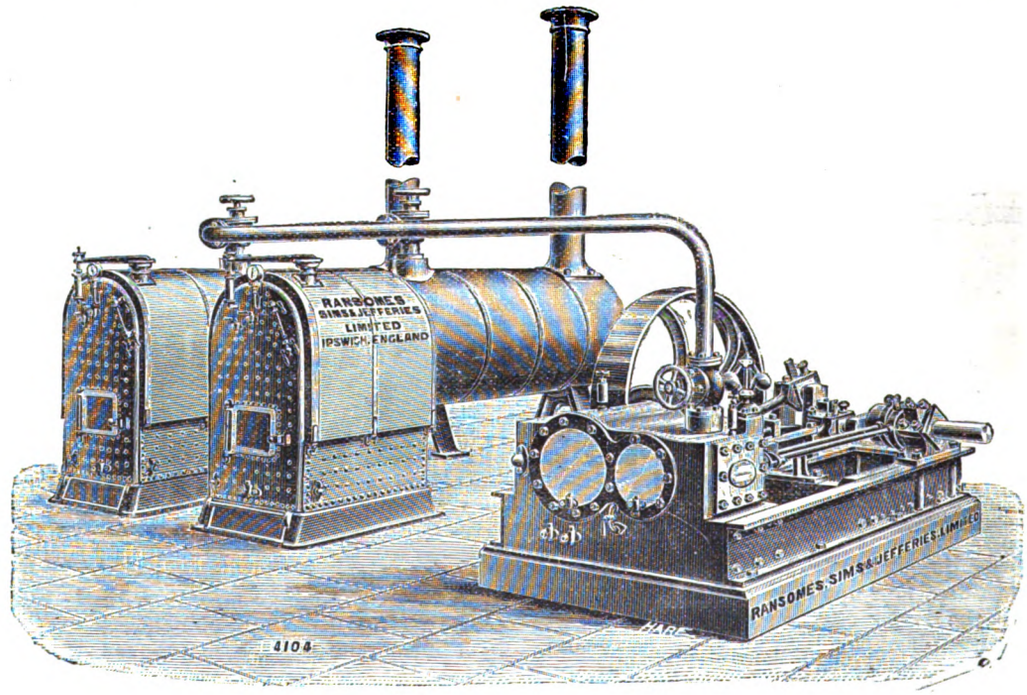

FIG. 2.

THE COX-WALKER SWINTON MAGNETO-BELL AND GENERATOR.

The system of magneto-bells which we illustrate herewith bears some resemblance to the Abdank-Abakanowicz system which was brought out last year. It is, however, sufficiently distinct to have involved separate invention, and the details have been carefully and ingeniously worked out, The current is obtained from a little magneto-generator (Fig. 1), provided with a Siemens shuttle-wound armature. A wing-shaped handle is attached to this shaft, whose motion is confined to an arc of about 30°; when held between

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the finger and thumb and moved to and fro the current generated makes a stroke on the bell at each reversal. There is no gearing, and the whole apparatus is reduced to the simplest and most compact form.

Several patterns of bells are made. The one which we illustrate in Fig. 2 is, we believe, the first self-contained magneto-bell which has been constructed. It consists of the usual electro-magnet with polarised armature, and is well designed and finished. These

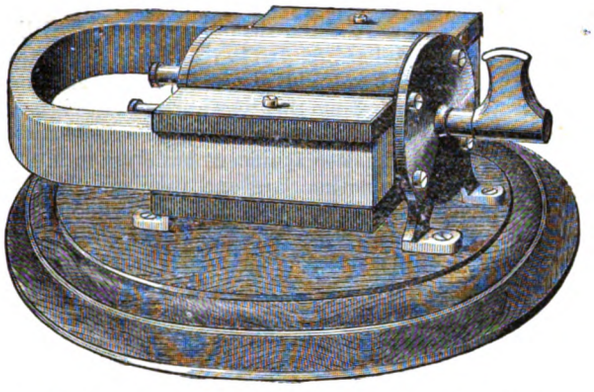

FIG. 1.—The Cox-Walker Swinton Magneto-Generator.
The handle moves to and fro about 30deg. only.

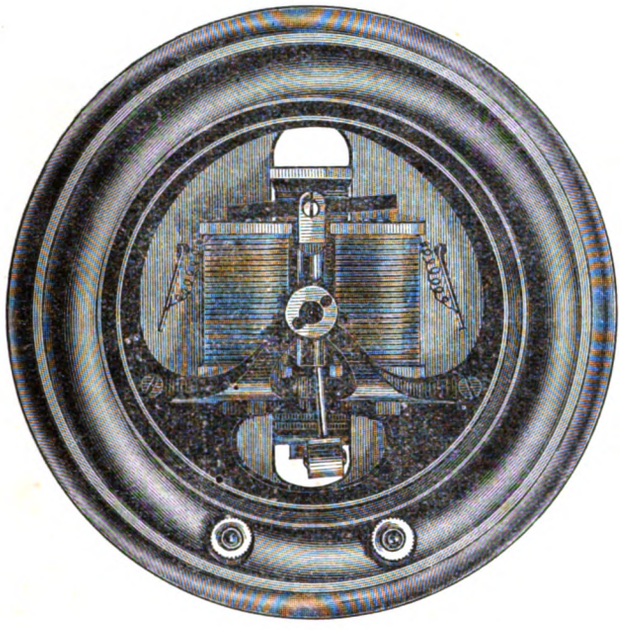

FIG. 2.

instruments are supplied by the Equitable Telephone Association, and are the joint invention of Messrs. Campbell Swinton, and Cox-Walker.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *July 21st*, 1888.

The New York Board of Electrical Control, which has been pushing matters so vigorously here in regard to the overhead wires of the arc light companies, is now agitating a subject of even greater importance, viz., the admission of the alternating-current system into the city for the purpose of commercial supply and distribution. The discussion of the matter has been precipitated by the publication in the *Evening Post* of a letter from Mr. Harold P. Brown, an electrical engineer, criticising the alternating current as "damnable," and proposing that no alternating current with a higher E.M.F. than 300 volts shall be used. Mr. Brown went so far as to say;—"The only excuse for the use of the fatal alternating current is that it saves the company operating it from spending a larger sum of money for the heavier copper wires which are required by the safe incandescent system. That is, the public must submit to constant danger from sudden death in order that a corporation may pay a little larger dividend. I do not know a single disinterested electrician of high standing who does not condemn the alternating system." He asserted that the Board should forbid the use of the alternating current in this city, therefore, except under the conditions specified. This letter attracted so much attention that the Board determined to make it the basis of an investigation on the subject, and invited the attention to it of those interested. In this manner it comes to pass that the battle of the currents is being fought this week in New York. The first meeting for the consideration of the subject was held on the 16th inst., when a number of interesting documents were filed. One of these was a letter from Mr. W. H. Browne, the secretary and manager of the Safety Electric Light and Power Company, which proposes to introduce the Westinghouse system here. Mr. Browne stated that the Westinghouse alternating system for incandescent lighting is in successful daily use in some 82 central stations, located all over the country, that 45 more are being built, and that the average rate of increase at the present time is two stations per week. These stations have a capacity of from 2,000 to 18,000 lights each, yet in no case has there occurred, says Mr. Browne, any death from accident or any fire. Mr. Browne states that the station to be put up would be built on the west side of the town, right on the bank of the Hudson River, adjoining the Sawyer-Man lamp factory, and that its currents would be conveyed underground, the wires being lead-covered and placed in conduits. The converters will be placed against the cellar wall, or in the coal vaults under the side walk. A primary potential of 1,000 volts will be used, reducing in the secondary to 50 volts. Accompanying this letter was one from Mr. T. Carpenter Smith, who has had charge of the big alternating system in Pittsburg. Mr. Smith gave his evidence as to the danger attending the use of the alternating current, and said that, while disagreeable, it was far less perilous than a direct current of the same potential. He had received the full 1,000 volts of alternating current, not once, but half-a-dozen times, and he had also received a direct current in the same way; and while the direct current always made one ill for some time after the shock, the alternating current left no such effect. He had seen five or six men get an alternating-current shock in a similar manner. He had himself pulled one of them off the bare switch-board wires; although the man's hands were badly burnt he had been at work again in half an hour, and had in the meantime walked by himself to the doctor to get his wounds dressed. A communication was read from Mr. Ralph W. Pope, to whom Mr. Brown's proposed rules had been submitted by the Board. Mr. Pope pointed out that the Board was undertaking a very difficult thing, if not an impossible one, in fixing upon an arbitrary standard which an electric current should not be allowed to exceed. The pith of the policy to be pursued, in his opinion, therefore, was not to fix upon any particular number of lamps to be operated on one circuit, or any standard of voltage which must not be exceeded, but rather to insist on such methods of construction, and the use of such material, that the current would always be confined to its designated conductors. This implied the use of a conductor of ample size for the current to be employed, and properly insulated at all points, the insulating resistance increasing with the voltage.

A letter was also read from Mr. H. M. Byllesby, the vice-president of the Westinghouse Company, confirming the statistics already quoted as to the growth of the alternating business, and stating that as to the alleged impossibility of the operation of the system on an underground circuit, any allegation of such a character was absolutely and entirely false. The company at Denver was operating very successfully under ground, with a distributing capacity of over 12,000 16 candle-power lamps. At Springfield, Mass., the underground system had a distributing capacity of 2,100 lamps; in Philadelphia, the Keystone Company were distributing 2,600 lamps.

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Supplementary to this was a communication from Mr. O. B. Shallenberger, electrician of the Westinghouse Company, discussing the question of shock or of danger of fire. Mr. Shallenberger held it to be evident that while the passage of the direct current through the human body for even a moderate length of time may be sufficient to so decompose the fluids and tissues of the vital parts as to produce fatal results very quickly, a current of the same quantity of rapidly alternating potential might produce only a shock to the nerves without any organic change, and consequently without permanent or even serious danger. Speaking of the insulation on the converters, Mr. Smith said that among the several thousand now in use he had yet to learn of a single instance in which any connection had been discovered between the primary and the secondary wires, although the converters had been in use under every conceivable condition. In point of fact he regarded the converter as an extra safeguard to the consumer, as it was a protection from lightning. Under all other conditions than the burning out of the converter by lightning, or its destruction by fire, the nature of the insulation between the primary and the secondary circuit was so perfect that it was almost impossible for any connection to occur between them.

Mr. S. C. Peck, the expert of the Thomson-Houston Company, also submitted a statement, in which, taking up several points presented by Mr. Harold P. Brown, he held, first, that the alleged comparison between the effects from a medical or galvano-faradaic coil of the alternating dynamo did not exist; that the death-dealing quality of the current from dynamos having open coil armatures is a conjecture; that placing a shunt of high resistance about the terminals of the dynamo is impracticable, and would but partially compensate for the after or extra current, which was regarded as so awful; that it was not clear that death was caused by the after current; and that finally putting all such matters aside as having little to do with the question at issue, it was absurd to make 300 volts the limit for alternating-current service, because practical demonstration extending over a period of two years had shown that with the proper devices there was no danger even with a thousand volts. What was needed in regard to electric currents was *control* and not *prohibition*.

Another expert view of the case was presented by Mr. M. M. M. Slattery, the electrician of the Fort Wayne Jenney Company, which has now introduced the alternating-current system. Mr. Slattery remarked, as to underground systems, that in point of fact a low tension current of 220 volts offered a far greater strain upon insulation than an alternating current at 1,000 volts. With low tension continuous currents during the hours of heaviest lighting a loss of some 20 to 25 per cent. occurred in the conductors, and hence the trouble and strain which was not experienced with the alternating current, despite its higher E.M.F., the strain from which he characterised as more apparent than real This long string of documents closed with one from Prof. Henry Morton, the well-known president of the Stevens Institute of Technology, who took up the cudgels for overhead wires, claiming that there were as many dangers with the underground as with the aerial system. As to danger from shock, Prof. Morton said there was certainly nothing in the results of experiments and observation so far which would warrant us in requiring less protection in the use of one sort of current as compared with the other, or in excluding one where the other was admitted. Prof. Morton challenged Mr. Brown as to his statement about the universal condemnation of the alternating system by leading electricians, and proceeded to criticise Mr. Brown's proposed rules in a very sharp manner. It may be mentioned that Mr. Brown, in his talk on the alternating system, laid himself open to pointed retort from the fact that he had himself put on the market a converter for the use of incandescent lamps on direct arc circuits of 2,000 or 3,000 volts.

While speaking of the Subway Board, I may mention the fact that Broadway is once more undergoing an upheaval, as new conduits are being laid for more wires. The consequence is an incessant blockade in the midst of the summer dulness, and the dust is perfectly maddening. This breaking up of the streets is fast becoming an intolerable nuisance. One of the Philadelphia papers has been complaining very bitterly about the everlasting ripping-up of the paving in the streets there, and it publishes a sectional view of Market-street, showing the number of services that now underlie the granite blocks. It protests against any further interference of this kind with municipal cleanliness and convenience, and insists that all work of this nature should hereafter be carried on in subways similar to those in Paris.

It is announced from Boston that the Americal Bell Telephone Company there has invested in real estate with the object of putting up a fine office building for its own accommodation. This investment of telephone earnings in real estate is becoming quite a notable feature. Here, in New York, the Metropolitan Telephone Company has a magnificent building in Cortlandt-street, and is to have another fine one uptown. In Chicago, the Telephone Company has just taken possession of a very fine building of its own; in St. Louis, the local company will also soon have a beautiful palace. At Louisville there is a fine telephone exchange, and in Pittsburg and Providence the new quarters are very handsome and comfortable. It looks as though, in a few years, all the leading telephone exchanges in the country will be magnificently housed—far more so, in fact, than the telegraph offices are.

It is generally accepted here as a fact that the two years' struggle among the cable companies has about exhausted all the combatants, or at least finds them ready and willing to come to terms. The announcement of impending peace has been hailed with satisfaction, and has contributed in no small degree to the improvement of the stock market. It is said that the new rate will be 25 cents a word, but on this point you are probably well informed in England by this time. It is reported that all the conditions have been adjusted, and that the only one remaining for settlement is the number of words which shall be accepted as a minimum for a single message. It is understood here that the Commercial Cable Company, with their two cables, have been doing about 40 per cent. of the whole business, which, of course, would be more than their share *pro rata*, and it is further stated that they have cleared $200,000 profit during the past year; although that is exceptional from the fact that no repairs have had to be provided for, and no provision has been made for renewals. The Commercial Cable Company claim that they have been willing to make reasonable terms for some time, but that the delay has arisen from the fact that there was more fight inside the pool than outside of it.

The Paper which Mr. Frank J. Sprague read last month before the American Institute of Electrical Engineers, has just been published by the papers, and proves a contribution to electrical literature of more than ordinary value. I sent you a synopsis of it at the time it was delivered * It will be remembered that Mr. Sprague, as an exemplification of many of his theories and much of his practice, cites his big road at Richmond, Va., which is now carrying from 75,000 to 100,000 passengers per week, and which has been put into operation in the face of endless difficulties and discouragements. The Sprague Company, which six months ago was not turning a single wheel, now has in operation, or in course of construction, nearly 200 cars, at Richmond, Va., Manchester, Va., Davenport, Iowa, Akron, O., Steubenville, O., Carbondale, Pa., Wilkesbarre, Pa., Harrisburg, Pa., Scranton, Pa., Lafayette, Ind., St. Joseph, Mo, Wilmington, Del., Hartford, Conn., Salem, Mass., and Brocton, Mass. This shows something like activity in street railway work, and it may be added that the Thomson-Houston Company has just started a road at Pleasant Beach, Mass., and the Daft Company one at Meriden, Conn.; while the Reckenzaum storage system has just gone into operation on one of the roads in Philadelphia.

I believe I have already referred in a previous letter to the rumours current regarding the combination between the phonograph and the graphophone interests. The announcement is now formally made to that effect. A company has been formed which will control both machines. The purchase includes all

* This Paper is one of so much interest that we have considered it worth while to give a fuller account of it, which will be found elsewhere in the present issue.—ED. *E.*

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the improvements which Mr. Edison may make in the phonograph during the next 15 years, as well as those which may be made in the graphophone in a similar term, but it does not affect the foreign rights in either case. I hear it stated that the introduction of the graphophone in England will be made by Mr. Hy. C. Edmunds, who is well known in English electrical circles, and who is at present visiting this country. The rumour in Wall Street this week that the Edison phonograph rights for England had been sold to a syndicate for $250,000 is absolutely denied.

The decisions in England this week, reported by cable in the *Electrical World*, upsetting the Gaulard-Gibbs patent, and invalidating one of the ruling Edison incandescent lamp patents, have been received with considerable interest, and are now the subject of general comment. The chief question that arises is as to the effect of these decisions on corresponding patents in this country. With regard to the alternating-current patent, it is said that it was drawn in this country with far greater skill and precision than was applied to it in England, and that it was as strong as Mr. F. L. Pope, a master in his art, knew how to make it. The decision may, however, it is said, offer certain advantages to the concerns here which do not regard the Westinghouse patents as valid and are manufacturing alternating-current apparatus. As to the decision on the Edison patent, it is claimed on the one side that the principles which governed in England will govern here, and on the other side it is argued that the ruling in the case would have no influence whatever, the patent laws, as everybody knows, being very different in the two countries. Very little can be said till a fuller report arrives. Mr. Park Benjamin, however, does not wait, but is quoted in one of the dailies as saying:—"Of the American patent little need be said, on the principle *de mortuis*. It expired recently at the hands of Judge Wallace, because of the haste of the promoters in getting sundry prior foreign patents on the same thing, which, dying a natural death, dragged the patent here down with them."

CORRESPONDENCE.

UNIPOLAR INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

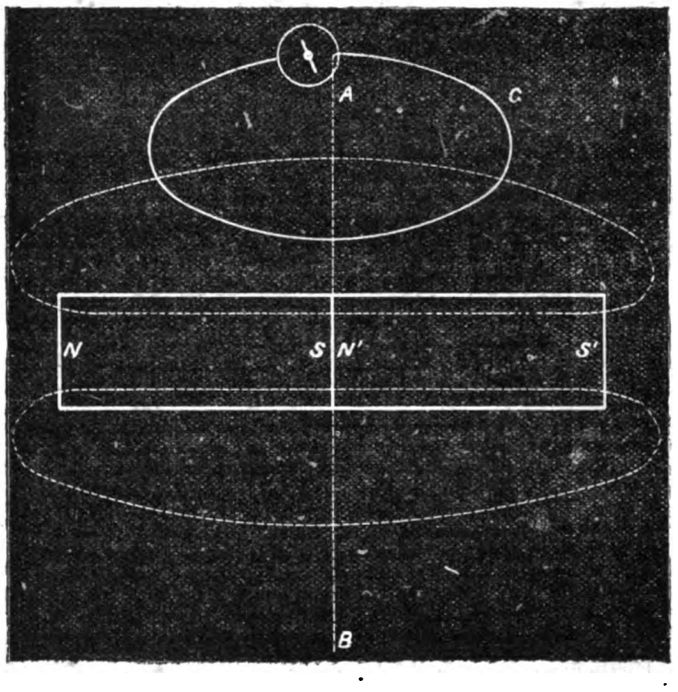
SIR: A line of magnetic force, according to Maxwell's teaching, may be regarded as a sort of vortex ring or axis of molecular vortex motions taking place in the molecules of the ponderable or imponderable matter situate within a magnetic circuit.

I can displace these lines of force, in the case of any magnet, without moving the magnet itself, by introducing into its field a lump of iron, when the lines concentrate themselves within it at the expense of the remoter portions of the field. I may also displace the lines *holus bolus* by moving the magnet bodily, in which case the field remains intact both in form and in strength, having moved *quasi*-rigidly with the magnet.

Regarding these displacements of lines of force, it seems certain, that in neither case do they represent anything more material than a transference of the vortex motions to fresh matter or ether, just, for example, as waves, representing so much energy, may move from one situation to another without taking the water along with them. When this particular form of energy is made to traverse space, it sets up E.M.F. in the bodies traversed, by virtue of the mechanism by which the energy is propagated from molecule to molecule. The amount and the direction of this E.M.F. depends upon the rate of the propagation, and its direction relatively to the direction of the vortex rotations, and sets up current in the bodies traversed (provided there be a path and no opposing E.M.F.) proportional to their conductivities.

The important question which Faraday and Plücker regarded one way, Weber another, Ellund another, and so on, is this. When a magnet rotates about an axis, does its energy (the lines of force) rotate with it, in the sense that the vortex motions are passed on from atom to atom in a strictly circular direction? For instance, when the field is not uniform about the axis of rotation, and the magnetic intensity accordingly fluctuates at every fixed point in the field, or when the magnet is a straight cylinder and rotates about its axis, and there is no such fluctuation? In the latter case, the energy being absolutely constant in amount at every fixed point in the magnetic circuit, does anything but the magnet rotate? Is the energy of the field propagated from atom to atom in the circular direction at a uniform rate, and with the same angular velocity as the magnet; or does this circular propagation take place in the magnet itself while the energy of its lines of force remains fixed, or does one portion of the lines rotate and the other stand still?

Mr. Tunzelmann has not set this question at rest. In his concluding paragraph, p. 263, Article V., on "Unipolar Induction," he says (speaking generally of several experiments described):—"The results of these experiments follow at once from the theory which I have endeavoured to show must be the true one, that the lines of force revolve with the magnet, for the area of the circuit continually increases during the rotation." He proceeds to point out the truth of the corollary that when the magnet is fixed so are the lines of force.



Suppose I take two equal cylindrical magnets, N S and N' S', and mount them in line as shown, the field of the one becomes the field of the other. What happens when the magnets are rotated in opposite directions? The external field is common to both magnets; does each magnet control its own half so that the lines on either side of the equator A B rotate with the magnet on their respective sides? and would a circuit, C, fixed in the position shown, "continually increase in area"?

In his article on "Unipolar Induction," in to-day's *Electrician*, p. 366, Mr. Tunzelmann refers to an observation of Hoppe's, whose views he agrees with, that when the core of an electromagnet revolves—the exciting coil being fixed—the lines rotate with the iron core, just as they suppose them to do in the case of a permanent magnet. Suppose this core to be made up of two iron cylinders, one within the other, when one of these rotates, does that portion of the lines belonging to it rotate, the others remaining stationary?—Yours, &c.,

R. SNOWDON.

Staveley Ironworks, Chesterfield, 28th July, 1888.

BATH AND THE ELECTRIC LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I noticed your leaderette on the above subject which appeared in *The Electrician* of the 27th instant, and shall be pleased to give you the information you ask for.

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First, the proposed local company will be worked on as economical a basis as possible. In fact, like the Taunton Electric Lighting Company, it will be practically a consumers' supply company. The directors will receive no fees unless a dividend of five per cent. on the total capital is paid, and even then their remuneration will be but nominal.

Secondly, we propose using a valuable water-power, situated in the centre of the city, for which we have already obtained the right of purchase, whereas others who tendered probably estimated for steam power only.

As I originated the first electric lighting company in the country that paid a dividend of five per cent. on its total share capital out of its earnings upon the mere supply of light, you may take it for granted that no efforts will be spared on my part to make the Bath Electric Lighting Company as successful as the Taunton Company. I shall probably be the largest shareholder, and accept the position of managing director.

I may mention that the desire for the introduction of the electric light into several towns in the West of England has been brought about entirely by my efforts, and it was generally assumed that I should be in a position to send in a lower tender than anyone else. In fact, had any tender been sent in which was apparently lower than mine, it is not improbable that none would have been accepted, as was the case when the Maxim-Weston Company sent in a lower tender when the metropolitan authorities were on the eve of accepting the tender from the Anglo-American Brush Corporation for lighting the streets of the City.

This action of the Maxim-Weston Company I consider to be one of the most unfortunate incidents that have come under my notice in connection with electric lighting. It was not only a loss to the Brush Corporation, but tended to retard the electric lighting industry in general.—Yours, &c.,

Bath, 30th July, 1888. H. G. MASSINGHAM.

THE LIGHTING OF EASTBOURNE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I trust you will be able to spare a short space in your valuable columns in order to prevent any misunderstanding which may arise from the letter in your last week's issue, from Mr. Willoughby Smith, with reference to the arc light at Eastbourne. We are sorry to hear that he was displeased with the steadiness of the arc lamps on the Parade, and cannot but think that he must have seen them at some disadvantageous time, as the Corporation have only recently complimented the Eastbourne Electric Light Company upon the satisfactory working of these lights. We are, however, quite aware that better results might be obtained if the contract price would allow of a better carbon being used. The light given by a powerful search-lamp and that of an ordinary arc lamp (absorbing only 45 volts 10 amperes) seems to us incomparable.

We are pleased to hear that Mr. Willoughby Smith has heard good accounts of the incandescent light. He is doubtless not aware that the lighting by incandescent lamps as supplied to the town hall and municipal buildings, churches, hotels, clubs, private houses and shops, is run on the Lowrie-Hall system, and that the Parade arc lamps are the remains of the original system that was erected nearly seven years ago.—Yours, &c.,

117, Bishopsgate-street Within. HAMMOND AND CO.

Berne.—The directors of the Felsenau (Switzerland) Spinning Company have prepared plans with a view to increasing by 1,500 horse-power the hydraulic force at their disposal, with the intention of supplying electric motive power and light to Berne. The communal authorities of Berne, however, have declined to sanction the necessary works, on the ground that the Berne municipality has at its command sufficient hydraulic power of its own to provide electric power.

Removal.—The Bernstein Electric Lamp Company, Limited, notify that they have removed their offices to 2, Marlborough Mansions, Victoria-street, Westminster, S.W.

Cuba Submarine Telegraph Company (Limited).

Report of the directors for the half-year ending 30th June, 1888, to be presented at the thirty-fourth ordinary general meeting of shareholders to be held at the offices of the Company, 61, Old Broad-street, London, E.C., on Wednesday, the 8th inst., at 1 o'clock:—

2. From the accounts it will be seen that the gross receipts (including the balance brought from last account) amount to £24,274 19s. 8d., and the gross expenditure (including the half of the annual payment on account of the 1881 cable, and the expenses in connection with cable repairs) to £6,879 2s. 3d., leaving a sum of £17,395 17s. 5d. to the credit of the revenue account.

3. Of this the sum of £6,000 has been added to the reserve fund, increasing that fund to £80,000.

4. The dividend on the Preference Shares will absorb £3,000, and leave £8,395 17s. 5d., out of which the directors recommend the payment of a dividend on the Ordinary shares at the rate of 9 per cent. per annum, free of income tax, the balance, £1,195. 17s. 5d., being carried forward to the current half-year's account.

5. The Batabano-Cienfuegos (original) cable broke down on 3rd February, and was repaired on 18th idem. This cable not being duplicated, messages were forwarded during the interruption over the land lines of the Government. All the cables are now in good working order.

6. The Director who retires from the Board at this time is Mr. Horatio J. Perry, who, being eligible, offers himself for re-election. Mr. Thomas Greenwood, the auditor, also retires, and offers himself for re-election.

PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

9,825. W. MACKIE. London. Improvements relating to switches for electrical purposes. July 6, 1888.

9,854. LARS BRISTOL. London. Improvements in and connected with secondary batteries or electrical accumulators. July 6, 1888

9,907. M. VON DOLIVO-DOBROWOLSKY and THE COMPANY ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT. London. Improvements in electric current and tension meters. July 7, 1888.

9,910. G. KAPP. Manchester. Improvements in and relating to continuous-current dynamo-electric machines. July 7, 1888.

9,912. G. HUGHES. London. A combined automatic magic lantern and electric apparatus for mechanically exhibiting in succession, by day or night, views, photographs, or other subjects consecutively, whenever desired. (Victor Bonnet, Hippolyte Lissagaray, Armand Richard, A. Richard and Nephtali Grumbach, France). July 7, 1888.

9,927. G. V. FOWLER and E. W. LANCASTER, trading as Fowler, Lancaster and Co. London. Improved electrical make-and-brake switch for charging circuits of secondary batteries, and automatic cut-outs for other circuits. July 9, 1888.

9,928. G. V. FOWLER and E. W. LANCASTER (trading as Fowler, Lancaster and Co.) and E. J. PENN. London. Improvements in electrical regulators and armatures for dynamo-electric machines and motors. July 9, 1888.

9,991. W. R. LAKE. London. Improvements in magneto-electric apparatus (W. Humans, United States). (Complete specification.) July 10, 1888.

10,088. J. V. SHERRIN. London. Improvements in and connected with primary batteries. July 11, 1888.

10,092. A. L. LINEFF. London. Improvements in the means or apparatus for supplying electricity to tramcars or other vehicles. July 11, 1888.

10,093. J. S. LEWIS. London. Improvements in magneto-electric calling or signalling mechanism used for telephonic or telegraphic purposes. July 11, 1888.

10,102. W. R. LAKE. London. Improvements in electric batteries (Lacombe and Co., France). July 11, 1888.

10,107. C. S. SNELL. Cornwall. Improvements in casing used for electrical conductors. July 11, 1888.

10,194. A. C. COCKBURN. London. Improvements in electrical switches. July 13, 1888.

10,209. F. V. MAQUAIRE. London. An improved electric regulator. July 13, 1888.

10,245. E. PERRETT. London. Improvements in and connected with electrical safety cut-outs. July 14, 1888.

10,239. N. W. WALLACE. London. Improvements in electric logs. (Percy Scott, H.M.S. "Edinburgh," Malta). July 16, 1888.

10,492. S. C. SNELL. Saltash. Improvements in holders for incandescent electric lamps. July 20, 1888.

10,515. E. ROSSEAU. Leyton. Improvements in instantaneous make and break electric switches. July 20, 1888.

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COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

July 14, 1888.

12,111. W. P. THOMPSON. Liverpool. Improvements in electric fuses for mines (E. Dumas, Paris, agent for Messrs. Bickford, Smith and Co., Cornwall). September 7, 1887.

12,166. H. K. READ. London. Improved appliances for making and breaking and protecting an electric circuit. September 8, 1887.

12,325. W. FAIRWEATHER. Glasgow. Improvements in telephonic apparatus (The Western Electric Co., United States). September 12, 1887.

7,805. H. J. ALLISON. London. Improvements in the method of and apparatus for the production, transmission and distribution of electric currents (C. E. Fritts, United States). May 29, 1888.

July 21, 1888.

10,131. G. FORBES. London. Improvements in meters or apparatus for measuring electricity. July 19, 1887.

10,157. THOMAS A. GARRETT. London. Improvements in and connected with apparatus for transmitting and receiving electrical signals. July 20, 1887.

11,252. H. MOWER. London. Improvements in secondary batteries or electrical accumulators. August 17, 1887.

11,901. R. A. SCOTT. Hammersmith. Improvements in lamp-holders or sockets for incandescent electric lamps. September 2, 1887.

12,015. W. LÖNHOLDT. London. Improvements in incandescent electric lamps. September 5, 1887.

12,683. F. M. A. LAURENT-CELY. London. Improvements in the manufacture of a spongy lead suitable for electrical accumulators. September 19, 1887.

12,718. J. TATE. Bradford. Improvements in electrical speed indicators. September 20, 1887.

3,883. A. J. BOULT. London. Improvements in electrical devices for type-writers (J. F. McLaughlin, United States). March 13, 1888.

4,221. T. COAD. Forest Gate. Improvements in the construction of holders for incandescent electric lamps. March 19, 1888.

7,852. W. P. THOMPSON. Liverpool. Improvements in or relating to central station apparatus for system of electric distribution by alternate currents (G. Westinghouse, jun., United States). May 24, 1888.

PATENTS SEALED.

July 13, 1888.

7,235. F. C. PHILLIPS and H. E. HARRISON. London. Improvements in the safety mechanism or cut-out of electric arc lamps or other electrical apparatus. May 18, 1887.

7,802. W. E. AYRTON and J. PERRY. London. Improved ammeters and voltmeters. May 28, 1887.

7,834. H. EDMUNDS. London. Improved means for controlling, transforming, regulating, synchronising and registering electric currents. May 28, 1887.

8,214. W. P. THOMPSON. Liverpool. Improvements in telephone systems (E. Mauritius, Germany). June 8, 1887.

9,256. J. L. ZULC and H. W. ANDREWS. Southsea. Improvements in and apparatus for regulating the speed of dynamos employed on railway trains for lighting the same. July 29, 1887.

15,537. R. W. PAUL. London. Improvements in electric switches. November 14, 1887.

137. J. C. PÜRTHNER. Vienna. Improvements in apparatus for producing induced electric currents. January 4, 1888.

3,075. A. W. SOUTHEY. London. An improved clutch for regulating feeding rods in electric arc lamps. February 29, 1888.

3,215. J. W. OLDROYD. London. Improvements in electric incandescent lamps. March 2, 1888.

3,235. G. MIOT. Paris. Improvements in multipolar dynamo-electric machines. March 2, 1888.

4,277. A. J. BOULT. London. Improvements in electro-mechanical movements (J. F. McLaughlin, United States). March 20, 1888.

4,929. W. GILIETT and G. HASELTINE. New York. Improvements in magneto-electric generators. April 3, 1888.

July 20, 1888.

6,400. J. R. SCHILLER and C. MEYER. Zurich, Switzerland. Improvements in electro-magnetic apparatus for the automatic lighting and extinguishing of gas lamps. May 2, 1887.

7,189. W. H. AKESTER. London. Improvements in secondary batteries. May 17, 1887.

8,495. A. M. CLARK. London. Improvements in electric lamps (C Berton, France). June 13, 1887.

9,281. T. W. HELLIWELL. Brighouse. Improvements in the method of and means of raising and lowering or otherwise controlling as desired the gas, electric or other similar and suitable lights employed for illuminating railway carriages, vans or other vehicles or rolling stock requiring such lights. June 30, 1887.

9,598. J. A. TIMMIS. London. Improvements in electrical apparatus for working railway signals. July 7, 1887.

3,246. F. WALKER. Upton Park. Improved electrical lamp and projector, and method of applying same for maritime and other purposes. March 2, 1888.

3,303. H. HARRINGTON LEIGH. London. Improved apparatus for registering the consumption of electric energy (J. Louis, Paris). March 3, 1888.

SPECIFICATIONS PUBLISHED.

7,185, 1887. AKESTER, W. H. Electro-propulsive motors. (Price 8d.)

10,177, 1887. MAGER, E. S., and LIEPMANN, H. Electric batteries. (Price 6d.)

11,417, 1887. GARRETT, T. A Electrical connections with moving bodies. (Price 8d.)

11,502, 1887. LAUCHERT, E. F. H. H. Dynamo electric and electro-dynamic machines. (Price 6d.)

11,816, 1887. LONSDALE, R. Medical magnetic appliances. (Price 8d.)

13,758. 1887. BOULT, A. J. (Smith and Kimble). Electrical apparatus for dental operations. (Price 8d.)

7,536, 1888. WILLCOX, B. (Whittier). Galvanic batteries. (Price 4d.)

9,264, 1887. LORRAIN, J. G. Electric clocks. (Price 8d.)

10,199, 1887. BULL, H. C., and Co. and BULL, H. C. Electric metallurgical processes, &c. (Price 11d.)

10,555, 1887. ELIESON, C. P. Electrical batteries. (Price 8d.)

11,091, 1887. RAWORTH, J. S., and SAYERS, H. M. Friction couplings governed by electricity. (Price 8d.)

11,704, 1887. LANGDON, W. E., and others. Electrical insulators. (Price 8d.)

11,776, 1887. BECK, W. H. (Cassagnes). Synchronising electric telegraph instruments. (Price 11d.)

14,270, 1887. MILLS, B. J. B. (Emerson). Producing sheet copper by electro deposition. (Price 8d.)

ELECTRICAL TRADES AND THE LONDON CHAMBER OF COMMERCE.

On Friday last a meeting was held at the London Chamber of Commerce, Botolph House, to further consider the proposal to form an Electrical and Allied Trades Section of the London Chamber of Commerce. Mr. R. E. Crompton occupied the chair.

The CHAIRMAN, in opening the proceedings, said that since the meeting held a fortnight ago upon the invitation of Mr. Murray, an informal meeting had been held at the Holborn Restaurant, when twenty-eight gentlemen connected with the electrical trades had added their names to the list, so that the numbers had now reached 60 or 70, and with a little canvassing he thought they could be increased to 100. Such a number would form a very respectable section of the London Chamber of Commerce, and would be fit to run by itself. The meeting at the Holborn Restaurant was very unanimous on the subject of the necessity for the union of the trade in the form proposed. That being so they were encouraged to hope that they would find in this section properly constituted that body to represent their trade interests which they had been so long looking for. It had been at first suggested that they should have a separate society, and that suggestion had been warmly supported by various technical newspapers. Unfortunately, it fell through, as there were considered to be insuperable difficulties in the way. He could never see those difficulties himself. Then a few gentlemen belonging to the Dynamicables, which was a purely dining society, thought a society might be formed within it for the protection of their mutual interest. But immediately he received Mr. Murray's circular, and found that they could have the use of all the working machinery of the London Chamber of Commerce, he saw at once they could attain their end with much less trouble and loss of time by at once enrolling themselves members of the Chamber in sufficient numbers to constitute a section. They were now in a fair way to do that, and he invited suggestions from the gentlemen present as to whether the next step should be the formation of a provisional committee to organise a section, or whether the committee should be a management committee, and whether they should appoint permanent officials. He was not in favour of taking the latter step until the section had assumed a more important form. The country firms were practically unrepresented at this meeting, and it would be unfair to appoint a permanent Board of officers upon the votes of London members only. He wanted the new section to be one in which they could air their grievances and agree on co-operative action with regard to questions which concerned all equally, and he thought that, as very important matters would be dealt with this autumn, if anything could be done before the holidays towards constituting such a section, it would be so much the better for the electrical trades.

After a few remarks from Mr. LANE-FOX,

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Mr. H. S. PRICE said he thought their present duty was to form a provisional committee, and to enrol members. Later on sub-committees could be formed.

General WEBBER then suggested that the proposed committee should be no more than a committee of management, and that it should be clearly understood that when the committee came to debate the many questions which would occur to all as being matters of great interest to the general body, then every member might have an opportunity of joining such sub-committee as might be appointed to deal with each subject. It was just possible that the proposed new section might end in being represented by a committee with whose views a large number of the members who were not on that committee might not agree, and such an anticipation might deter gentlemen from joining.

Major FLOOD PAGE said they were met to see whether the electrical trade thought it advisable to have a section in the London Chamber of Commerce. If they did think so, then it was important that they should appoint an organising committee, who, after consideration, would draw up a report calling the Electrical Chamber together again, and then, if everybody approved, join the Chamber of Commerce. There was one great advantage, they must bear in mind, in connection with such an organisation. It would be the first time that the telegraph interests, the telephone interests, the light interests, and all the other interests in connection with electricity, would be working together. This was to be an Electrical and Allied Trades Section, and there would probably be a few representatives on the permanent committee on each branch of the trade. He agreed with Mr. Crompton that the time had come when they ought to organise themselves, and also that they would gain more advantage by joining the London Chamber than if they started an independent organisation. He concluded by moving a vote—

"That an organising committee representative of the electrical trade be appointed this afternoon, with a view to organising an Electrical Section under the London Chamber of Commerce, such committee to remain in office until the permanent committee be appointed."

Mr. GARCKE, in seconding the motion, suggested that the number of the committee should be specified, and that the date should be fixed upon which to report It was very desirable that they should go cautiously to work in the first instance, as there were many intricate matters to be considered, and therefore he strongly advocated the formation of a provisional committee now, who could take into consideration the general bearings of the question, and then report to the general body.

Mr. RAWSON said they were all in sympathy with the views expressed by the previous speakers. In his opinion, the reason why so many of the attempts which had been made had broken down was that perhaps those interested had worked it too much in the form of a clique. It was very important that the movement should be widespread, and for that reason he felt inclined to move that the list of the provisional committee be kept open. No doubt there would be certain members of their body who ought to belong to that committee of whom the gentlemen present might not think of at that moment. If the list were kept open, then gentlemen in the country might feel that they had a chance of being represented upon the committee.

Mr. C. DEXTER BARKER agreed with Mr. Rawson.

Mr. TROTTER, upon the invitation of the Chairman, then related the steps which he had taken to bring about such an union of the trade. He thought they were now taking the best road to success.

Mr. WHARTON concurred in the resolution. The only doubt in his mind was, how the committee should be elected.

Major FLOOD PAGE then handed in his resolution to the chair in the following amended form, so as to meet the suggestions of the previous speakers :—

"That an organising committee of six representatives of the electrical trade be appointed this afternoon with a view to organising an Electrical Section under the London Chamber of Commerce, such committee to report to a meeting of the electrical trade about the 15th of September; the committee to remain in office only until a permanent committee be appointed, the committee to have the power to add to their numbers."

The CHAIRMAN asked Mr. Murray, the Secretary of the London Chamber of Commerce, what, according to the practice of the London Chamber, was the proper name to give to the proposed committee.

Mr. MURRAY said that up to the present the Chamber had only one general term—a Trade Section Committee—for all their sectional committees, but it was within the power of each such committee, the members of which were always elected by the whole body of members belonging to that section, to nominate any sub-committees which they might desire. There could be a standing sectional committee, and then at any particular moment for any special question which they wished to study they could nominate a special committee. If, in addition to that, they wished such a standing committee for management purposes only, it would be within their power to have such a committee. The Council would leave their hands entirely free, but it preferred to have the one name in the printed list of the Trade Section Committee. Whether they subdivided the sectional committee according to the trades, or according to the idea which he believed Mr. Crompton had, of engineers only, and engineers and electricians, was entirely according to their wish.

General WEBBER said his desire was that the members of the section should not feel that they had named a council in the same way as societies had, upon whom they were to throw the whole of the work, and to whom they were to refer everything. The sub-committee could be drawn from the whole body, and if they had a hundred members it was possible that the whole number might be serving on the various committees.

Mr. WILDING thought there was an idea that this committee was to be a technical committee, and that the sub-committees should be technical also. There ought to be rather a division of commercial interests, and they should divest themselves entirely of the technical idea.

Mr. GARCKE reminded the meeting that a small committee worked better than a large one.

Mr. H. S. PRICE suggested that the committee should be composed of not less than ten members.

Mr. RAWSON suggested twelve, and after some further conversation the twelve was accepted, and the motion was then carried unanimously.

The meeting then proceeded by ballot to elect the twelve members, the CHAIRMAN stating that Mr. Murray had informed him that they could vote for any gentleman in the trade, subject to his subsequently qualifying as a member of the London Chamber of Commerce.

The papers having been collected,

The CHAIRMAN announced that the following eleven gentlemen had been elected members—Price, Garcke, Webber, Gatehouse, Rawson, Wharton, Trotter, Siemens, Flood-Page, Callender and Crompton. Messrs. Immisch, Gray and Courtenay had tied for the 12th place—what was to be done? Would the meeting choose between these gentlemen by show of hands, or would they add those three gentlemen to the Committee?

It was decided to adopt the latter suggestion, and a vote of thanks to the Chairman having been carried unanimously, the proceedings terminated.

COMPANIES' MEETINGS & REPORTS.

Globe Telegraph and Trust Company.

The fifteenth ordinary general meeting of this company was held last Friday at Winchester House, Old Broad-street, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. W. Payton) having read the notice convening the meeting and the minutes of the last meeting, the report of the Directors was taken as read.

The CHAIRMAN: Before asking you to approve of the resolution which I will read, I will make a few remarks as usual on the working during the past year of the different concerns in which we are interested. The resolution is—

"That the report and accounts for the year ended July 18th, 1888, submitted to this meeting be and they are hereby received and adopted, and that a dividend be now declared payable on and after this day of 3s. per share on the Preference shares (less income-tax), and of 3s. per share on the Ordinary shares, income-tax having already been deducted, making, with previous payments, a total dividend for the year of 6 per cent. on the Preference shares (less income-tax), and of 3½ per cent. net on the Ordinary shares."

Gentlemen, when I last had the pleasure of addressing you our prospects were not bright, and the surroundings were rather gloomy. The Atlantic system was being worked at a very low rate; and the Eastern and Eastern Extension systems, in which we are largely interested, were just feeling the effects of the reduction that had been made at the Berlin Conference. We then, I believe, paid you the lowest dividend that the Company has ever paid. To-day I am glad to say that things look brighter. What was obliged to be given up at the Berlin Conference has been in a great measure recouped, and we have also now the prospect of seeing an increase in the rate upon the Atlantic systems. I may also say that the prospects of the other investments are all encouraging. The Eastern system is doing well; and the South African system, in which the Eastern Company are the principal proprietors, is doing remarkably well. The Eastern Extension Company is also doing well. In all those companies we are very largely interested indeed. We are also interested now to some extent—and very shortly we may be interested to a larger extent—in the Western and Brazilian Company. The Brazilian Company's system we are largely interested in; and that is doing well. The Western and Brazilian Company is emerging from a state of depression, and I think is taking up a worthy position among the other telegraph systems which now encircle the world. Therefore, upon the whole, our prospects are very much brighter than when I last had the pleasure of addressing you. But the first question—the one which interests you more immediately—is that of the dividend. It is so far satisfactory that we now pay £3. 10s. per cent. for this year, as against £2. 7s. 6d. per cent. for last year. I have generally on these occasions brought before you our position as to dividends from year to year, so that you may contrast them with the dividends paid by the different submarine telegraph companies, and in order to give you some idea of the dividends of the Globe Company as a trust company in which you will find the averages. Taking our dividends from the beginning, including this year—that is, extending over a period of fifteen years—we have always paid our Preference dividend; and our highest dividend on the Ordinary shares has been 5½ per cent., and the lowest, paid last year, has been 2⅜ per cent. All the dividends combined form an average of 6 per cent. on the Preference shares, and of £4. 4s. 8d. per cent. on the Ordinary shares; or, taken together, on our combined shares the average dividend paid by us has been £5 2s. 4d. per cent. or, say, 5⅛ per cent. This is a point of interest to us, as showing that the system of averages which this Company set up for telegraph shares and stocks has, on the whole, been successful, and that whilst a shareholder who, say, has brought in his Anglo-American shares at par has reason to be glad, the shareholder who brought in Eastern, Eastern Extension, or Indo-European shares has had no reason to regret it, because his position meanwhile has been made secure. Those who brought in Anglo-American shares are getting double the dividend they would have received had they remained simply in

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direct connection with that Company. If we take the last four years we find that the Eastern Company have contributed £53,000 in 1885, £53,000 in 1886, £48,448 in 1887, and £53,000 in 1888. You will observe that 1887 was the period when we were working at and feeling the reduced rates imposed at the Berlin Telegraph Conference. The Eastern Extension Company gave us £39,176 in 1885, and £39,176 in 1886. It is very remarkable how much one year is like another for a certain time, and then we have bounds, and next little deficiencies. In 1887 the Eastern Extension Company gave us £33,000, and in 1888 £36,000. This has enabled us to maintain our dividends on our Ordinary shares, but, as you are aware, during the last two years the Anglo-American Company has been paying next to no dividend at all; and as our investment in that company is very large the return it makes us very materially affects our dividend. Therefore, the prospect of an increased tariff, which I believe is now settled, to come into operation about the 1st of September, when it is proposed that the rate shall be raised from 6d. to 1s., is of considerable importance in its bearing on us. If that 1s. rate gives the companies anything like the increased traffic brought about by the 6d. tariff—if that traffic is maintained—then I expect we shall be very beneficially affected. I may mention that every additional 1 per cent. paid on the Anglo-American Stock means 1s. 6d. a share on our Ordinary shares—that is, ¾ per cent. additional, so that if the Anglo-American Company pay what we expect it will pay next year it will give us practically 1 per cent. additional dividend if all the other companies in which we are interested should be in precisely the same position as they are in to-day, but let us also hope that there will be progress in those other companies also. I therefore look forward to the time, not very far distant, when we may resume something like the respectable dividends we paid in the earlier part of the Globe Company's career. Since I had the pleasure of addressing you last the German Government have taken over the Channel cable, and we who have a large interest in that concern are now about to be paid off. I expect that we shall be paid off at the end of this year, and at a very considerable premium; and I hope that with the premium and the good investment we shall make of the money handed to us we shall not get in the future a smaller amount of interest on that particular portion of our capital than we have been obtaining in the past. As I have said, we are now interested to some extent in the prosperity of the Western and Brazilian Company, and we believe that that undertaking will prosper. The general aspect of submarine telegraph affairs at the present moment may be regarded as favourable. The war of rates has been a very disastrous war. I am one of those who are now managing in connection with that matter, and I never believe in throwing away money if that can be avoided. Mr. Mackay and Mr. Bennett, who did not know very much about telegraphy, thought a great deal of money was to be gained, and a good deal of prestige too, if they established a cable at low rates. They thought they were going to be national benefactors; but it does not require long to convince a man that it is not very profitable business to be engaged in when he finds he is putting his hand into his pocket instead of putting money there as a return for his investment. I think that that is being realised now, and as it takes a long time to bring about a combination when people have suffered I think we shall have a quieter time in the submarine telegraph system. During that quieter time I hope we shall have such an amount of progress as will materially tell on the interests of the Globe Company. With these remarks, and congratulating you upon the improvement in your position which I have forshadowed, I beg to move the adoption of the resolution which I have read.

The Marquis of TWEEDDALE seconded the motion.

After remarks made and questions put by the following gentlemen, viz., Dr. Griffiths, LL.D.; Mr. Weatherley, Mr. Odell, the Rev. J. J. Heaver—all shareholders of the Company—the resolution was put from the chair and carried unanimously.

On the motion of the CHAIRMAN, seconded by Sir JAMES ANDERSON, the Marquis of Tweeddale was re-elected a Director of the Company, as was also Mr. Henry Daniel Gooch, on the motion of the CHAIRMAN, seconded by Dr. GRIFFITHS.

Mr. NEWTON then proposed, and Dr. GRIFFITHS seconded, the re-election as auditors of Mr. John George Griffiths, F.C.A. (of the firm of Messrs. Deloitte, Dever, Griffiths and Co.), and of Mr. Wm. Griffith, B.A.

Mr. WM. GRIFFITH returned thanks, and assured the shareholders that they were in a sound state. The securities were all safe, and the accounts were well vouched for. He hoped the picture drawn of the future success would be realised. They were in a condition to take advantage of it, and he hoped they would be able to do so.

A vote of thanks to the Chairman and Directors was then passed.

The CHAIRMAN: I beg to thank you on behalf of my colleagues and myself, and notwithstanding the remarks that are made to throw doubt upon us and to cut us down as much as possible, I can say that your interests are in very safe hands. I am glad to say, further, that as far as any movement against the Directors is concerned, that does not arise from the body of the shareholders, who are loyal and true, and who believe in the men acting for them. I beg to thank you.

The proceedings then terminated.

The Submarine Telegraph Company.

The half-yearly general meeting of this Company was held on Tuesday, at the offices, 2, Throgmorton-avenue, London-wall, E.C., Sir Julian Goldsmid, Bart., M.P., in the chair.

Mr. S. M. CLARE (the secretary) read the notice convening the meeting, and the following is the report of the Directors, which was taken as read:—

The joint earnings of the two companies for the six months ended 30th June, 1888, amounted to £67,397. 18s. 9d., and the working expenses to £27,788. 1s. 9½d. The joint earnings are £2,663. 10s. 8d. more, and the working expenses £521. 4s. 5½d. less than the corresponding period of 1887. The result of the business for the half-year enables the Directors to add, as usual, 15 per cent. of this Company's proportion of the receipts to the reserve fund, to recommend a dividend at the rate of 13½ per cent. per annum, and to carry a balance of £261. 4s. 7d. to next account. The dividend paid for the half-year ended 30th June, 1887, was at the rate of 12 per cent. The number of messages transmitted in the six months ended 30th June, 1888, was 1,717,311, containing 19,073,919 words, against 1,618,634 messages in 1887, containing 17,901,009 words. All the Company's cables, as well as those worked by the Company, are in good working order. The Company's steamer "Lady Carmichael" has been thoroughly overhauled in the course of the half year at a cost of £907. 14s 9d., of which £500 has been charged in the annexed accounts, and the balance will be charged against the revenue of the next half year. The steamer is now in excellent condition, both as to her hull and general machinery, and has been surveyed by Lloyd's surveyors, who have classified her as 90 A1, *i.e.*, as a vessel of the first class. The negotiations between Her Majes y's Government and the Board, referred to in the last report, have been continued during the half year, and are now on the point of completion. As soon as an agreement has been finally arrived at the Directors will forthwith lay it before the proprietors for their approval.

The CHAIRMAN said: It now devolves upon me to move the adoption of the report and statement of accounts, and the observations I have to make to-day are very short and very simple. You will see that there has been a fair increase in the traffic during the six months which are now under review. The number of words is given in the report. The average length of the messages is not given; I dare say that that is a matter of interest to many people. I find that last year during the same period of six months the average length of the messages was 11·06; during the period now under review it was 11·11, showing a very slight improvement in the length of the messages. I have often told you in former years, when we complained of the diminution in the number of words in the messages, that I thought we must come to a termination of that reduction before long, and when I was asked to fix a figure at which it would terminate I said I should not imagine it would go below 11. It has gone below 11 on one or two occasions, but it appears to me that that is the average. It is a subject of only passing interest to us now. Much to our regret, as you know, our concession will terminate very shortly. I mentioned to you on a previous occasion, not so very long ago, we had great hopes that the concession given to us by the French Government would be renewed, and if it had not been for the very strong opinion entertained by the English Government on this subject I believe that would have been the case; but, like sensible men, a decision having been come to, we thought it in the interest of the shareholders of this Company to make the best of it, and, consequently, ever since we have all been in active negotiation with our Government and the French Government on the subject of taking over the property of this Company at the termination of the concession. Mr. Brand told you last winter, when he was in the chair, that those negotiations were progressing; they have continued ever since. I have been in constant communication with various members of the Government upon the points that have been raised, and upon most of them we have come to an arrangement, but there are still some which depend partly upon the English and partly upon the French Government, which are not finally concluded, and consequently I am not able to place before you to-day any result of our negotiations. Of course, you are aware we can only provisionally agree to anything which we may consider desirable, and that it will have to be submitted to the shareholders for their sanction and approval. But as ever since I have been on the Board, and I believe ever since any gentleman present has been on the Board, the shareholders have always shown the greatest confidence in the Board, I think you will now rely on the fact that we are doing our very best in the interest of the Company itself. Gentlemen, I do not know that it is necessary for me to say more than that. I would just add that we have maintained our cables and our ship—in fact, all the property connected with our business—in the best possible condition, and I believe there is no telegraph company in the world that has a better plant than we have at the present time. I think, therefore, that if our property is purchased it will be a very valuable property, with a very large income attached to it, and that the persons, of course, who will gain will be the Governments of the countries who obtain it. Gentlemen, I think that is all I have to say. I beg to move the adoption of the report and accounts.

The Hon. ASHLEY PONSONBY seconded the motion.

Mr. SODEN said that on the last occasion he made some observations, and he would not pretend to go through what he then said. He did not wish to say a word that would in any way hamper the Board, in whom the shareholders had rightly the utmost confidence, but he could not help saying that all telegraph companies carrying on business in this country to parts beyond the United Kingdom were in one sense certainly in exactly the same position as this Company—they all held by the license of the Crown the use of the foreshore; and if the Government considered it a wise policy to buy up the business and trade of submarine telegraphs, they ought to pay what was fair and just. This was not the place to discuss the wisdom of that policy, but it seemed to him that it was the interest of every shareholder in this Company to interest every shareholder in every other submarine company starting from these shores, because they were all more or less in the hands of the Government. The Government might any day arbitrarily, or for good reasons, give notice to revoke the license for the use of the foreshore, and away would go a business built up by a vast expenditure of capital. Whatever was done on this occasion would be a precedent in the future, and they ought to bear in mind that most of the companies did business

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with our colonies, and it seemed to him if this was carried it was not at all improbable a somewhat similar policy would be adopted with regard to submarine telegraphs to our colonies.

The CHAIRMAN replied that he did not understand that the hon. proprietor had made any objections to the remarks he had made, or to the course that the directors had adopted. He could assure the hon. proprietor that he and his colleagues had not forgotten any argument which could be used, or to enlist any interest which they possibly could, and which they thought might be of special value, but the difficulties with which they were surrounded arose from the fact that it was not only the English Government with whom they had to deal and satisfy, but they had to treat with the French and one or two other Governments, who were intimately concerned in this matter, and consequently a proposal which might entirely satisfy one would not satisfy another. It was impossible to foresee every eventuality which might occur, and he could assure the shareholders that the Directors had done their best in the interest of the shareholders. If they had not met the success they desired it was not owing to any fault of their own, but owing to affairs over which they had no control.

The motion was then put to the meeting and carried unanimously.

A dividend at the rate of 13½ per cent. per annum, less income-tax, was then declared payable on and after the 1st September next.

The Hon. Ashley Ponsonby and the Hon. H. B. Brand, the retiring Directors, were re-elected, and Mr. William R. Cole and Sir Thomas Dakin, the retiring auditors, were re-appointed.

A vote of thanks to the Chairman and Directors then closed the meeting.

The Northern District Telephone Company (Limited).

At the sixth annual meeting of the above Company, held at the offices, Arcade-chambers, Sunderland, Mr. R. T. Wilkinson presiding, the report of the Directors was read for the year ending 31st of December, 1887. The following is a summary :—

Capital Expenditure.—The capital expenditure for the year has been £14,657. 15s. 2d., which, added to previous amount of £31,854. 5s. 6d., shows a total of £46,512. 0s. 8d. expended in the Company's district.

Revenue and Expenditure.—The revenue accounts show that the receipts of the Company from all sources, attributable to the year, have been £6,585. 16s. 1d., as against £4,277. 7s. 10d. for 1886, or an increase of £2,308. 8s. 3d. ; and the expenditure has been £2,858. 14s. 1d., as against £2,041. 10s. 9d. for 1886, an increase of £817. 3s. 4d.

Progress of Business.—The Company are continuing to make considerable progress in the development of their system. The number of subscribers to the exchanges have increased from 438 on 31st December, 1886 (representing a total rental of £4,114. 3s.), to 562 subscribers on 31st December, 1887 (representing a total rental of £7,277. 19s. 4d.). Exchanges have been opened at Blyth, Bishop Auckland, and Seaham, and are now working satisfactorily. The Company have now in all thirteen exchanges in full working order. Considerable additions have been made to the trunk wires connecting the whole of the Company's system together. The private line business of the Company continues to increase, the rentals from this source being £1,430. 15s. 1d., as against £1,237. 8s. 4d. last year, and the Directors still anticipate a very large increase during the present year. The Company have 150 private lines erected in the various towns of their district, and the Directors are glad to state that the use of the trunk wires between the various towns is very rapidly increasing, the amount received for occasional messages alone being £511. 4s. 9d., as against £105. 3s. 6d. for the year ended 31st December, 1886. The continued development of the Company's business is further evinced by the fact that of the total amount of the rentals for the year 1887 (£7,817. 12s. 9d.), the large proportion of £3,217. 6s. 10d. is carried forward to 1888, against £2,038. 0s. 2d., brought forward from 1886.

Dividend.—The balance of net revenue as shown by the balance-sheet is £2,392. 5s. 11d., of which £2,333. 14s. is absorbed by the payment of the dividend of 6 per cent. upon the paid-up Preference capital, leaving a balance of £58. 11s. 11d. carried forward. The progress of the business for the present year has, so far, been such as to lead the Directors to hope that they may be able to recommend at their next annual meeting a dividend upon the Ordinary shares of the Company.

The CHAIRMAN, in moving the adoption of the report, congratulated the shareholders on the great progress made by the Company during the past year, notwithstanding the strong competition of the Post Office. With respect to this competition, the Post Office have lately abandoned their exchange in Plymouth, leaving the ground to a private company, the Western Counties Telephone Company (Limited), and he had little doubt that it would be to the interest of the Post Office revenue, and also the commercial population, if the same policy was carried out in this district. The increase in the revenue over 1886 amounted to £2,303. 3s. 3d., and he was glad to say the current year would show a much better result. For the first six months of the present year the revenue from subscribers alone had increased by no less a sum than £1,674. 13s. 7d. The large increase in the calls also proved that the public had appreciated the policy of the Directors in reducing the charge for local calls to one penny, and in opening call offices where they found there was a demand. The charge made for conversations by this Company was, he believed, at a less rate than any other telephone system in existence, but the public at large had not as yet realised the fact that for sixpence they could converse for three minutes with their friends between any of the following towns, namely, Sunderland, Newcastle, North or South Shields, Durham, Bishop Auckland, the Hartlepools, Stockton, Middlesbrough, Darlington, Blyth, or Seaham, whereby they could ask and receive a reply for half the price of the lowest charge for telegraphic communication, and for the sum of one penny they could speak to their friends or order their goods from their tradesmen. The local and trunk calls had increased 71 per cent. over the preceding year. The Chairman regretted to say that as regards Newcastle the Company had not made the progress they expected, partly owing to the competition of the Post Office, also to other minor difficulties ; but he was glad to be able to report that the United Telephone Company had at last obtained an agreement with the City Corporation for them, which would admit of the application of cheap rates of subscription and of the rapid erection of lines. The amount shown in the balance sheet as being in suspense is so treated by permission of the United Company, who desired to have a legal decision concerning various items of the agreement with the District Companies before calling upon us to admit the liability. The matter, which arose in the case of the Lancashire Company, has recently been arranged, and the similar items in our accounts will therefore now be settled probably with some concessions on the part of the United Company, who have always hitherto met us in a generous spirit, and with whom we have always been on the best of terms.

Mr. J. B. MORGAN, Managing Director of the United Company, congratulated the meeting on the progress of the Northern Company, and promised to use his best endeavours to arrange all matters not yet settled between the Company and the United Company. He then proceeded to explain the progress of the negotiations for the amalgamation of the different companies, and said that as soon as these were completed the district would be put in trunk communication with London, Liverpool, Bristol, South Wales, Birmingham, and the Midland districts on the south and west, and to Scotland on the north.

It was unanimously decided, after some discussion, to accept the principle of the amalgamation, leaving the details for other arrangement.

On the motion of the CHAIRMAN, seconded by the VICE-CHAIRMAN, a dividend of 6 per cent. was declared on the Preference Shares.

Mr. R. M. Hudson, jun., was re-elected a Director on the motion of the CHAIRMAN, seconded by Mr. MORGAN, and Mr. Smyrke was also re-elected auditor.

The meeting was then resolved into an extraordinary general meeting, and the following resolution was moved and carried ;—

"*That the Articles of Association be altered as follows :—*

"*(a) The following Article shall be substituted for Article 67a, namely :—' They may borrow any sum or sums of money on such security and terms as to interest or otherwise as they may deem fit, and may secure the same by mortgage or other debentures or by bonds or other securities, or by any mortgage or charge of or upon the whole or any part of any property, funds, assets, or effects of the Company or its uncalled capital ; but so that not more than £25,000 be owing at any time without the consent of a general meeting, and provided that no part of the said sum of £25,000 shall be borrowed without the consent of the United Telephone Company (Limited), and no borrowed money shall, without the like consent, carry interest at a higher rate than 6 per cent. per annum.'*

"*(b) In Article 87, the word 'and' coming after the word 'agencies' shall be omitted, and the words 'trunk lines and new business' shall be inserted after the word 'branches.' The clause as amended shall apply as from the formation of the Company.*"

A vote of thanks to the Chairman having been passed unanimously, the meeting terminated.

South-Eastern (Brush) Electric Light and Power Company (Limited).

An extraordinary general meeting of this Company was held on the 30th ult., at the Guildhall Tavern, Gresham-street, at which, the notice intimated, the following resolutions would be proposed :—

"*1. That the accounts and report presented by the liquidator (audited and approved by four of the principal shareholders) as to the manner in which the winding up has been conducted and the property of the Company disposed of be received and adopted, and that the liquidator be authorised to distribute the balance of cash in hand as proposed in the said accounts.*"

"*2. That the liquidator be authorised to destroy all books and papers of this Company, and of, or relating to, this liquidation at the expiration of three months from this date.*"

"*3. That the liquidator do forthwith, in accordance with Section 143 of the Companies Act, 1862, report to the Registrar of Joint Stock Companies that the affairs of this Company are fully wound up, and that the final meeting has been held.*"

The chair was taken by the liquidator, Mr. W. H. Pannell, F.C.A., from whose report the following passages are extracted :—" When my appointment was completed by the confirmatory resolution of the Company, on the 13th August, 1885, the Company held a large nominal value of shares and debentures of the Consolidated Electric Company (Limited). These now form the first assets in this balance-sheet ; but as neither of them were then of any marketable value, and the Consolidated Company was shortly afterwards compelled to liquidate, and proved to be quite insolvent, I have been unable to derive any benefit from them, and, together with other nominal assets, they form a large item at the head of the deficit column. The next and most important item then appearing in the balance-sheet is the Company's property at Colchester. The position as to this I have already explained in my circular of the 14th May, 1887, and I will therefore only recall that in the unique position in which I was placed with respect to this property, and in view of the serious statutory liabilities of the Company under its license, and of the not only expensive but (in addition to the liability to an injunction in Chancery to restrain such a course) the positively ruinous consequences of a cessation of the light, which would probably have entailed, in lieu of the call of 2s. 3d., with which I have now succeeded in closing the matter, a loss of the whole remaining capital of 6s. 6d. per share, I was compelled to continue the Company's contracts and works there until

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I could dispose of the whole, with the licence, as a going concern, which was not until nearly a year after the liquidation. So that in addition to the loss shown on sale of the property, there was a further loss of nearly £500 from carrying on the business during this period, which, added to the serious but necessary legal expenses in obtaining the sanctions and consents from the Board of Trade, the Chancery Division of the High Court, the local authority, and the numerous private parties concerned (required for the purpose of releasing the Company from the statutory liabilities already referred to), and taking account of the deduction from the price obtained, by reason of the indemnity against claims of the consumers (which have since been paid in cash by the purchasers), and of the difficulty of collecting a portion even of the disputed debts of the consumers for light and goods already supplied, reduced the net proceeds of the realisation, as shown in detail in the accompanying cash account, to the small sum of £116. . . . I have in hand a balance of £913. 18s. 1d. The final account explains the manner in which I propose to distribute this balance, and the ultimate position in which the capital account will then stand; leaving unused assets of 4s. 3½d. per share—equal to £3,959. 18s. 5d.—and bears a certificate by some of the leading shareholders of the Company representing between them the great bulk of the capital issued." The account showing the proposed distribution of the balance in hand stated that the total loss had been £45,953. It was proposed to distribute by way of dividend as return of capital 8s. 7d. a share on 400 fully-paid shares (£171. 13s. 4d.), and ½d. a share on 17,654 Ordinary shares (£36. 15s. 7d.).

The LIQUIDATOR stated that he had called the meeting in conformity with the Act of Parliament. If any gentleman had any question to ask, now was the time for doing so. He then put the first resolution (moved by Mr. C. H. Stewart and seconded by Mr. A. Leland Noel).

The LIQUIDATOR, in answer to Mr. Brooker, said that the return on the Ordinary shares was ½d. a share, and the return on the fully paid shares would absorb the balance.

Mr. BROOKER said that the fully paid shares were not entitled to anything. It was a most illegal thing to take over the Consolidated Company.

The LIQUIDATOR said that that had been done by the Directors before he had any connection with the Company. The claim of the holders of the 400 fully paid shares had been £2. 16s. 6d. a share, but he successfully reduced that by treating it as a claim on 800 £2. 10s. shares instead of 400 £5 shares.

Mr. BROOKER desired that the books might not be destroyed. The shareholders would see if they could not prosecute the promoters, Directors, and others who had been connected with the Company.

The LIQUIDATOR stated that he was not connected with either the South-Eastern or the Provincial Company until he became liquidator. He then put the motion and it was carried. The second resolution was then proposed.

Mr. JOHN EVANS said it was of no use going on and spending every shilling which might otherwise be available for the shareholders.

Mr. BROOKER: It was a swindle.

Mr. EVANS: Then I am in it. I am one of the swindled. It appears to me that the liquidator has done all he could for us. Let us bring the matter to an end as quickly as possible, and I hope that the books will be destroyed.

Mr. BROOKER: That is what the Directors want.

The LIQUIDATOR put the resolution, which was carried. He then put the third resolution, which was also carried, and the meeting terminated.

Provincial (Brush) Electric Light and Power Company (Limited).

An extraordinary general meeting of this Company was held subsequently, Mr. Pannell again presiding, the resolutions submitted being the same as at the meeting of the South-Eastern Company.

The report of the liquidator stated:—"It will be remembered that when my appointment was completed by the confirmatory resolution of the Company, on the 26th June, 1885, the Company held a large nominal value of shares and debentures of the Consolidated Electric Company (Limited). These now form the first assets in this balance sheet, but as neither of them were of any marketable value, and the Consolidated Company was shortly afterwards compelled to liquidate, and proved to be quite insolvent, I have been unable to derive any benefit from them, and, together with other nominal assets, they form a large item at the head of the deficiency column. The assets to be realised were thus reduced to some book debts (the chief of which were disputed), the stock on hand (at cost, not valuation), the office furniture and fittings, and a small amount in cash and stamps. The Liquidation Account starts with the deficiency on realisation of the assets already mentioned. The next item is the further claims paid. Here again it will be seen that, though in addition to a large amount of time and trouble, I have incurred law costs to the extent of £78 in resisting these claims, principally a claim of the Consolidated Company (ultimately admitted under the orders of the Court at £1,800), for further advances on the debentures above referred to, and on current account, this amount is very far more than covered by the large reduction I succeeded in making in such claims. Adding to the admitted claims the general costs of liquidation, and taking, on the other hand, the nominal surplus brought from the balance-sheet, and the further capital collected, I have a balance in hand of £618. 14s. 6d. . . . . I had thus net proceeds of £692 only, and as I had on the other hand to meet claims for £2,267, it became necessary to obtain further capital from the shareholders. This entailed law costs to the extent of £102, but it should be noticed that while this is more than covered by the £107 of arrears collected, it was expended in recovering, not only this amount, but also a very large proportion of the further call made by me, which, upon a list of over 800 contributories, could not otherwise have been obtained. The concluding account explains the manner in which I propose to distribute the balance of cash in hand, and the ultimate position in which the capital account will then stand, leaving unused assets of 2s. 9½d. per share, equal to £2,498. 17s. 3d., and bears a

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certificate by some of the leading shareholders of the Company, representing between them the great bulk of the capital issued. The balance available for distribution by way of dividend, as return of capital to the shareholders, was, at the rate of 3½d. a share, £248. 19s. 9d. The total loss of capital had been £51,096."

Mr. C. H. STEWART moved the first resolution. He said he quite sympathised with Mr. Brooker in his observations as to the Directors and the management of both companies. The liquidator had, however, attended well to the interests of the shareholders. If he had not done so they might have had more calls to pay instead of receiving a small return. In that case their position would have been even worse than it was.

The motion was seconded and carried with one dissentient—Mr. Brooker.

The second resolution as to destroying the books, &c., in three months, was then proposed.

Mr. BROOKER: Alter that to 12 months.

The LIQUIDATOR said he could not do so, and the feeling of the meeting was evidently with him.

Mr. BROOKER: Are you bound to three months?

The LIQUIDATOR replied in the negative, but added that by operation of law, after that meeting the Company would be dissolved in three months. The liquidation had been going on for some time.

Mr. BROOKER moved an amendment that the books be not destroyed for 12 months, so as to give the shareholders time to consider what steps they should take.

Mr. EVANS: You have had three years.

Mr. BROOKER: We ought not to let these men off scot free. If I were to come to your office you would not let me overhaul the books as I like?

The LIQUIDATOR: Certainly, I will.

Mr. BROOKER: Then I will come.

The LIQUIDATOR said that the amendment was not seconded, and put the resolution, which was agreed to.

Mr. NOEL next proposed, and Mr. STEWART seconded, the third resolution, which was also agreed to, Mr. BROOKER dissenting.

A SHAREHOLDER: When is it proposed to pay this?

The LIQUIDATOR: At once.

Mr. STEWART proposed a vote of thanks to the liquidator for the manner in which he had conducted the winding up and brought it to a conclusion. There was no doubt that it had been a difficult and intricate matter to deal with. With the Consolidated Company neither the South-Eastern nor the Provincial Company had had anything to do, except that they had been drawn upon *ad lib.* for the benefit of the Consolidated Company. There was no doubt that the inception of the two companies and the working of them had been a stain upon the commercial morality of the city. Seeing the difficulties that had had to be contended against, he thought the liquidator had got over them in a masterly manner. He (Mr. Stewart) was a severe sufferer by both companies.

Mr. BROOKER seconded the motion, which was carried unanimously.

The LIQUIDATOR, in acknowledging the vote, said that the liquidation of the South-Eastern Company had been unique, because it was the first case where a liquidator had been called upon to liquidate an electric light company having an installation lighting a town, and the various authorities he had had to deal with had caused the solicitor and himself a good deal of trouble. However, the liquidation had resulted so far satisfactorily that the shareholders had not been called upon to contribute to the full amount of their shares.

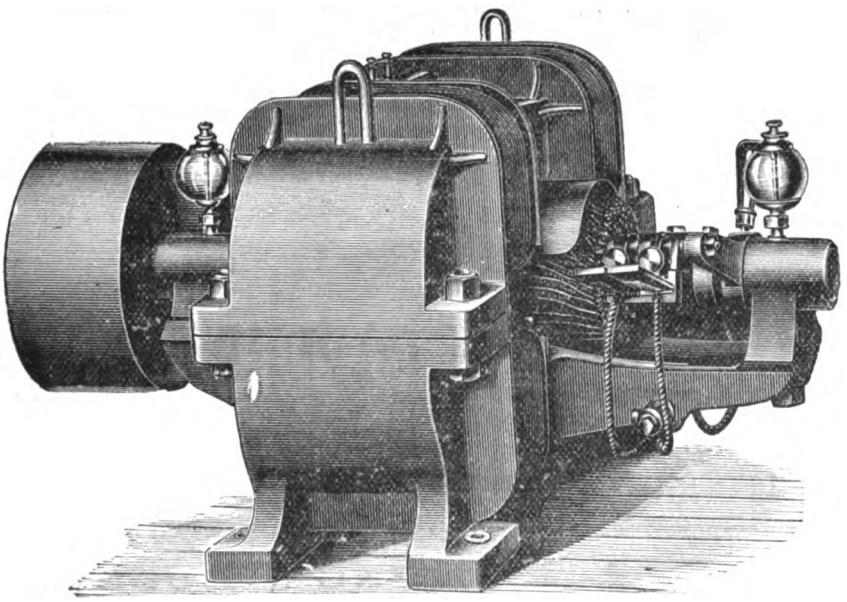
The proceedings then terminated.

National Telephone Company (Limited).

Report of the Directors for the year ended 30th June, 1888, to be presented to the shareholders at the eighth annual ordinary general meeting of the Company, to be held at the Offices of the Company, 162A, Queen Victoria-street, London, E.C., on Saturday, 4th August, at 12 o'clock:—

Capital Expenditure.—The capital expenditure for the year has been £43.854. 8s. 6d., against £36,718. 12s. 1d. in the previous year.

Revenue.—The gross revenue allocated to the past year is £99,119s. 2s. 2d., against £85,073. 6s. 1d. allocated to the previous year, and the amount carried forward to next year is £58,495. 18s. 4d., against £49,525. 15s. 8d. carried forward last year. The annual rentals on the 30th June reached £106,572. 12s. 7d., against £90,537. 2s. 4d. at the corresponding date of the previous year, showing an increase of £16,035. 10s. 3d. There is also a revenue derived from fee messages, at the rate of £3,000 a year, against £1,800 last year, making the total gross revenue reached on the



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30th June £109,572. 12s. 7d., and giving an increase of £17,235. 10s. 3d. over the total of last year.

Dividends.—After providing for the accrued interest on the debentures, the dividend of 6 per cent. on the First Preference Shares, the dividend of 6 per cent. on the amount of Second Preference capital paid up, and after having paid an interim dividend for the first half of the year, at the rate of 4 per cent. per annum, on the Ordinary capital, there remains a balance of profit amounting to £17,003. 5s. 1d. Out of this the Directors propose to allot a further sum of £11,250 to the payment of a dividend upon the Ordinary capital for the second half of the year, at the rate of 5 per cent. per annum, and besides placing £2,500 to the reserve fund, to carry forward £3,253. 5s. 1d. Out of the amount carried forward a sum will be required towards the adjustment of long-standing claims between the United Telephone Company and this Company, now in process of being satisfactorily settled by mutual concession.

Trunk Wires.—The Company has increased its trunk system, so that it has now 842 miles of trunk pole lines connecting towns with each other, carrying 2,509 miles of wire, against 643 miles of pole lines carrying 1,919 miles of wire at the same time last year.

New Exchanges.—The Company has 117 telephonic exchanges with 8,056 lines. The lines of the private wire renters number 1,268, making the total number of exchange and private lines 9,324. The increase of exchanges is 26 and of exchange and private lines, 1,470.

Retiring Directors.—The retiring Directors are Messrs. John Bruce, Edinburgh, and Jeremiah Garnett, Manchester, who, being eligible, offer themselves for re-election.

Retiring Auditors.—The auditors, Messrs. Quilter, Welton and Co., also retire, and are eligible for re-election.

NEW COMPANIES REGISTERED.

CROMPTON AND COMPANY (LIMITED).—Registered by Ashurst, Morris, Crisp and Co., 6, Old Jewry, E.C., with a capital of £140,000, in £5 shares. Object, to adopt and carry into effect an agreement dated July 16, 1888, and made between R. E. Crompton and Co. of the one part and Francis R. Reeves, on behalf of the company, of the other, for the acquisition by the company of the business, goodwill, machinery, privileges and other property of Messrs. R. E. Crompton and Co.; to acquire any additional letters patent relating to inventions for the production or supply of heat, light or power by means of electricity, magnetism, or any other agent, or any inventions of a like character, and to take and work any license or business in connection with such inventions. The first subscribers are:—

	Shares.
The Right Hon. Viscount Torrington, Maidstone	1
Sir C. Grant, K.C.S.I., 5, Hyde Park-place, W.	1
F. T. Medcalf, 4, St. Mary-axe, E.C.	1
J. F. Albright, Savernake Lodge, Chelmsford	1
R. S. B. Crompton, 23, Porchester-gardens, W.	1
H. S. Price, 52, Queen Victoria-street, E.C.	1
E. T. Botwright, 23, Sutton-place, Hackney, E.	1

There shall not be less nor more than seven directors, and the first shall be appointed by the subscribers to the Memorandum of Association. The qualification of a director shall be the holding of at least £500 in the capital of the company. The remuneration of the directors is fixed at £1,000 per annum.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended July 27th, 1888, amounted to £4,592.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended July 27th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £3,864.

DISSOLUTION OF PARTNERSHIP.—We are informed by Mr. A. L. Lineff, that the partnership formerly existing between himself and Mr. W. Jones, as consulting engineers, has been dissolved, and that he (Mr. Lineff) intends to devote his attention in future chiefly to the electric tramway system with which his name is identified.

ELLIOTT BROTHERS,

101 & 102, ST. MARTIN'S LANE, LONDON, W.C.

TELEGRAPH ENGINEERS AND MANUFACTURERS OF ALL KINDS OF ELECTRICAL TESTING AND TELEGRAPH INSTRUMENTS.

Submarine Mining Apparatus, &c. Contractors to H.M. Government.

SOLE AGENTS FOR THE SUPPLY OF SIR WILLIAM THOMSON'S NEW STANDARD ELECTRIC INSTRUMENTS.

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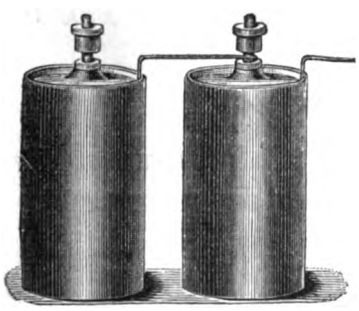

Dr. GASSNER'S PATENT

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TELEGRAPHIC WORK, ELECTRIC BELLS, AND MEDICAL USE.

Possesses all the advantages of a Leclanché Cell, and none of its deficiencies.

Can be placed in any Position, on side or upside down, in very Warm or very Cold places, so that for Ship use, carrying about, as well as for General Purposes, it is a PERFECT DRY CELL. *Sole Wholesale Depot for England—*

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THE NEW BURGLAR ALARM CONTACT (Patent applied for); cannot get out of Order. Rubbing Contact, and Wetproof.

THE NEW INDICATOR MOVEMENT (Patent applied for). Simplicity and Efficiency.

Trade Terms and particulars on application to MAYFIELD, COBB & CO., Limited.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, August 1, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending August 1, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	10/0	Anglo-American ....xd	41 42	3 5 6	Jan., Apr., July, Oct.	41½	...
2,614,820	Stock	20/0	Do. Preferred ....xd	68½ 69½	3 19 2	,, ,,	69½	68¼
2,614,820	Stock	nil.	Do. Deferred	13⅜ 14¼	...	February	14⅜	...
130,000	£10	3/0	Brazilian Submarine	12⅝ 12⅞	5 8 9	Mar., June, Oct., Dec.	12⅛	...
16,000	10	8/0	Cuba Submarine ....xd	13½ 14	5 14 3	February and August	14	...
6,000	10	10/0	Do. Preference ....xd	18⅞ 19½	5 2 6	,, ,,	18¾	..
12,931	5	4⅞'87	Direct Spanish (£4 paid)	3¾ 4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference	9¼ 10½	4 15 3	April and October ...	...	...
60,710	20	2/0	Direct United States ....xd	9⅝ 9⅝	4 5 8	Jan., Apr., July, Oct.	9 5/16	9½
380,000	10	2/6	Eastern ....xd	12 12¼	4 9 0	,, ,,	12 5/16	12
70,000	10	3/0	Do. 6 per Cent. Preference ....xd	14⅜ 15¼	3 19 0	,, ,,	15 3/16	15⅛
200,000	100	5%	Do. 5 per Cent. Debentures, 1899 ....xd	108 109	3 16 3	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅞ 13⅛	5 0 0	Jan., Apr., July, Oct.	13⅛	12 13/16
22,050	10	5/9	German Union Telegraph and Trust	9 9½	7 7 4	January and March	9¼	...
179,177	10	1/6	Globe Telegraph and Trust	6¾ 7	4 10 10	Jan., Apr., July, Oct.	7	6¾
178,992	10	3/0	Do. 6 per Cent. Preference	14 14¼	4 4 3	,, ,,	14 5/16	14
150,000	10	5%	Great Northern	13¾ 14¼	5 5 3	Jan., July, and April	14⅛	1 6/8
17,000	25	5/0	Indo-European	36 38	6 11 9	April and October	...	...
33,348	10	3/0	London Platino Brazilian	5⅞ 6¼	...	May and November	...	...
9,000	8	4/0	Reuter's	7⅞ 8	5 0 0	April and October ...	...	...
338,225	Stock	12%	Submarine ....xd	140 150	9 3 4	February & August	145	140
30,000	10	4/0	West Coast of America	6½ 7	7 2 10	January and July ...	7	6¾
150,000	Stock	8%	Do. Debentures	110 115	6 19 2	June and December	...	...
88,321	10	nil.	West India and Panama	1 1¼	...	...	1⅛	1 1/16
34,563	10	9/0	Do. 1st Preference	11 11½	...	April and October ...	11⅜	11 1/16
45,181	15	9/0	Western Brazilian	11⅛ 11⅝	5 13 3	March & September	11⅝	10½
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	102 104	5 15 5	March & September	...	...
			TELEPHONES.					
224,850	14/0	0/4½	Consolidated Telephone and Maintenance	1/16 1/8	5 10 0	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	¼ ⅜	3 13 6	...	...	...
80,000	5	5/0	United	13½ 13¾	5 15 0	June and December	13 1/16	12⅞
50,000	5	2/6	United River Plate....xd	5⅛ 5⅛	...	April and October ...	5⅛	5 1/16
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3 3½	...	...	3 5/16	3
23,692	5	nil.	Do. (fully paid)	4¼ 4⅜	...	February & August	4⅜	4
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅛ 2⅜	...	...	2¼	...
312,000	½	0/1½d '86	Maxim-Weston....	1/16 3/16	...	February	⅛	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	39 40	5 19 9	March and July	39¾	39½
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works xd	17 18	5 9 7	February & August	18	17¾

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CAPITAL, £2,000,000.

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1. Performing the duties of Trustee, Executor and Administrator.
2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the duties of the family solicitor.

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For terms, &c., application should be made to the General Manager at the Company's Office.

GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 534.—Vol. XXI. FRIDAY, AUGUST 10, 1888. Price 4d.

NOTES.

The Philosophical Magazine for August contains a highly interesting and important Paper by Dr. Oliver Lodge "On the Theory of Lightning Conductors," in which the author deals with the results of some of the experiments which he lately exhibited before the Society of Arts from a mathematical standpoint. Amongst other striking conclusions he is able to estimate the order of magnitude of the frequency of the oscillations of a lightning flash at about one million per second. The results which follow from this excessive rate of alternation are both curious and instructive. The author hesitates to express a final opinion whether it is not, after all, a better plan to insulate lightning conductors from the buildings to which they are attached. We present a tolerably full abstract of the Paper further on, but must refer our readers to the original article for the complete mathematical reasoning.

Prof. Elihu Thomson (U.S.A.) states that he has observed as many as six lightning-flashes very quickly following each other along the same path. He kept his head rapidly wagging during a thunderstorm, and his eyes fixed in one direction, which is a well-known method of observing discontinuity of illumination.

The half-yearly dividend of the London Street Tramways Company has fallen from 8½ to 4 per cent. per annum, and consequently the directors had to face a stormy meeting on Wednesday. The Chairman explained that the fall was largely due to the high price of forage and excessive mortality amongst their horses. The price of forage is not at all likely to come down, but nevertheless the shareholders have at hand a very simple and perfectly trustworthy means of raising their dividend. We have no doubt whatever that the line could be worked by electric traction at a cost not exceeding 5d. per car mile. The shareholders can easily form an idea as to the dividend which this figure would imply, and since there are now nearly 100 tramway lines worked by electricity in the United States alone, there need be no hesitation on the score of the supposed experimental character of the undertaking.

Our esteemed contemporary, the *Electrical Review*, whilst sharing our views with regard to the impracticability of the proposals for working the Underground Railway by accumulators, thinks that we have considerably over-estimated the weight of the cells. Our contemporary does not advance any calculation in support of this criticism. The figures we gave a fortnight ago were, however, based upon actual estimates separately prepared by two of the leading manufacturers of accumulators in this country, in connection with a scheme for working an electric tram or railway line in Spain. The estimate was in each case very nearly equivalent to a dead weight of 7cwt. for each horse-power electrical, with a discharge of two hours. This figure is, of course, very much in excess of that corresponding to the normal type of cells intended for lighting purposes, and if the question of duration is not to be considered, no doubt it can be much diminished, even when the cells are to be used for electric traction. The Spanish railway, by the bye, is *not* to be worked by accumulators. From the statements which we published as long ago as April 27 (p. 705) it may be conjectured that the projectors of the present scheme consider the life of the cells to be of secondary importance, hoping later on to induce the Railway Company to adopt a method of working better calculated for a permanent success. If this be the true explanation of the present state of affairs we can only express bewilderment at the short-sighted character of the policy adopted. When the Metropolitan Railway Company have once got the electric locomotive upon their lines it can hardly be supposed that they will neglect the question of the cost of working, or that in this connection they will overlook the importance of the item of depreciation. And if the direct system of working be the method finally aimed at by the Electric Traction Company, it is still more difficult to understand how its adoption is to be facilitated by first presenting an experiment which at the very best must be both costly and inconclusive. In this relation, however, Mr. Evershed's article on "Electric Traction," which appears in another column, may be studied with advantage.

By far the most valuable contribution we have yet met with on the subject of technical education is from the pen of Dr. Crichton-Browne in this month's *National Review*. If anyone suspect the writer of prejudice because of the strong line which he took up some time ago against over-pressure in elementary schools, their misgivings will all disappear on perusal of this article. He gives physiological reasons, of extreme interest and importance, for cultivating the motor centres of the brain between the ages of four and fourteen, and, consequently, against "cramming it with decimals and geography while the hands hang flaccid and the digits grow clumsy and stiff." All the same, Dr. Crichton-Browne entirely approves of the Education Act, and would not reduce the period assigned by it

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to elementary schooling. He asks chiefly for some mitigation of the demand of inspectors in respect to compulsory and class subjects, in order that time may be found for manual training. He has not much faith in the workshops which have been superadded to some of the Board Schools, and which have utterly failed, partly because the scheme is too ambitious, but largely, no doubt, because the pupils have had no early training in those manual dexterities which the author so much desiderates. What he recommends is that drawing and modelling be taught from early infancy, and continued till the boy or girl leaves school. In the infant school these arts should occupy half the school-time, and in elementary schools much more time than is at present given to them.

These propositions, at first sight, appear rather startling; but hey are based not merely on the physiological facts which examination of brain functions have recently disclosed, but on the indisputable characteristics of the Anglo-Saxon race. The report of the Royal Commission on Technical Education proves to demonstration that there is no race to compare with ours for natural—that is to say for inherited—skill in all manner of handicraft. It is the fear lest this characteristic of the race may be lost to us if we occupy the best years of our children's lives in mental and non-manual exercises that has induced Dr. Crichton-Browne to plead for the latter with such earnestness and vigour. Not the least instructive portion of his paper is taken up with evidence that our real or supposed losses of trade are not due to any inferiority in our technical skill, but to other and quite different causes. Nevertheless, it may be feared that the apprehended inferiority will become a reality if we do not take steps to prevent it; that is to say, if we stop the natural course of heredity which has hitherto given the children of our handicraftsmen a natural aptitude for handicraft—an aptitude which was formerly, and ought to be still, cultivated while the brain and the hands are still young.

An interesting consequence of the extension of electric lighting under the amended Act will arise from the necessity for the appointment by the local authorities of Inspectors of Electric Lighting. The chief duties of this important functionary will consist in the testing of both main and service lines for insulation and conductivity and in the testing and certifying of meters. He is also empowered, "at all reasonable hours," to have access to and to test any instruments which the undertakers may be required by the Board of Trade to set up in the central station for the purpose of recording such observations as the Board may from time to time prescribe, "and if the same are not in order he may require the undertakers forthwith to have the same put in order." The undertakers are, moreover, compelled to provide all due facilities for the proper execution of such tests, and in default of compliance they will become liable to a penalty of five pounds, and a further penalty of one pound per day for every day after the first day during which such offence continues. The tests of mains for conductivity and insulation are not to take place more often than once in three months. What will happen if the tests prove unsatisfactory we have been as yet unable to discover. It is, however, to be hoped that the penalty for permitting defective insulation is of a thoroughly deterrent character. Either the undertakers or the consumers are at liberty to require the inspector to test the accuracy of any current or energy meter, and the party making the demand is to pay the Inspector certain fees, which fees the said Inspector is either to pocket or to hand over in relief of the local rates, as the local authority by whom he is appointed may see fit to determine. If, however, a consumer provide his own meter, and the undertaker require an inspection thereof, the said consumer is himself to pay the fee if the said meter be certified by the Inspector to be incorrect.

With duties so onerous and delicate as these it is satisfactory to note that the Act requires that the Electrical Inspector be a "competent and impartial person," and furthermore that the local authority shall provide him with suitable and proper appliances wherewith to carry out the tests. It is also provided that the local authority "shall pay to every electrical inspector such reasonable remuneration (if any) as may from time to time be determined by the said authority." The rate of emolument is therefore not to be unreasonably high; but, on the other hand, it may be nothing at all. The position will of course be one of considerable dignity and pride, since it demands familiarity with the art and mystery of a craft very little understanded of the people; but we doubt whether many competent and impartial persons will be found to do the work for the honour of the thing. Speaking seriously, the proper performance of the inspector's duties will be of no little importance to the smooth working of the Act, and we trust that due care will be taken for the appointment of properly qualified men. The position will evidently demand a good deal of common sense as well as a competent knowledge of electrical measuring instruments and methods of testing.

In this connection there also arises the important question of *Quis custodiet custodes ipsos?* The appointment by the Board of Trade of an Electrical Inspector-in-Chief cannot long be deferred. It is much to be hoped that this appointment will fall into the hands of some one qualified not merely by technical knowledge and ability, but also by actual experience of electrical engineering on a commercial scale.

The non-technical interviewer, when practising his calling upon a well-informed inventor, is in much the same predicament as the non-technical judge who is trying a technical case, only considerably more so; and, on the other hand, the person interviewed is beset with the same temptations as those to which the skilled witness has been known to succumb. A curious illustration of the severity of this temptation is to be found in a recent interview between the representative of an important London firm and the reporter of an enterprising newspaper in South Wales. This paper has employed the electric light in its own offices for a considerable time past, and a knowledge of this fact evidently proved of considerable value to the interviewed one in his endeavour to say nothing extravagant on the question of the comparative cost of gas and electricity. But it

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is our sad duty to record that after struggling manfully with this temptation, the interviewed one fell at last lamentably and hopelessly (where many a better man, perhaps, has fallen before) when he came to speak of secondary batteries. "You may," he said, "safely lay down these batteries and be confident that they will require no attention or looking at, though in constant use for a period of two years and a-half" (!)

THE extension of the telephonic inter-urban communication continues to progress apace in the Midland and North-country districts. At the meeting of the National Telephone Company, on Saturday last, some very interesting particulars were furnished by Colonel JACKSON. Birmingham is at the present time the centre of activity, and four important lines radiating from this centre are now in course of construction, and will all be completed within a few months. Three of these lines will severally connect Birmingham with the Potteries, with the Lancashire and Cheshire, and with the Yorkshire system; while the fourth is the line to London, of which we have already given particulars. When these extensions are complete the Metropolis will be within speaking distance, *viâ* Birmingham, of practically the whole of the important commercial centres of the Midland, Northern, and North-Western districts, and we shall be curious to learn what sort of service the United Telephone Company will then be able to give us.

IN France the question of long-distance telephony wears a somewhat different aspect to what it does in this country, owing to the fact that while the local exchanges are chiefly in the hands of private companies, the trunk lines have been built by the Government. At present the Paris-Marseilles line is only available from the head offices, and the high tariff of three francs for three minutes' (or five, the accounts differing) conversation is charged. The daily papers are speaking of this line as the longest hitherto built for telephonic purposes. As a matter of fact, the distance from Paris to Marseilles is only about three-quarters of that from New York to Chicago, which cities have been for some time in telephonic communication.

IT is to be feared that in their anxiety to disparage the electric light some of our gas lighting contemporaries are willing to lay hold of almost any weapon which can be made to serve their turn. For instance, one of the journals recently published a paragraph under the heading of "The Dangers of Electric Light Installations in Thunderstorms." This paragraph read as follows:—"The residence of Sir Albert Sassoon, in Eastern-terrace, Hove, narrowly escaped destruction by fire on the night of Sunday, the 22nd inst. During the heavy thunderstorm which occurred that night one of the maids, who had been roused by the storm, was startled by a smell of fire coming from the entrance hall, which is lighted by incandescent electric lamps. The girl called the butler, who found that flames were flickering near one of the lamps. He poured some water upon the spot, and in this way the outbreak was checked. One of the lamps was broken, and the woodwork near it scorched. It is supposed that the wire was struck by lightning, which was thus conducted into the house." But on making inquiries as to the accuracy of this story we received the following letter from the Brighton Electric Light Company:—"In reply to your favour of 1st inst. with reference to enclosed cutting from the *Gas Journal*, we beg to advise you that the electric light installation at Sir Albert Sassoon's was totally disconnected from our outside mains during the whole of last month. The accident that occurred was attributed by the fire insurance inspector to the lightning striking a very elaborate weather vane on the roof, which conducted it into the house in close proximity to one of our brackets, on which there were electric wires and lamps."

THE obvious lesson to be learnt from this incident is that it is unsafe to erect weather vanes which are not at the same time treated as lightning conductors and provided with a good earth contact. As to the comparative degree of danger produced by gas and by electric fittings during a thunderstorm, that obviously depends in part on the special circumstances of the case. Other things being equal, gas is certainly the most dangerous, from its liability to be set alight. Three distinct instances in which this has actually happened have come to our notice within the last few days. But it must be admitted that overhead wires introduce a certain element of danger of their own, which may, nevertheless, be guarded against by the use of an efficient lightning protector. We should be glad to see a clause to this effect incorporated in the next edition of the Phœnix Fire Office Rules.

IN the "tetantograph" with which the *Daily News* has threatened a long-suffering generation our readers will probably have recognised the somewhat less cacophonously named "telautograph" of Prof. ELISHA GRAY. Prof. GRAY has evidently taken a leaf out of EDISON'S book (which, after all, is perhaps only tit for tat), and for a long while past he has been careful to remind the public at intervals that he is engaged in inventing or perfecting a writing telegraph. The information now vouchsafed lays stress upon the fact that a "pulsatory" current is used instead of a "variable" current. This may or may not be a valuable improvement, but it does not at present enable us to see in what way the telautograph is going to surpass ROBERTSON'S modification of COWPER'S instrument, either in simplicity or in reliability. Neither have we as yet discovered the exact nature of the service which the Writing Telegraph, however good in itself, is destined to fulfil. In the regular telegraphic service it is too slow for all but the least important lines, where cheap and simple apparatus is the chief requirement; while for public use it can scarcely expect to displace the telephone.

WE are officially informed that Mr. HUGH WATT, M.P., has resigned his position of director and manager of the Maxim-Weston Electric Company, and that the Board has accepted the resignation. The engagement of Mr. J. WRIGHT (the secretary) has also been terminated, and the company's offices have been removed to No. 2, Metal Exchange-buildings, Gracechurch-street. The Liberal Association of the Camlachie Division of Glasgow has likewise asked Mr. WATT to resign his seat for that constituency. Commenting on these announcements the *Financial News* says: "This is so clean a sweep as to suggest

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the Brush rather than the Maxim-Weston; in fact, Mr. WATT had better begin to resign himself—to the inevitable."

The Globe makes merry over Mr. VERNON HARCOURT'S holophotometer thusly:—"We are compelled to admit that we do not understand much of the description of the 'Holophotometer.' But, as far as we can make out, it has something to do with Mr. GLADSTONE. In the first place, it is invented by VERNON HARCOURT (though not 'Sir,' but 'Mr.'); secondly, its object is to 'measure the light emitted in every direction by a luminous source,' and we all know that Mr. GLADSTONE is considered by his party to be the source of all light; and, finally, its technical description is 'an axis working friction-tight in a *collar*.' If this is not Mr. GLADSTONE, what is it?"

Train Lighting.—We learn that the Midland Railway Company are now going to try the electric light for some of their local trains.

The Transvaal.—The Transvaal line of telegraphs has, we learn, been extended to Pietersburg, which is about twelve miles from Eersteling.

Milan.—The Milan Omnibus Company has appointed a committee to consider the desirability of adopting electric traction on the line from Milan to Conza.

The Hansthohn Lighthouse.—We learn that Messrs. A. de Meritens and Co., of Paris, are about to furnish the electric plant for the lighthouse of Hansthohn, Denmark.

The Direct United States Cable Company.—We are informed that this company's main cable between Ireland and Halifax (Nova Scotia) is now in efficient working order.

The Cox-Walker-Swinton Magneto Bell.—In reference to our description of these appliances in our last issue, we are requested to add that the Equitable Telephone Association has been appointed sole agents for their sale.

The Mechanical Engineers at Bessbrook. — The members of the Institution of Mechanical Engineers, which is now holding its annual summer meeting at Belfast, paid a visit on Thursday, 2nd August, to Bessbrook, and inspected the electrical railway.

Annual Outing of Messrs. Immisch and Co.'s Workmen.—On Saturday last the sixth annual summer excursion of the *employés* of Messrs. Immisch and Co. took place at Rickmansworth. The party, numbering about eighty-five, drove down by road, and spent a very enjoyable day.

The American Electric Light and Telephone Associations.—The eighth meeting of the National Electric Light Association will be held in New York on August 29th, 30th, and 31st, and the tenth annual convention of the National Telephone Association will also be held in the same city on September 4th and 5th.

Theatre Lighting.—We learn that the contract for lighting the Shakespeare Theatre at Liverpool has been secured by Messrs. Hills and Thomson, of 62, Dale-street, Liverpool. It is intended to use a gas engine as the source of motive power, and accumulators will be introduced. A number of Sunbeam incandescents of about 150 candle-power will be used.

The Atlantic Cable Rates.—The Anglo-American, the Direct United States, and the Commercial Companies have given public notification that on and after the 1st prox. the rates for the transmission of ordinary telegrams from the United Kingdom to New York by their system will be 1s. per word, and for press messages 5d. per word.

Innsbruck.—Messrs. Ganz and Co. have just established a central lighting station on the transformer system at Innsbruck. The station is some five miles outside the town, and the motive power is obtained from a waterfall. The primary current is conveyed to the town by an underground cable. At present 3,000 lamps are in use, but before long the number will reach 6,000.

New Incandescent Lamp.—Messrs. Woodhouse and Rawson are bringing out a new form of lamp adapted for ship work, where the vibration, especially on board men-of-war, considerably shortens the length of life of the lamp. In this new lamp the filament, although requiring the same E M.F. and giving the same candle-power, is of higher specific resistance. We shall shortly be able to give some further information on this important subject.

Rapid Cabling to Australia.—The Governor's messages to the Queen and Prince of Wales announcing the opening of the Melbourne Exhibition, consisting of 117 and 86 words respectively, were transmitted between Melbourne, *viâ* the Eastern Company's lines, and London in thirty-eight and forty-nine minutes respectively. Her Majesty's reply of congratulation, consisting of thirteen words, reached Melbourne in sixteen minutes after its receipt at the London station.

A New Submarine Cable Company.—The *Bulletin de l'Electricité* announces the formation of a French submarine cable company, with a capital of 5½ million francs, to purchase work, and lay down a network of cables between Venezuela, Curaçao, Hayti, Cuba, and the United States. The company is called the Société Français des Télégraphes Sous-Mairnes, and is intended to acquire the rights granted by the various Governments to MM. Jules Lair and Paul Wallerstcia.

Temesvar.—The Anglo-American Brush Electric Light Corporation, who have for some years carried out the public lighting of the streets at Temesvar on the Brush series-multiple system, have decided to undertake the lighting of private houses also, and to adopt for that purpose the Zipernowsky-Déri-Bláthy system of transformers. The Brush Company has already ordered the necessary material for this new installation, which is to be furnished by Messrs. Ganz and Co., of Budapest.

Telegraphic Communication with Lighthouses.—In the House of Commons on the 5th inst., Sir M. Hicks-Beach moved the second reading of Lloyd's (Signal Stations) Bill, and explained that its object was to improve the telegraphic communication at present existing between the mainland and lighthouses. The association known as Lloyd's were willing to undertake the work to a certain extent, and the Bill empowered them to take land for the purpose. The Bill was then read a second time and referred to a select committee.

The Phonograph.—We are pleased to learn from Colonel Gouraud that Mr. Edison has cabled him that, in deference to numerous requests, he has despatched several phonographs to be placed at the disposal of the scientific and learned societies of Great Britain, in such a manner as Colonel Gouraud may determine, and, so far as possible, in the order of priority of dates of the applications received. These instruments will contain several new devices for rendering audible to small audiences the sounds emitted. Colonel Gouraud has been invited to read a Paper on the subject at the forthcoming meeting of the British Association.

The Metropolitan Electric Supply Company.—We learn that owing to the lateness of the present Session the Metropolitan Electric Supply Company have dropped the Bill which sought the confirmation of a provisional order recently granted by the Board of Trade for lighting with the electric light the

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parishes of St. James's, Westminster, St. Martin's-in-the-Fields, Waterloo Bridge, and a portion of the Victoria Embankment. This Bill, which was the only Electric Lighting Bill introduced in the present Session, had passed the examiners, but opposition had been threatened by the parish of St. James's and a competing electric lighting company.

"How it Strikes a Contemporary."—"The electric lighting engineers," says the *Journal of Gas Lighting, Water Supply, and Sanitary Improvement*, "appear to be a very jolly and social set of fellows, at any rate; for although they are necessarily living in the sharpest competition with each other, and are always treading on one another's toes in the matter of patents, they are ever ready to meet formally or informally, at a dinner or in a lecture room, and combine for pleasure or business purposes with a cheerful alacrity that might be emulated with advantage in other callings. The reason for this probably is that they are all educated gentlemen. It requires an underbred man to be spiteful and jealous in business relations."

An Improved Magneto Call Bell.—We have recently examined an improved magneto call bell, for telephonic and general purposes, introduced by the Telegraph Manufacturing Company, of Helsby. Externally—but for the smaller size and better finish—the apparatus is similar to the well-known American pattern; a closer examination, however, shows several important mechanical improvements, the driving wheel, for instance, instead of having the boss of the wheel only as a bearing, is mounted on a tubular shaft, through which the driving axle passes. An inclined slot arrangement causes this axle to move forward when rotated, pressing a contact spring, which brings the armature coils in circuit in the usual way; the continuity of the circuit does not, however, depend on the axle bearings, as is the case in the old pattern. The bearings are of hard brass, ensuring the least possible wear, and the design is such that the whole of the working parts can easily be removed for inspection or repair. The entire apparatus seems to be of first-class manufacture.

Exports of Telegraphic Wires, &c.—The satisfactory features of the Board of Trade returns for July, issued on Wednesday last, are not reflected in the exports of telegraphic apparatus. The exports of metals, ironwork and machinery were exceptionally favourable both for July and for the previous six months, but the exports of telegraphic wire and apparatus were exceptionally small. The following is a comparative statement to date:—

Exports of Telegraphic Wires and Apparatus connected therewith.

	1886.	1887.	1888.
1st Jan. to March 31st	...£124,074	...£131,879	... £88,077
1st April to June 30th	... 354,331	... 56,933	... 156,136
Six months	478,405	188,812	244,213
July	219,463	195,950	21,571
Seven months	...£697,868	...£384,762	...£265,784

The July exports this year have been almost the smallest of any month so far, while in 1887 and 1886 the July exports were up to date by far the largest.

Electrically-formed Copper Pipes.—Lloyd's Committee have recently had their attention directed to the increasing number of accidents arising from the bursting of copper steam pipes, chiefly in marine engines, in consequence of the high steam pressure which it is now customary to employ. In our issue of March 2, page 436, will be found a description of the interesting process introduced by Mr. Elmore, of Cockermouth, for forming seamless pipes by means of electro-deposition. Mr. W. Parker, the chief engineer surveyor to Lloyd's, has recently investigated this process, and has furnished a report to the committee. From this it appears that at ordinary temperatures the tenacity of the deposited metal is equal to 23¾ tons per square inch, as against 20¼ tons and 14 tons per square inch for solid drawn and rolled sheet copper respectively. At the temperature of high pressure steam the tensile strength of ordinary sheet copper does not exceed 10 tons per square inch, while the deposited metal stands equal to that of solid-drawn copper at 15 tons per square inch. The ductility of the deposited copper is, however, far higher than that of the solid-drawn, while its uniformity of structure is remarkable. Under these circumstances the introduction of these pipes on a large scale would seem to be only a question of cost.

An Invisible Lightning Flash.—The Paris correspondent of the *Daily Telegraph* writes as follows:—"A curious case of death by lightning has just occurred at Puy-de-Fourche, in the Department of the Dordogne. A farmer named Verneuil was at work in the fields with his family and some neighbours, when a thunderstorm came on. The whole party had sought a refuge from the rain under a large tree, when some one remarked that this was rather an imprudent step. They accordingly determined on moving off to a small wood at a little distance, and quitting their shelter they ran towards it as fast as their legs could carry them. When, however, they had got about half-way one of Verneuil's daughters, a girl of fourteen, stopped suddenly and slowly returned to the tree which they had left. Some of her companions followed to remonstrate with her on her rashness, but ere they could reach her they saw her throw her arms with a smile round the trunk. A moment afterwards the poor child fell backwards on the ground, with her arms outstretched, quite dead. Very strangely they had not perceived any flash of lightning or noticed any clap of thunder at that time. The girl, however, had been killed by the electric current, as the careful examination made afterwards proved conclusively."

Alleged Restoration of Sight from a Flash of Lightning.—A paragraph with the above heading appeared in a Wolverhampton paper, and has been copied into several London journals; it affords a good example of the very flimsy evidence that suffices to render the marvellous credible to the general public. The case has been investigated on behalf of the *British Medical Journal*, which says that so far as can be ascertained the facts are briefly as follows:—"The patient was injured by an explosion in a mine; one eye was totally destroyed, and he became unable to see with the other. He was in the hospital for seven weeks for 'fits,' and on leaving was led about owing to his defective sight. One evening, after a flash of lightning, he noticed that he 'could see indistinctly objects near to him,' and a few days later he could see to walk about without a guide. On inquiry we learn that for some time after the patient could only partially open the eye, that the cornea was opaque, and had been gradually clearing for many months past. In the absence of any authoritative statement as to the condition of the vision before and after the lightning flash, there seems no reason for assuming that the case was anything but an ordinary one in which the cornea was slowly clearing. Nothing is more common than for a gradual improvement to be suddenly noticed when it has reached a certain stage."

Electrical Conductivity of Metals and other Physical Constants.—The fact that the electrical conductivity of the various metals is in the same relative order as their heat conductivities is a commonplace of the text books, but Prof. Kundt has recently shown (*Phil. Mag.*, July, 1888) that the analogy also extends to the velocity of light in metals. This

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velocity is easily calculated when we know the index of refraction. Hitherto the indices of refraction have only been known for certain metals, and by indirect methods of observation, but Prof. Kundt has succeeded by means of electrolytic deposition in preparing metallic prisms of very small angle and sufficiently transparent to admit of the direct measurement of the refractive indices. The relative velocities of red light in seven metals, calculated from these observations, are as follows —

Silver	100	Iron	14·9
Gold	71	Nickel	12·4
Copper (impure)..	60	Bismuth (crystallised).	10·3
Platinum.....	15·3		

The order will be seen to be the same as that of the relative electrical conductivities. The number 60 for copper appears to be too small, but Prof. Kundt thinks that this is probably due to the existence of traces of cuprous oxide in the prism. He is now engaged in investigating the influence of a magnetic field upon the velocity in question.

The Electric Resistance of Copper at Low Temperatures.— A contribution to this subject has just been made by M. Wroblewski, who undertook to test the truth of Clausius' remark in 1856 that the electric resistance of chemically pure metals should be proportional to their absolute temperature. That is to say, if the temperature of a metal could be reduced to the absolute zero, would its conductivity increase to infinity? M. Wroblewski took advantage of one of the new methods of producing intense cold by the evaporation of liquefied gases. Copper wire of about 4·100 millimetres in diameter, covered with a double layer of silk, was taken, the conductivity being guaranteed as 98 per cent. of that of pure copper. With this wire M. Wroblewski wound a number of small bobbins having a resistance at ordinary temperatures of between 3 and 20 Siemens units As the bobbin had to be plunged in liquefied gas, M. Wroblewski began his investigation by studying the electric properties of liquid oxygen and nitrogen. He found that these substances ought to be ranked among the most perfect insulators. The resistances of the bobbins were then measured by the Wheatstone-Kirchhoff method at the temperature of boiling water; at the ordinary temperature; the temperature of melting ice; the temperature of boiling ethylene at atmospheric pressure (−103° C.); the critical temperature of nitrogen (−146° C.); the temperature of boiling nitrogen under atmospheric pressure (−193° C.); and a temperature nearly that of the solidification of nitrogen (−200° C. to −202° C.). The results are embodied in the following table, where t is the temperature, r the resistance in Siemens units, and a the coefficient of variation of resistance between two consecutive temperatures :—

Bobbin I.			Bobbin II.		
t.	r.	a.	t.	r.	a.
deg. C.			deg. C.		
+100	5·174	—	+23·75	19·251	—
+ 21·4	3·934	0·004365	+23·75	17·559	0·004075
—	—	—	−103	9·848	0·004263
−103	2·073	0·00414	−146	6·749	0·004104
−146	1·360	0·004588	−193	2·731	0 004869
−193	0·580	0·004592	−201	1·651	0·007688
−200	0·414	0·006562	—	—	—

These numbers seem to show that the resistance actually decreases much more quickly than the absolute temperature, and approaches *nil* at a temperature not very far from that obtained by evaporating liquid nitrogen in a vacuum. In view of this remarkable result it is to be hoped that the question will receive further investigation.

Injury by Lightning.—In the *British Medical Journal* Messrs. A. H. Cook and William Boulting give a detailed account of a case of serious injury by lightning which occurred at Hampstead during one of the recent storms, from which we extract the following:—"About 1 p.m. on June 14th, 1888, W. F., aged sixty-two, and D. H., aged forty-two, sawyers, were working in a wood at the Spaniards Farm, near Hampstead. There was no rain nor any sign of a thunderstorm at the time. The men were eating their dinner under an oak tree, their saws, six and a-half feet long, leaning against the fence, about two feet from the trunk. One of them, F., was standing leaning against the trunk, while the other, H., was seated on a block of wood about three feet from it, with his open knife resting upon his knee. Suddenly H. 'saw the clouds open and a sheet of fire falling.' He heard a deafening thunderclap, and felt stunned for some minutes, but had no sensation of pain. Then he discovered that his trousers were on fire, smoking but not blazing, and that his knife had been knocked out of his hand, and his steel buckles torn from his legs. He saw F. lying senseless on the ground and quite still, as though he were dead. He had lost all feeling in his legs, and he tumbled down when he tried to walk. His boots were 'in ribbons,' and fell off when he moved. He managed first to quench the fire in his trousers, and then to crawl to the road near by shouting for assistance. He was somewhat deaf, but could hear himself shout, and 'felt as though he had been blown from a cannon.' F. says that he remembers nothing of the accident, and neither felt nor saw anything. Insensibility must have been instantaneous. H. managed to attract the attention of some men passing in a cart, and both men were conveyed to the infirmary, F. still quite unconscious, and his clothes torn off him to such an extent that for decency's sake he had to be covered with one or two sacks on admission. In the absence of Mr. Cook, the medical officer, they were seen by Mr. William Boulting, a neighbouring practitioner, who saw the men an hour and a-half after the accident, and found them in a state of intense collapse. The features were ghastly blue, with a dull yellowish-white showing through the leaden colour. F. was almost pulseless, but became slightly conscious on being roused. H. was groaning, and complained of a burning pain as from a red-hot iron, which was 'travelling up his legs.' Their clothes were cut from them, and F. was found to have burns on the right side from his shoulder to his feet, bearing the appearance of abrasions. The whole of this side (presumably the side on which he was leaning against the tree) had exactly the appearance of an exaggerated example of *post-mortem* staining. H. had his legs burnt in places from the point where he had been resting his knife downwards. The legs were cut, probably by the steel buckles he had worn. His pulse was intermittent at the time, and for several days after the accident. Since the accident he had been so deaf that he could not hear a watch laid against the ear on either side or when held between the teeth. On July 9th he could hear a watch at a distance of four inches from the left ear, and was much less deaf. The oak tree was found to have been struck about fourteen feet above the ground, leaving a track all the way down. The exact position of the men and of the long metal saws which doubtless attracted the discharge to the tree under which they were was as follows:—The fence passed close to the tree, the saws were leaning against it at a distance of about two feet from the trunk. F. was leaning with his back against the trunk about a yard, and H. on the opposite side of the fence was sitting about two yards distant from the saws. The case illustrates the danger of the proximity of steel instruments during times of electric disturbance. Nor should it be forgotten that without lightning dangerous return discharges from the earth to the atmosphere may take place at a considerable distance from an atmospheric storm."

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THE ANGLO-AMERICAN BRUSH CORPORATION'S ELECTRICAL ENGINEERING WORKS.

We recently paid a visit to the factory of the Anglo-American Brush Electric Light Corporation at Lambeth, with a view to the following descriptive account, which we feel sure will be of much interest to our readers. It is scarcely necessary to say that there are very few electrical engineering enterprises in this country which can be compared either in importance or magnitude with that carried on by the Anglo-American Brush Corporation. From a technical and an engineering point of view the operations of this company have been characterised by a long and unbroken series of successes, which reflects the highest possible credit upon the technical staff, whose inventive genius and mechanical skill deserves, as it has indeed received, a wide recognition. From a commercial point of view, the history of the company has been of a chequered and somewhat remarkable character, but the present board of directors, with their able staff, have made great and by no means unsuccessful efforts to establish the company on a sound and permanent basis. Of the extent to which the foundation—and something a good deal more than the foundation—of a career of prosperity has now been laid our readers will be better able to judge after reading this description.

The works in Belvedere-road, Lambeth, cover an area of about 28,000 square feet, and consist of three separate main buildings, each of three floors, besides an iron building containing drawing and works manager's offices. The first of these is devoted to the offices of the board and the staff. The second contains the dynamo and arc lamp factories; to this there is also attached a smithy, an erecting shop, and a building of one story where the greater part of the testing work is carried on. In the third building chiefly women and girls are engaged in the manufacture of incandescence lamps. It would be a mistake to suppose that all the secrets of lamp making have been disclosed during the late proceedings in the Court of Chancery, and for that reason our lips are sealed with regard to the contents of this building. We return, therefore, to the second department, where there is enough of interest to be seen in the various processes of manufacture of the Brush and Victoria dynamos, the Mordey alternator and transformers, the Brush and Brush-Sellon arc lamps, together with motors, projectors, switches and minor fittings innumerable. It is not, however, our present purpose to enter upon any description of these apparatus, which at various times have all been described and illustrated in *The Electrician*.* We have now to do chiefly with the machinery and with the organisation by which they are produced.

The heavy tools are placed on the ground floor of one of the three-story buildings already mentioned. Here there is every appliance for dealing with the large masses of iron with which modern electrical machinery is built up, including a powerful traveller, which passes overhead along the whole shop. At one end is a horizontal Galloway engine of about 150 horse-power, which supplies motive power to the whole of this building. Steam is generated in a couple of Galloway boilers, placed in the adjoining boiler house. The principal tools in this shop are large planing machines, shaping machines, some very fine radial drills, and a substantial row of heavy lathes, together with numerous milling machines and other tools; lastly, though not least interesting, we find here some special tools adopted in the factory for building up the iron cores of the modern Brush armature. As our readers are aware, the Pacinotti projections of this armature consist of a very large number of various-sized stampings of sheet iron. By means of special jigs, the apparently difficult operation of building up this structure with the necessary uniformity and rigidity is easily and rapidly accomplished. This shop is lighted all day by electricity. For this purpose a large Brush dynamo, driven by the engine already mentioned, supplies 55 arc lamps in this and other parts of the building. Every lamp has its own switch, and as the current from the same machine is employed in the adjacent lamp factory, and also for some of the testing work, the load on the dynamo is very variable. But by means of the Brush automatic regulator—which, it will be remembered, consists of a variable carbon shunt upon the field—the lamps burn with remarkable steadiness, and the current is maintained almost perfectly constant at 10 amperes. At the time of our visit many tons of wrought and cast iron were being planed and turned up for the construction of dynamos.. Every portion of these dynamos, of whatever size, from 1,500 up to 75,000 watts (which happens to be the largest size at present in progress), is made to template, so that all the parts are interchangeable. The largest possible number of machines of the same type is put through at the same time, so as to economise the work of the factory to the utmost. Unfortunately for incandescent machines, so many different voltages, outputs, and speeds are demanded that it is impossible to carry out this principle to the fullest extent. It is much to be hoped that dynamo makers will shortly see their way to adopt some united course of action in this respect.

Adjoining this shop, and on the same floor, is the erecting room, where the machines are erected and finished ready to be sent out after being thoroughly tested. Here also is a travelling crane driven by high-speed rope gear, by means of which parts of dynamos or the entire machines are rapidly placed in any required position. Amongst a large number of machines here approaching completion we noticed a 40-unit Mordey Alternator of the type recently introduced by the Brush Corporation. This machine has abundantly fulfilled the expectations formed of it, and since its description in this journal the only improvement it has been found desirable to make consists in the substitution of porcelain for wood in the flat sector-shaped cores on which the armature coils are wound. Another interesting machine which attracted our attention was a low-tension Brush dynamo, designed for train lighting on the London, Brighton and South Coast Railway, and also in use on several other lines. These machines are driven by a belt from the axle of the guard's van, and are used in connection with an accumulator of about 25 cells. The machine gives a constant E.M.F. over a wide range of speed, so that no regulating device of any kind is needed. The brushes are brought to bear on the commutator, by an automatic arrangement, as soon as the train is running at a speed of 10 miles per hour. Two sets of brushes are fitted, which come into use alternately as the van runs backwards or forwards. On the London, Brighton and South Coast Railway and the Great Northern Railway these machines have been in use for some years. The dynamo and accumulators are placed in a locked compartment of the guard's van, and are found to be quite capable of taking care of themselves upon the journey. Here also we noticed a 15-unit Victoria machine, ordered by the War Office for installation in a certain fortification, for which purpose over 30 similar machines have already been supplied.

Ascending to the first floor, which is the light turnery department, we found some seventy or eighty men engaged, chiefly on lathe work, turning out the transformers, brass fittings, arc lamps, projectors, switches, lamp-holders, &c., &c. The projectors made by the Brush Corporation are largely employed for military and naval purposes, and for navigating the Suez Canal, and doubtless their use will extend in the mercantile marine for navigating other narrow channels at night. An ingenious but simple dioptric electric side light for steamers, of quite recent design, was here undergoing completion. An incandescent lamp is placed in the focus of the lantern, and by means of an electro-magnet whose armature retains a spring-catch, if the lamp burns out, not only is a second lamp immediately lit up, but it at once replaces the first in the focus of the lens. This practically does away with the objection which has hitherto been felt against the electric side lights. Considering the scale upon which the manufacture of the Brush arc lamp is now carried on we need hardly say that every part of the lamp is made to template, but our readers will perhaps

* *See* the following numbers of *The Electrician*:—The Brush dynamo, February 3rd, 1883, p. 271; March 3rd, 1883, p. 379; August 9th, 1884, p. 304, Vol. XV. (Exhibition Record, p. 29); January 7th, 1887, p. 198. The Victoria dynamo, February 16th, 1884, p. 315; January 7th, 1887, p. 199. The Mordey Alternators, May 25th, 1883, p. 81. The Mordey Transformer, February 10th, 1888, p. 346. The Brush Company's portable electric light apparatus, March 4th, 1887, p. 371.

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be surprised to learn that so great is the accuracy with which some portions of the apparatus are turned out that an inaccuracy of $\frac{1}{2000}$ inch determines their rejection. In order to secure this extreme nicety the greater part of the work is carried out by specially designed tools, most of which are automatic in their action. We cannot, of course, enter upon any description of these appliances, some of which are extremely beautiful and ingenious, and are the results of a great deal of thought and mechanical skill.

For cutting spur and bevel gearing for the projectors and arc lamps, an automatic tool is used, which was also designed in the works. The iron plates for the Mordey transformer are stamped out on this floor by a power press, attended by a boy, which works at the rate of twenty-five strokes per minute. Another boy then slips the outer and inner stampings alternately through and over the long coil, and the transformer is thus quickly and cheaply put together. A special and somewhat dirty compartment on this floor is occupied by the "buffing" machinery, where the highest polish is given to the work requiring it.

On the third floor are the pattern and the winding shops. The iron cores of Brush and Victoria dynamos which were seen in course of construction on the ground floor here receive their copper coils. Some surprise is often expressed that the coils of high tension dynamos so very seldom give rise to insulation troubles. But while watching the operation of winding a large Brush armature designed for an E.M.F. of 3,000 volts, we perceive that the greatest possible care is taken with every inch of the conductor, and the work is only entrusted to those men who by long experience and skill are thoroughly qualified for the task. In the Victoria armatures, all the larger sizes are wound with copper strip, and the details of the old style of Gramme winding are somewhat departed from. Instead of winding each coil separately and connecting its own end to the commutator—which involves a considerable twist in the wires—the whole core is wound continuously with one length, and the commutator bars are connected by separate wires which are securely fastened to the armature conductors.

Returning to the ground floor, and passing through the erecting shop, we arrive at the testing room. In this room there are racks provided with dark glasses for testing and adjusting arc lamps, and as many as eighty lamps are sometimes tested at the same time upon a single circuit. Motive power is furnished in this room by a couple of 70 horse power engines and boilers. These engines drive on to a counter-shaft, which is fitted with a claw clutch, so that one or both engines can be used in the same work, or each engine may be used separately on its own half of the counter-shaft, so that various operations demanding different speeds may be carried out at the same time. When large dynamos have to be tested whose output exceeds the joint power of the engines, a portion of the current from the machines is carried to an electro-motor whose pulley is belted back on to the counter-shaft. This modification of Dr. Hopkinson's method of testing is often useful in enabling heavy work to be economically dealt with even when the full power of the engine is not exceeded by that of the dynamos. For power tests for motors, or dynamos, there is provided a transmission dynamometer, designed in the drawing office of the works. The apparatus may also be used as an absorption dynamometer, by attaching a friction brake to one of the pulleys.

In the adjoining courtyard we come to another small engine house, which contains a "Brush" vertical engine, driving a 10-unit Victoria dynamo by means of the Raworth friction gearing. This forms an excellent combination for use where it is desired to supply a small installation with the minimum amount of trouble and attention to the engine, the advantage being that the friction pulley enables the dynamo to be driven at the required speed by means of a comparatively slow running engine of the simplest possible type, one which can be put into the hands of the most ordinary mechanic or engine driver with the certainty that he will find no point in its management beyond his skill. This machine is compounded (as most of the Victoria machines are) exactly to suit the special conditions under which it is working—that is to say, it maintains a constant potential difference at the end of its leads through any variation of load, and also corrects for the 5 per cent. irregularity of speed which is permitted by the governor of the engine. We may add that for ship lighting a very large number of these sets has been supplied, it being found that their simplicity and reliability admirably adapt them for use on long voyages. We were informed that one, supplied to an Orient liner, had just returned into port after a voyage to Australia and back, the total stoppages amounting to only 23 hours, and this due to the ship being in port and not requiring any lights, and not to any mechanical or electrical necessity. It is in this department of ship-lighting that some consolation has been found for the slow development of land work, but now that Lord Thurlow's Bill has become law, and the electrical atmosphere cleared in other respects, we fully anticipate that the electric light will become at least as common on shore as afloat.

At this point we may also refer to the fact that the Brush Corporation has for some time been devoting special attention to the subject of the electrical transmission of energy, and particularly to electric traction. An arrangement has just been concluded by which they will have an opportunity of showing what can be done in this direction upon a large scale. We are unable to go into details at the present moment, but we may say that the scheme contemplates the use of electric traction upon a tramway some 10 miles in length, traversing a very hilly district, with grades and curves of the most severe character. An overhead conductor will be employed, and each motor will be constructed to develop more than 20 horse-power. We have every confidence that the scheme will be brought to a highly successful issue.

As an illustration of the extent to which the machinery and appliances which we have now briefly described is capable of dealing with a very large amount of work in a remarkably short time, we may quote an instance which has quite recently occurred. On the 23rd February an order was received from the Australasian Electric Company for 1,000 Brush arc lamps, 40 Brush dynamos, and 7 Victoria dynamos each of 3,000 20 candle-power lamps capacity, a condition being made that a guarantee should be given that the whole of the plant would be shipped within two months, it being required for the lighting of the Melbourne Exhibition. It so happened that very few Brush lamps were in stock at the moment, owing to demands for the exhibitions at Glasgow, Brussels and elsewhere, and of the Brush machines required only six or seven were then in stock. The order was, however, immediately accepted, and duly carried out within the specified time, and the plant is now at work lighting the Melbourne Centennial Exhibition. It will be evident to all that to obtain such results as these demand not merely adequate mechanical appliances, but also a highly skilled and intelligently organised staff, accompanied by the most careful supervision of detail. It is to the perfection of these minutiæ, and the development of the commercial side of its organisation, that this company has devoted itself during the comparative lull of the past few years.

It would, however, be of little avail for a firm to keep in touch with scientific progress if its organisation were such as to render the economical execution of contracts impracticable, and this is just what the officers of the Brush Corporation have so fully recognised. What may be called the economics of electric engineering find full application in the establishment of the Brush Corporation. This is exemplified by the fact that the volume of the Corporation's transactions is now nearly three times greater than it was five years ago, while the aggregate expenses of management have been reduced by over 40 per cent. This absolute reduction in the expenses of the establishment is the more surprising and creditable when it is considered what a large amount of work has been done which has not been remunerative in the past, and which has been incurred solely with the object of facilitating future operations, and making them more profitable. The records in the possession of the Brush Corporation show that the company has, during the past few years, laid open much new ground in various important branches of the electrical industry, and it naturally looks forward to reaping a

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good harvest now that the conditions of the business have improved, while the careful analysis of cost of manufacture of a large variety of articles will enable the company to enter into close competition for orders without any uncertainty as to the result. The processes of manufacture are carried out in a systematic and economical manner, and there is much in the methods adopted for registering material and labour which is both instructive and interesting.

What strikes one more especially is the general thrift and absence of extravagance, and this is attributable in a large measure to the *esprit de corps* existing among all the *employés* of the Corporation. We have before us a striking evidence of this in the form of a neat set of rules for the Sick Benefit Club for the workmen, which has been spontaneously formed by the officers acting in concert with the men. We understand that there are close upon 200 regular subscribers to this club, and a reserve fund which has been created entirely by voluntary contributions by the staff and directors amounts to a very respectable figure, and affords a guarantee that in no case of sudden demand upon the funds of the club will there be serious risk of claims not being satisfied.

Another interesting feature is the adoption of the principle of participation in profits, which was sanctioned by the shareholders some little time back, upon the recommendation of the directors. This is not merely a scheme by which a few favoured officers receive commission corresponding to the business done, but is an instance of the true principles of co-operation being put into practice. Every officer who qualifies himself under certain general rules is eligible to be nominated as a participant. The arrangement is that a sum equal to 10 per cent. of the dividends is set aside as a fund to be divided in proportion to salary among the officers from time to time nominated by the Board. In this way the interests of the staff are made identical with those of the proprietors, and the experience of the past affords every reason for satisfaction with the operation of the plan.

The Brush Corporation, it will be seen, has shown much commercial enterprise and initiative, not only in the direction above indicated, in the admission of pupils and apprentices into the factory, or other internal affairs, but also in their efforts to develop the electrical industry in this country.

It is well known that the first practical steps taken with a view towards amending the Electric Lighting Act were initiated by the Brush Corporation, and that the Bill which has just received the Royal assent was successfully piloted through Parliament by the chairman of the Corporation.

Another reform which has received less attention, but which will be of much pecuniary advantage to electrical firms generally, namely, the re-classification of railway freights, was also largely brought about by the efforts of this company.

The introduction of the purchase hire system into this business has also done much to promote the extensive adoption of electric lighting. Firms who have been deterred from expending capital in introducing the new illuminant were enabled to do so by the facilities thus afforded them, and in this way the electric light has been more extensively advertised, and increased demands for it have arisen. We can only express surprise that other firms have been so slow to follow the example thus set them.

It would be impossible for us to dwell upon these and other matters at greater length, but we felt that a sketch of the company's work and resources for undertaking large contracts would not be complete without some notice of the important commercial features of its organisation which have so largely contributed to placing the Corporation in the position it now occupies.

Auckland, N.Z.—The Thomson-Houston Electric Company of Boston appear to be anxious to secure a footing in New Zealand. They are now endeavouring to promote a local company in Auckland, with a capital of £12,000, under the title of the Grey-Brumner Electric Company, to light the wharves and streets of that city.

ON THE THEORY OF LIGHTNING-CONDUCTORS.*

BY PROF. OLIVER J. LODGE, D.SC., LL.D., F.R.S.

That a condenser discharge is oscillatory has been known ever since 1858, when Sir William Thomson's great Paper "On Transient Currents" appeared. Quite recently it has been recognised, first quite explicitly perhaps, by Mr. Heaviside, in *The Electrician* for January, 1885,† that rapidly alternating currents confine themselves to the exterior of a conductor;‡ and Lord Rayleigh (*Phil. Mag.*, May, 1886) has developed an expression of Maxwell's so as to give the real resistance and inductance of a conductor for any frequency of alternation.

I propose to apply these considerations to the case of a lightning-flash.

A lightning-flash is the discharge of a condenser through its own dielectric, and is more analogous to the bursting or the overflow of a Leyden jar than to any other laboratory phenomenon. The condenser-plates may be two clouds, or they may be a cloud and the earth. The discharge occurs mainly through broken-down air, but a lightning-rod may form a part of its path.

The particular in which lightning transcends ordinary laboratory experiments is difference of potential or length of spark. The quantity of electricity is very moderate, the capacity of the condenser is quite small, but the potential to which it is charged is enormous. Flashes are often seen a mile long, and there is said to be a record of one seven miles long. Allowing 3,000 volts to the millimetre, a mile-long spark means a potential of 16 million electrostatic units.

The capacity of a condenser with plates a square mile in area and a mile apart is roughly about $\frac{2}{3}$ of a furlong, or, say, 10^4 centimetres.

The energy of such a condenser charged to such a potential is enormous, being over 10^{20} ergs, and there is no need to assume that so much as a tenth of this is ever dissipated in any one flash.

We may not be far wrong if we guess the capacity emptied by a considerable flash as about 10 metres, or one-thousandth of a microfarad. The total *charged area* is commonly much greater, but it is not all well connected, and it does not discharge all at once.

[The author proceeds to calculate the self-induction of the discharge under certain probable assumptions. We know first that the discharge will be of an oscillatory character§ if the total resistance of the path be not greater than L/S, L being the self-induction coefficient and S the capacity, or, as Mr. Heaviside calls it, the permittance. It is then shown that the critical resistance R_0 below which the discharge is oscillatory may be approximately expressed by

$$R_0 = 120 \frac{h}{b} \sqrt{\left(2 \log \frac{b}{a} - 1\right)} \text{ ohms} \quad . \quad . \quad . \quad (1)$$

where h is the height of the cloud, b the radius of the area which is discharged by the flash, and a the radius of the channel occupied by the flash. If the path is a metal rod, then a is the sectional area of the rod.]

And inasmuch as in practice h is likely to be much greater than b, and b much greater than a, this is a big resistance, which is not likely to be exceeded by the discharger. For if the line of discharge is a metallic conductor, a is moderate, but then so is R: whereas if the flash occurs through air, and it is not easy to say what the equivalent R is, then a must be considered extremely minute.

Suppose h to be a mile, b 50 metres, and a a millimetre; R_0 comes out about 15,000 ohms.

I think we shall be right in saying that this far exceeds any reasonable value that can be attributed to the resistance met with by a disruptive discharge. It is generally supposed, indeed, that

* Abstracted from the *Philosophical Magazine*, August, 1888.

† See also *Phil. Mag*, August, 1886, *et seq.*

‡ It is not possible, I think, to give Mr. Heaviside the credit of the original discovery of this theorem (though, doubtless, he discovered it for himself), for it had been virtually anticipated by so many persons. Not counting a wide general mechanical theorem of Sir William Thomson, which may be held to include this as a special case, a great part of it is clearly indicated by Clerk-Maxwell in his Paper in the *Phil. Trans.* for 1865. It then reappears in a more or less developed form in several Papers of Lord Rayleigh, specially perhaps that in the *Phil. Mag.* of May, 1882; and it is clearly stated for electrical oscillations in a spherical or cylindrical conductor by Prof. Horace Lamb (*Phil. Trans.*, 1883). There are also several papers by Oberbeck, the references to which I am unable to give just now. It is certain that all these philosophers had the data at command, and could at any time have constructed the completely explicit statement; but it may be held that none of their *actual* statements were quite so explicit as that of Mr. Heaviside in 1885. It is well known that some ingenious experiments of Prof. Hughes first excited public interest in the matter and quickened the mathematical abstraction into life.

§ The student may be referred to Dr. Fleming's exposition of this subject in *The Electrician* of May 11th, page 6.

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a conductor and earth must have a resistance of only a few ohms, unless they are to form a considerable portion of the whole resistance a flash meets with.

[The author next shows that when the resistance of the path R is greatly less than R_0, the frequency of the oscillation is very great, "being usually something like a million a second more or less." But it has been shown by Lord Rayleigh* that with excessive frequencies of alternation, owing to the circumferential distribution of the current in the conductor, the resistance assumes a greatly modified value. If R be its ordinary amount, the new value R′ may be written

$$R' = \sqrt{\{\tfrac{1}{2} n h \mu R\}},$$

where n is the frequency, and μ_0 the permeability. Or, taking the permeability of the conductor the same as that of the space outside, this becomes

$$R' = \frac{1}{2u}\sqrt{(R R_0)}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Where $u^2 = \log \frac{b^2}{a^2} - 1$; the author believes that in practice u may be a number not greatly differing from 4 or 5. The actual resistance is, therefore, some fraction, something like, say, an eighth of the geometric mean of the ordinary resistance of the conductor and the critical resistance.

Under the same circumstances it is shown that the modified coefficient of self-induction L′ takes the form

$$L' = \mu h u^2 + \frac{R'}{n}.$$

But for very high frequencies the second term is negligible, and then L′ = L, or the normal value of the coefficient again holds good.

Now for condenser discharges, the impedance, instead of taking the sinusoidal form, or $\sqrt{(R'^2 + n^2 L'^2)}$, has the value $\sqrt{\left\{\frac{3}{4} R'^2 + \frac{L'}{S}\right\}}$. Here the second term is so much the larger that it is the only one that matters, and so

$$\text{impedance} = n L' = n L = n \mu h u^2 = \tfrac{1}{2} R_0 = \sqrt{\frac{L}{S}},$$

or

$$\text{impedance} = 60 \frac{h}{b} \sqrt{\left(2 \log \frac{b}{a} - 1\right)} \text{ ohms.} \quad . \quad . \quad (3)]$$

The total impedance, therefore, to a condenser discharge is half the critical resistance which determines whether the discharge shall be oscillatory or not; it has no important connection with the ordinary resistance of the conductor; neither does it depend appreciably on the magnetic permeability of its substance.

Hence, so long as the specific resistance of the conductor does not rise above a certain limit its impedance depends almost entirely upon the amount of space magnetised round it and upon the capacity of the discharging condenser, and is barely at all affected either by the magnetic permeability or the specific resistance, or even the thickness of the conductor. The one thing that does matter is its length. True, the diameter of the conductor does appear in the expression for impedance, but only under a logarithm; hence the effect of varying the thickness is only slightly felt.

Thus, then, we find that a lightning conductor offers an obstruction to a discharge as great as what a resistance of several thousand ohms would offer to a steady current of corresponding strength, the actual obstruction being given by equation (3).

Another way of putting the matter, is to say that for the first few oscillations the damping term, * * * has no appreciable effect; and that, accordingly, the E.M.F. applied to the conductor alternates rapidly from V_0 to $-V_0$ and back again.

But V_0 is the initial potential of the condenser, diminished (so far as the conductor is concerned) by the E.M.F. needed to jump whatever thickness of air it has jumped before reaching the conductor. Hence this V_0 may be something quite comparable to the potential needed to jump through air all the rest of the way, and it may depend on a mere nicety whether it prefers the conductor or not.

Thus arises the difficulty experienced in helping a jar to overflow by means of discharging-tongs brought near the two coatings. Sometimes the flash will make use of the tongs, sometimes it will prefer to go all the way through air; the fact being that the obstruction offered by a metal requires a large portion of the potential needed to break through a corresponding length of air. Undoubtedly the metal rod offers some advantage, but it is much less than has been usually supposed.

During the instant of discharge, therefore, the upper part of a lightning-rod experiences enormously high potentials in alternately opposite directions. Any conductors in the neighbourhood may easily receive side flashes, and even the bricks into which its supports are driven may be loosened and disturbed; and all this quite irrespective of any question as to the goodness or the badness of the "earth." It becomes, therefore quite a question whether it is not, after all, advisable to try and confine the discharge to the conductor by means of insulators, or whether it is better to reduce the excessive potential by lateral extensions of considerable static capacity. The advantage of sharing the discharge among a number of well-separated conductors, instead of concentrating it all in one, is obvious.

* *Phil. Mag.*, May, 1886.

Theory of Experiments on "Alternative Path."

In a lecture to the Society of Arts (see *Journal* of the Society for 22nd June, 1888, reprinted also in *The Electrician*, 29th June, 1888) I describe some experiments I have made on the E.M.F. needed to force a discharge through various conductors by seeing what length of air-space it will prefer to jump. The original potential of the condenser being able to jump, say, two inches without any alternative path, it remains able to jump, say, 1½in. when offered as an alternative a copper rod a quarter of an inch thick and six or seven yards long. This gives a rough notion of the kind of results obtained, and it shows that the extremities of the rod experience almost the whole of the original E.M.F. of the condenser.

Some experiments on much the same lines had been previously made by Prof. Hughes and M. Guillemin (see *Comptes Rendus*, 1886, *Annales Télégraphiques*, 1865,* Address to Society of Telegraph-Engineers, 1886); but they used a fine wire instead of an air-space, and tried what conductor would protect the fine wire from being deflagrated.

Under these conditions the experiment is practically a comparison between the impedances of two conductors, one of which has its inertia term the bigger, while the other has its resistance term the bigger. * * *

The complete solution for a case of divided-circuit condenser-discharge is by no means simple.

The experiment with an air-gap as the alternative path is better; because one may be sure then that *none* of the discharge chooses that path, when it is properly adjusted for its sparks just to fail.

Liability of Objects to be Struck.

There are also described in my lecture to the Society of Arts, above-mentioned, some experiments on the liability of objects to be struck. A distinction is drawn between two possible cases:—

(1) Where the air above the object is subjected to a steadily increasing strain till breakdown occurs.

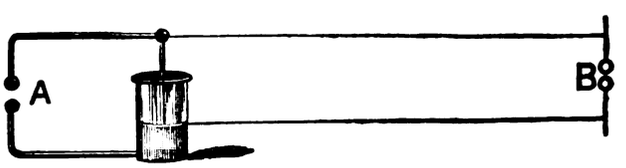
(2) Where the strain is thrown instantaneously upon air and conductors with a sudden rush.

In the first case the path is prepared inductively in the air, and the breakdown occurs at the place where the tension first reaches its limiting value; this is generally on a small knob or surface, and so this is struck and carries off all the discharge independently of its resistance. If its resistance is great the flash may be feeble; if its resistance is small the flash may be noisy; but the place of occurrence of the flash is not determined by these considerations. Glow and brush discharges from points and small surfaces may readily prevent any noisy flash from occurring.

The second case is different. When a sudden rush occurs the discharge shares itself among several conductors in proportion to their impedances, quite independently of any considerations of maximum tension or pre-arrangement of path by induction; so that no distinction is observable between points and large knobs in this case. Points cease to have any protective virtue; they can be struck by a noisy spark as readily as can a knob. The highest object will, in general, be struck most easily, provided its impedance is not very great. If it has a very high resistance it is barely struck at all, and it does not then protect the others.

Experiment of the Recoil Kick.

Among other experiments described in the lectures above-mentioned are some which appear to be of considerable theoretical



interest, wherein a recoil kick is observed at the ends of long wires attached by one end to a discharging condenser-circuit.

This diagram shows the arrangement.

The jar discharges at A in the ordinary way, and simultaneously a longer spark is observed to pass at B at the far end of two long

* *See* also a translation in *The Electrician*, July 13th, 1888, p. 305.

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leads. Or if the B ends of the wire are too far apart to allow of a spark, the wires glow and spit off brushes every time a discharge occurs at A.

The theory of the effect seems to be that oscillations occur in the A circuit with a period

$$T = 2\pi\sqrt{(LS)},$$

where L is the inductance of the A circuit, and S is the capacity of the jar. These oscillations disturb the surrounding medium and send out radiations, of the precise nature of light, whose wave-length is obtainable by multiplying the above period by the velocity of propagation.

This velocity is known to be

$$v = \frac{1}{(\sqrt{\pi K})};$$

so the wave-length is

$$\lambda = vT = 2\pi\sqrt{\left\{\frac{L}{\mu}\cdot\frac{S}{K}\right\}}. \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Now, $\frac{L}{\mu}$ is the electro-magnetic measure of inductance, and $\frac{S}{K}$ the electrostatic measure of capacity. Each of these quantities is of the dimension of a length, and the wave-length of the radiation is 2π times their geometric mean.

The propagation of these oscillatory disturbances along the wires towards B goes on according to the following laws :—

Let l_1 be the inductance per unit length of the wires ; let s_1 be their capacity, or permittance as Mr. Heaviside calls it, per unit length ; and let r_1 be their resistance per unit length.

Then, for the slope of potential along them, we have

$$-\frac{dV}{dx} = l_1\frac{dC}{dt} + r_1 C, \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and for the accumulation of charge, or rise of potential with time,

$$-\frac{dV}{dt} = \frac{1}{s_1}\cdot\frac{dC}{dx}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

These are equations to wave-propagation, and will give stationary waves in finite wires of suitable length, supplied with an alternating impressed E.M.F.

The solution for a long wire, for the case when r_1 is small and the frequency big*, is

$$V = V_0 e^{-\frac{m_1 x}{n_1}} \cos n\left(t - \frac{x}{n_1}\right). \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where $m_1 = \frac{r_1}{2l_1}$, and $n_1 = \frac{1}{\sqrt{(l_1 s_1)}}$.

The velocity of propagation is therefore n_1, and the wave-length is $\frac{2\pi n_1}{n}$.

Now, for two parallel wires, as in the figure,

$$l_1 = 4\mu\log\frac{b}{a} + \frac{r_1}{n},$$

and

$$s_1 = \frac{K}{4\log\frac{b}{a}},$$

while r_1 = the geometric mean between its ordinary value and $\frac{1}{2}n\mu_0$;

where the μ and K refer to the space outside the substance of the wires, μ_0 refers to their subtance, a is their sectional radius, and b their distance apart.

The second term of l_1 is, we have seen, practically zero for these high frequencies. Hence (n_1) the velocity of propagation of condenser-discharges along two parallel wires is simply the velocity of light, the same as in general space ; because $l_1 s_1 = \mu K$.

The pulses rush along the surface of the wires with a certain amount of dissipation, and are reflected at the distant ends ; producing the observed coil kick at B. They continue to oscillate to and fro until damped out of existence by the exponential term in (7). The best effect should be observed when each wire is half a wave-length, or some multiple of half a wave-length, long. The natural period of oscillation in the wires will then agree with the oscillation-period of the discharging circuit, and the two will vibrate in unison, like a string or column of air resounding to a reed.

Hence we have here a means of determining experimentally the wave-length of a given discharging circuit. Either vary the size of the A circuit, or adjust the length of the B wires, until the recoil spark B is as long as possible. Then measure and see whether the length of each wire is not equal to $\pi\sqrt{\left(\frac{L}{\mu}\cdot\frac{S}{K}\right)}$.

I hope to communicate some numerical results of observations made in this way to the British Association Meeting at Bath.

It is interesting to see how short it is practically possible to make waves of this kind. A coated pane can be constructed of, say, two centimetres electrostatic capacity, and, by letting it overflow its edge, a discharge circuit may be provided of only a few centimetres electro-magnetic inductance. Under these circumstances the radiated waves will be only some 20 or 30 centimetres long, corresponding to a thousand million alternations per second. Some beautiful diffraction experiments have been described by Lord Rayleigh in a recent Friday evening discourse to the Royal Institution (reprinted in *Nature*, June, 1888), and some of these might be used to concentrate the electro-magnetic radiation upon some sensitive detector—possibly one of Mr. Boys's radio-micrometers, more likely some chemical detector—some precipitate or other that can be shaken out of solution by the impact of long waves, or some of Captain Abney's photographic agents.

Certainly the damping-coefficient R/2L is high, and the radiation has a very infinitesimal duration ; but a rapid succession of discharges can be kept up by connection with a machine.

No doubt much shorter waves still may be obtained by discarding the use of any so-called condenser, and by causing the charge in a sphere or cylinder to oscillate to and fro between its ends, as might be done by giving it a succession of sparks. These oscillations, it is to be feared, however, would have too small energy to be detected by ordinary means. If they could be made quick enough to affect the retina, no doubt we could detect them with the greatest ease ; but it is manifest that this can only be done by reducing the circuit to a size less than the wave-length of light. The wave-length of the electrical radiation is six times the mean of the inductance and capacity, and each of these quantities is very comparable with the linear dimensions of the conductor concerned. By setting up electric oscillations in a body as small as a molecule no doubt they would be rapid enough to give ordinary light-waves, but the probability is that this is precisely what light-waves are.

Either the atoms are made to vibrate relatively to the æther, by the effect of heat, and so to produce radiation ; or else electrical oscillations are set up in comparatively quiescent atoms, not by heat but by the impact of radiation from other sources, or by some organic process set in play by living protoplasm.

It is thus I would seek to explain phosphorescence and other direct production of light from cold sources.

This direct production of light we have not yet learned artificially to accomplish ; we can only heat bodies and trust to their emitting light in some unknown manner as a secondary result ; but the direct process has been learnt by glowworms and Notilucæ, and it is for us, I believe, one of the problems of the immediate future.

University College, Liverpool, July 7, 1888.

Postscript.—Since writing the above I have seen in the current July number of Wiedemann's *Annalen* an article by Dr. Hertz, wherein he establishes the existence and measures the length of æther waves excited by coil discharges ; converting them into stationary waves, not by reflection of pulses transmitted along a wire and reflected at its free end, as I have done, but by reflection of waves in free space at the surface of a conducting wall.

My friend Mr. Chattock has also written to me about a recent experiment exhibited to the Physical Society, I do not know by whom, which shows that the same discharge as can excite æther waves a kilometre long, can excite air waves of one millimetre. The whole subject of electrical radiation seems working itself out splendidly.

Cortina, Tyrol, July 24th, 1888.

* Mr. Heaviside has treated the problem in a much more general manner, see *Phil. Mag.*, 1888, especially February, 1888, p. 146.

BOOKS, &c., RECEIVED.

"Our Cable Communications." By. S. VYLE, Government Electrician. (Reprinted from *Timehri*, the Journal of the Royal Agricultural and Commercial Society. Georgetown, Demerara.)

"Éléments et Méta-Éléments." Translation of a Paper read before the Chemical Society of London by Mr. Crookes, F.R.S. (Paris : Gauthier-Villars et Fils.)

MESSRS. ELWELL-PARKER'S EMPLOYÉS.—On Saturday last the workpeople of Messrs. Elwell-Parker (Limited), Commercial-road, Wolverhampton, including the electricians, clerks, and draughtsmen, to the number of over 200, held their annual excursion at Bridgnorth. Mr. Thomas Parker (managing director) and Mr. Walton (secretary) were present. Mr. T. Parker, in responding for the firm, said it seemed that the confidence of the people in electricity was being gained, and it needed no prophet to see that the beginning of the prosperous days of electricity were not far distant.

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SCIENCE IN COURTS OF JUSTICE.

So much of the valuable time of the Courts of Justice lately has been taken up with law suits relating to rival inventions that something very like a scandal has been created, and suggestions are being freely made to prevent the growth of an evil which readers of the legal reports in this journal will readily admit is seriously on the increase. A recent article in our contemporary *Nature* has drawn attention to the subject with becoming dignity and impartiality, and with a knowledge of its legal bearings which can hardly fail to exert some influence on all future litigation of the kind under discussion. With its concluding observation, everyone, we take it, will entirely agree : "The orderly and effective administration of justice, the weight which should be attached to judicial decisions, the economy of

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public time, and we would add, the self-respect of scientific men, and the best interests of scientific discovery, all call loudly for some . . . . . reform;" and after careful consideration of *Nature's* suggestions we think it is entitled to say "some such reform as that here suggested."

Briefly stated the proposition is, that the Court shall either make use of the power conferred upon it by the Judicature Act of 1873 to refer the matter in dispute to an umpire or referee; or else that it shall follow the practice of the Admiralty Court, which, on the application of one of the parties to the suit, can call in two Elder Brethren of Trinity House to assist the judge in trying the case. We want, in fact, "sworn scientific assessors in courts of justice to aid unscientific judges in arriving with reasonable despatch at reliable conclusions on matters which demand scientific knowledge." Our contemporary leaves us in little doubt as to which of the two methods would be most satisfactory. For our own part we have no hesitation in expressing a decided preference for the sitting of experts by the side of the judge, a practice which is permitted and generally adopted in what are called Admiralty cases; and we will give our reasons presently. But of course there would be no need to adopt either of these plans if our Patent Laws were framed so that they could be administered judicially. They are, on the contrary, so framed as almost to provoke or invite litigation, while providing no means of settling disputes except in a court of justice which possesses none of the technical knowledge essential to a proper adjudication upon them. As a rule the judge is in the position of Mr. Justice KAY, who, on a recent notable occasion, admitted that he had not had the requisite scientific training to try the case brought before him; and although the event showed that it could not be said of him, it may as a rule be said of most judges that they are at the mercy of the scientific witnesses, who are not slow to instruct the judge in the learning which he lacks. The astonishment created by Mr. Justice KAY's aptitude for learning is proof of its being a quite phenomenal exception to the rule.

It is beyond hope, however, to get the Patent Laws reformed so that the Patent Office shall itself interpret the documents for which it assumes responsibility; and we turn to the other methods of procedure as being the more feasible and attainable. It appears that the committee to which Mr. Justice KAY referred a crucial point in the Edison-Swan *versus* Brush case was in conformity with the powers granted under the Judicature Act already mentioned; and the question naturally arises, Why should he not have referred the main points to them at an early stage of the proceedings? By doing so probably two-thirds of the twenty-one days of the Court's time would have been saved. With the President of the Royal Society as moderator the decision might have been conclusive and final on the whole of the technical points at issue. But we could not count on such an arrangement for every case; and it may be feared that any selection the judge might make of expert referees would be open to objection on the score of their being interested directly or indirectly in the result. Again, it is, we believe, a common experience of litigants who have had their cases sent to umpires or referees that both parties come out dissatisfied. These dignatories are not bound by the strict rules which prevail in the higher courts; and are apt to take a Roger de Coverley view of their functions, namely, to arbitrate rather than adjudicate, there being "a good deal to be said on both sides."

Now, what is wanted above all things is a decisive ruling in cases involving the validity of a patent. A specification either means what the patentee alleges of it or it does not; and there is rarely any room for compromise. A court of justice is pre-eminently the place to try the question, which is mainly one of fact; and when the difficulties of interpreting language have been got over, the legal training of a judge is the best guarantee for a perfectly sound decision. These difficulties, it seems to us, would be easily overcome by following the practice of the Admiralty Judge, who is assisted by two nautical assessors, and who uses their knowledge on all technical evidence, but delivers his judgment independently of them. According to the writer in *Nature*, the 56th section of the Judicature Act of 1873 empowers the High Court or Court of Appeal to call in assessors; and if this be the case there is no reason why the usage of the Admiralty Court should not be followed by the other courts. It is greatly to be hoped that when the next technical dispute is carried to a court of law the litigants will agree to put this legal question to the test. Both parties would be gainers by the enormous saving of time and expense which the presence of scientific assessors would ensure, and no one would lose anything by having his claims listened to by a competent tribunal.

Procedure under these conditions would very likely reduce the number of cases brought up for adjudication; but even patentees may be thankful to have the temptation removed of trying their luck before a non-scientific judge. Patent causes are at present very much in the nature of a lottery, and it is no wonder there are so many of them. There would be fewer if the element of chance were considerably reduced by increasing the competency of the Court. The objection to expert referees apart from the Court would apply with less force to expert assessors sitting all through the trial. Their judicial function would be more pronounced, and the judge might be trusted to weigh their partiality if they betrayed any. What a vast amount of forensic pleading would the Court be spared at the very outset! and what a still vaster amount of technical evidence would be withheld if this practice were adopted! It would be no longer necessary for counsel to instruct the judge; nor would scientific witnesses then venture to hoodwink or to lecture him. We are not disposed to speak too hardly of either counsel or witnesses in these cases. The situation is one which offers direct encouragement to a display of superior knowledge, if not of downright partisanship. For the credit of scientific witnesses, as well as in the interest of justice, a form of procedure such as our contemporary has recommended for technical law suits is much to be desired.

ELECTRICAL TRACTION ON THE INNER CIRCLE.

BY S. EVERSHED.

Ever since the possibility of an economical system of electrical transmission of power became apparent to engineers, the application of electrical traction to railways has been regarded as only a question of time. One railway in particular has always seemed to suffer for want of some economical method of working by which steam locomotives would be dispensed with. In these circumstances it is remarkable that so little progress should have been made during the past ten years. Electrical engineers who deplored the severe check given to their industry by Chamberlain's Act seem to have been unable to divert their stifled energy into a new channel where no oppressive legislation barred the road to success. The reasons for their want of activity are not far to seek, the financial question alone forming an almost insuperable difficulty where steam locomotives are already in use. On the Underground Railway, however, the imperative necessity of dispensing with steam at almost any cost is becoming more apparent every day.

When the chairmen of the Metropolitan and District Railways have settled their microscopic differences, and have arranged so to work their lines as one system, then, and not

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until then, the engineering world may be called upon to apply electrical traction on the Inner Circle line. How will it be done? The ways in which this question will be answered will differ only in detail, since the broad outlines of all strictly engineering schemes would be alike. The writer proposes to discuss here only those points which would be common to every system, entering into details only where such details are of vital consequence. Perhaps it is as well to warn the reader who expects to be introduced to a novel or original idea that he will be disappointed.

The comment just made on the inactivity of electrical engineers should have been made with a reservation in favour of the advocates of the "accumulator" system, who have always been remarkable for their energy and their faith in the system. The writer is a little uncertain whether a recently-advertised scheme is to be taken seriously as another manifestation of the all-devouring promoter, or charitably as a sublime instance of "fools rushing in." In either case it seems desirable to ascertain just what the scheme involves.

The whole world knows that an electric locomotive is being built for use on the Underground Railway; it is to "take its turn regularly with the steam locomotives on the line;" its working expenses are only to exceed those of the present engines by an insignificant amount; it is to carry accumulators sufficient for two trips round the Inner Circle; and although the present engines are said to be 450 horse-power, the electric motor is to be capable of working up to 600 horse-power.

Let us examine this statement in detail. The most efficient secondary cell at present in the market has a normal output of about 100 watts, with a weight of 240lb, but these cells will give 200 watts for a short time without injury to the plates; put it at 250 watts, or one third of a horse-power.

Taking 600 horse-power to mean electrical horse-power at the motor terminals, the motor car will have to carry $600 \times 3 = 1{,}800$ cells! The cells to be used are, however, no doubt of a *much-improved* type, and probably not more than two-thirds the dimensions of the cells now in the market; but even if we reduce each cell to $1\frac{1}{2}$ cubic feet they would, if put in a row, extend some 600 yards. 2,700 cubic feet implies a box 14ft. each way, packed full of accumulators. The imagination reels at the thought of such a tumulus of lead and acid rushing round the Inner Circle.

Those accumulators which are within the writer's limited experience weigh approximately 120lb. per cubic foot when the cells are packed in close order, and any improvement in the direction of increased output and durability would probably increase the weight per unit volume. Let us be merciful, and put down the weight at only 100lb. per cubic foot—alas! the tumulus will weigh 120 tons.

The timid shareholder will want to know what all this is going to cost? The present price of accumulators may be taken at £40 per horse-power, but as the motor's cells are to be worked at $2\frac{1}{2}$ times the normal rate they may be put at £16 per horse-power, or a total of $600 \times 16 = £9{,}600$. The makers ought to allow a liberal discount to a customer using cells on such a colossal scale, and it is only reasonable to deduct 50 per cent. from the account, and let it stand at £4,800. It may be remarked in passing that a heavy tank-engine costs from £2,500 to £3,000.

One of the charms of the "system" is that the wages of one stoker are saved on each train; on the other hand, maintenance of the tumulus at 10 per cent. = £480 = 7 stokers. Again, we must allow 3 battery men to look after 1,800 cells, and if we write 3 battery men = 3 stokers we have a net *increase* of 9 stokers per train! These locomotives being made of sufficient capacity for two trips, or one and a-half hour's actual work, the cells will presumably require at least two hours for recharging (a daily paper, noted for its scientific propensities, puts the time for recharging at ten minutes!), and consequently each steam locomotive will be replaced by *two* electrical ones; or, to be exact, there must be two sets of cells per train, which brings the capital account to £9,600 and the depreciation account to £960 per annum per train.

The only reasonable quantity in the whole scheme is the coal consumption, for, take 1·5lb. per 1 horse-power-hour as the consumption of the fixed engines, ·7 as the efficiency between I. h.-p and E. h.-p. at dynamo terminals, ·7 again for accumulator efficiency, ·9 for motor, and ·8 for gearing, and the consumption works out at about 4lbs. per horse-power delivered to the wheels, a consumption which probably does not differ much from that of the present engines.

It is stated that the engineers of the scheme have had some difficulty about working the vacuum brake. It is a difficulty. A store of vacuum is required to work the "plain vacuum" brake, unless an electric ejector is at hand; but why not try the locomotive on a District train using the non-automatic Westinghouse brake, requiring a small pump and a reservoir of a few cubic feet capacity on the locomotive? It would be a pity to delay the trials for such a trifle as want of brake-power when the horrible doubt is rising in some sceptical minds, "Will a brake of any kind ever be required on that locomotive?"

To sum up. It is proposed to employ an electric locomotive costing over £9,000, weighing over 100 tons, and requiring one driver and the equivalent of nine stokers to work it, to say nothing of the charging plant. Clearly the accumulator system is not in the category of the strictly engineering schemes which we set out to discuss.

Although the advantages of electrical traction on an underground railway are obvious, the conditions necessary for its successful application to the Metropolitan Railways are not too well understood. The conductor system of electrical traction is working successfully wherever it has been carried out rationally. No difficulty on this score is likely to be felt on the Inner Circle. Again the gearing problem has received many more or less successful solutions, and the difficulties met with on the Inner Circle will be those arising from the application of apparatus hitherto used only on a small scale to the necessities of a full grown railway on which the traffic is at times exceptionally heavy.

The Inner Circle will probably be worked electrically long before the numerous extensions are able to dispense with steam. The managers will have to choose between the present system of running trains from the city to the suburbs—in which case steam locomotives must take the electrical trains, motors and all, over the extensions—and running separate extension trains from the points of junction with the Inner Circle, and introducing a frequent service of light electric trains on the Circle itself. The writer is inclined to think the public would soon find the disadvantage of changing at the junctions outweighed by the gain from greater punctuality and quickness consequent on the adoption of the latter system, there being nothing to interfere with the absolute regularity of the Circle trains. To ensure popularity, the number of the new Circle trains must be at least as great as the total number of trains on the line at present. If 28 trains are put on each rail they will run half a-mile apart (the length of the Circle being 14 miles), and at the present speed of 12 miles per hour, inclusive of stops, the trains will follow each other at intervals of $2\frac{1}{2}$ minutes. The inner and outer rails will require the same number of trains on an average taken over a whole day, so that motive power must be provided for something more than the average requirements of 56 trains. But the discussion of the correct basis for the calculation of the total power required must be reserved until the maximum and average power required per train are determined.

Each train might be made up of four light cars of a similar type to the bogies used by the Metropolitan Company, but of lighter construction; the present rolling stock seems needlessly heavy for speeds which average 15 miles per hour. The dead weight of modern passenger stock often amounts to as much as ·4 ton per passenger, and is seldom less than half this amount, whereas in tramcars the dead weight does not usually exceed ·05 ton per passenger, or perhaps ·1 ton where no outside passengers are carried. Now, although tramcars are designed for one-half the speed of the underground trains, the hard and uneven road bed over which these light cars run must subject them to far more serious strains than are experienced on the elastic and comparatively even permanent way of such a line as that under consideration. The writer will, however, assume the cars to weigh ·2 ton per passenger. A train should be capable of seating at least 300 passengers

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(some of the present trains would carry nearly 400), so that the dead weight, exclusive of motors and gear, will be 60 tons. The mean passenger may be put down at ·06 ton, the maximum live load being 18 tons. If 10 tons are allowed for motors and gear the whole train weighs 88 tons. It will be safe to provide power for 100 tons.

Each train has to perform the following cycle every 2½ minutes:—20sec. stopping at station, 20sec. to reach full speed of 15·6 miles per hour, 100sec. run at this speed and 10sec. to bring the train to a stand at the next station—a total of 150sec., or 2½ minutes. The maximum work done is during the 20sec. allowed to reach full speed, and is made up of the work stored as momentum + work done against friction + work done against gravity. The energy is stored at the rate of $\frac{100 \times 23^2 \times 3}{2 \times 32 \cdot 2} = 2{,}470$ foot-tons per minute, or about 168 horse-power.

Tractive resistance at low speeds is about 10lb. per ton, to which 5lb. should be added for curves, which are the rule on the Inner Circle, and the work done in overcoming friction is therefore $\frac{100 \times 15 \times 230 \times 3}{33000} = 31 \cdot 4$ h.-p. Lastly, to start up a gradient of 2 per cent., say, requires $\frac{100 \times 2240 \times 4 \cdot 6 \times 3}{33000} =$ 93·5 h.-p.

Thus for $\frac{1}{2} M v^2/t = 168$ horse-power is wanted.

„ friction = 31·4 „ „

„ gravity = 93·5 „ „

Total.....292·9

We will put this figure at 300 horse-power. This, then, is the maximum power a train will require when starting with full load up a heavy gradient and round a sharp curve. It is not the actual maximum which the train motors will be required to develop, however, as no allowance has been made for the static friction at starting, but as the effort to overcome it lasts for a fraction of a second only, it is more a question of the mechanical strength than of the output of the motors.

(To be continued.)

REVIEWS.

Applications of Dynamics to Physics and Chemistry. By J. J. Thomson, M.A., F.R.S. (Macmillan and Co., 1888.)

The author states in his preface that this work contains the substance of a course of lectures delivered at the Cavendish Laboratory in 1886, together with an account of some of his later investigations. A considerable portion of it consists of a systematic treatment of a series of researches, parts of which have been published in the *Philosophical Magazine* and in the *Transactions* of the Royal Society during the last few years.

The most important of these were the Papers published in the *Transactions* of the Royal Society for 1885 and 1887, which, dealing as they do with phenomena lying on the borderland between different departments of physics and between physics and chemistry, have hitherto been to a great extent neglected both by physicists and chemists. The principal object which the author has kept in view throughout has been to develop methods of applying the general principles of theoretical dynamics to the investigation, from purely experimental data, of the relations between various physical phenomena. He has succeeded in doing this for a large number of series of phenomena, showing them to be related to other phenomena in such a manner that the existence of either implies the existence of the others, quite independently of the explanations which may be given of them.

The general principle of the methods adopted consists in expressing the properties of a physical system in terms of a single function of quantities, fixing the state of the system. The method, due to Lagrange, was employed by Clerk Maxwell, in his Paper on "The Electro-Magnetic Field," and is extensively used in his "Treatise on Electricity and Magnetism," and it was applied to thermo-dynamic phenomena by Prof. Willard Gibbs, in his Paper on the "Equilibrium of Heterogeneous Substances."

This function, which has been called the Lagrangian function of the system, is a function of the energy of the system expressed in terms of the variables, equal in number to the number of degrees of freedom of the system, which determine its configuration at any instant, and of the velocities or the momenta corresponding to these variables.

The Lagrangian function assumes its simplest form when the kinetic energy is expressed in terms of the variables, or co-ordinates, and their velocities only, and is then equal to the difference between the potential and the kinetic energies of the system.

The author classifies the different phenomena to be considered into—

1. Reversible vector phenomena.
2. Reversible scalar phenomena.
3. Irreversible phenomena.

In the first class, which include the relations between most of the phenomena of elasticity, electricity and magnetism, the co-ordinates are to a greater or less extent under control, and may be made to assume any values within certain limits.

When scalar quantities such as temperature are involved, the phenomena depend on a multitude of co-ordinates over the individual motion of which no control can be exercised, though their average motion may be controlled to some extent.

In ordinary dynamics the configuration of a system is completely fixed by means of the co-ordinates; but this is not always the case for physical systems; Thomson and Tait have shown, however, that if the kinetic energy of the system can be expressed without certain of the co-ordinates, these co-ordinates may be ignored, and the system may be treated as if it were fully determined by the co-ordinates, in terms of which, together with their differential coefficients, the kinetic energy is expressed.

When the co-ordinates have been chosen the Lagrangian function may be written down in its most general form in terms of these co-ordinates and their differential coefficients. The physical consequences of the existence of each term are then considered, and if any of these are in contradiction with experience it is concluded that the corresponding term does not exist in the expression for the Lagrangian function. Another method of proceeding, which, however, is only applicable to the first class of phenomena, is to take a certain term which experimental results show must exist in the expression for the Lagrangian function, and to develop the consequences of its existence.

When the expression for the Lagrangian function has been simplified as far as possible in the case of any given system the author makes use generally of Lagrange's general dynamical equations, or of Hamilton's principle of varying action, for the investigation of its properties.

In the case of phenomena into which scalar functions enter the value of the Lagrangian function cannot be determined for any given moment, as the mean value only of some of the co-ordinates is known. The mean value of the function is therefore calculated, and as it is shown that for a system in dynamical equilibrium—that is, one in which the motion is steady—the Lagrangian function has a stationary mean value, the conditions of equilibrium of the system can be investigated by applying the methods of the calculus of variations to the mean Lagrangian function.

The portion of the book devoted to the consideration of phenomena which depend entirely or partly on scalar functions will probably, on account of the comparative novelty of the methods employed, excite the largest amount of interest, but some of the author's conclusions in this part of the work appear to us to rest upon somewhat dubious assumptions, and some of his experimental data are, in our opinion, not sufficiently well established for the conclusions based upon them to be accepted without further confirmation. Even in these cases,

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however, the methods employed are most interesting and suggestive, and as the sources from which the data are taken are invariably indicated, the reader will be able to form his own opinion of their value. It will be impossible within the limits of a review to do more than give a few examples of the results obtained, but these may perhaps help to induce those of our readers whose mathematical training has been carried beyond the elementary stage to obtain the book and study it for themselves. If they do so they may rest assured that they will not regret the time spent on it; and even if they are not mathematicians they will find a mass of information of great interest which otherwise they could obtain only by extensive search through recent scientific literature, together with numerous suggestions of subjects for experimental research.

Wiedemann has shown (*Electricität*, Vol. III., p. 689) that when an electric current flows along a longitudinally magnetised wire it produces a couple tending to twist the wire. The consideration of the term in the Lagrangian function indicated by this phenomenon shows that when a longitudinally magnetised iron wire is twisted an E.M.F. will be produced which will last as long as the twist is changing, and any alteration in the longitudinal magnetisation of a twisted iron wire will produce an E.M.F. lasting as long as the magnetisation is changing. The former result has been experimentally verified. The second result shows that Faraday's rule that the E.M.F. round a circuit due to induction is equal to the rate of decrease in the number of lines of force passing through it will not apply to the case of a twisted iron wire, for an E.M.F. might be produced by moving it in the plane of the magnetic force.

It is shown that if the electromagnetic theory of light is true the existence of the Hall effect leads to the result that a circularly-polarised ray of light must produce a magnetic force in the direction of its propagation, but the amount would be too small to be detected experimentally.

Some recent experiments made by Mr. Cassie in the Cavendish Laboratory have shown that the specific inductive capacities of glass and some other dielectrics increase with the temperature, from which it is shown to follow that a piece of glass will be cooled when it moves from a place where the electric force is weak to one where it is strong.

The numerical value of the increase in the case of glass leads to the result that at a temperature of 30°C. the mechanical equivalent of the heat absorbed by a Leyden jar while being charged, if its temperature remains constant, is about two-thirds of the work supplied to it from electrical sources.

A very important result pointed out by the author is that in the case of a thermo-electric circuit the consideration of the heat developed can only give information about the part of the E.M.F. which depends upon temperature, from which it follows that the Peltier effect can throw no light on the absolute difference of potential between two different metals, and therefore that there is nothing in the phenomena of thermo-electricity to lead to the conclusion that the large difference of potential observed by Volta between two different metals in contact is due to chemical action between them and the surrounding medium.

By the consideration of a dynamical analogue to a twisted wire, it is shown that Dr. Hopkinson's experiments on the residual charge in glass prove that glass cannot be homogeneous, but must be composed of a mixture of different silicates.

Blake has shown (Wiedemann's *Electricität* Vol. IV., p. 1,212), that the vapour proceeding from an electrified liquid remains unelectrified. The consideration of the mean Lagrangian function of a liquid and its vapour in contact with each other shows that this experiment proves that the effect of electrification will be to diminish the vapour density, for which there is equilibrium between the liquid and the vapour, and so to increase the tendency of the vapour to become condensed. An electrified drop of rain would therefore be expected to be larger than an unelectrified one, a conclusion which is well known to be in accordance with experience. The influence of dissolved salts and gases on the vapour pressure is also considered, and there is an interesting discussion of the experimentally-observed properties of dilute solutions.

The chapters devoted to the consideration of chemical dissociation, of the general theory of equilibrium, including the theory of mass actions, and of the influence of the physical conditions on the coefficient of chemical combination, are of exceptional interest, as they mark another stage in the slow, but sure advance which is being made in the application of mathematical analysis to the explanation of chemical phenomena, which we have every reason to hope will in time enable chemistry to definitely take up its position as a branch of dynamical science.

The existence of surface tension in gases, for which there is some experimental evidence, leads to the conclusion that in general gaseous chemical dissociation will be facilitated by increasing the free surface of the gas, which would afford an explanation of the manner in which chemical reactions between gases are facilitated by their absorption by such substances as charcoal or spongy platinum.

As the magnetic properties of solutions are very feeble, except in the case of salts of iron, magnetism cannot be expected to have any sensible effect on chemical action except for these salts. In the case of solutions of iron, however, such effects have been observed; for example, when a solution of copper sulphate is placed on an iron plate, copper is deposited and iron dissolved, and if the plate is placed over the poles of a strong electro-magnet, the copper deposit is found to be thinnest where the magnetic force is most powerful—that is, over the poles. The consideration of the Lagrangian function of a magnetic solution leads to the result indicated by experiment, and it can also be shown that any chemical action which produces an increase in the coefficient of magnetisation is hindered by the action of magnetic forces.

If a solution of a salt is placed in a non-uniform magnetic field, it can be shown that if the coefficient of magnetisation increases with the strength of the solution, as is the case for iron salts, the magnetic force will tend to drive the salt from the weaker to the stronger portions of the magnetic field, so that the strength of the solution will be the greatest where the magnetic force is most intense.

A chapter is devoted to the consideration of change of state from solid to liquid, and it contains an interesting discussion of experimental results. The chapter which follows this, and treats of the connection between E.M.F. and chemical change, contains a valuable discussion of the theory of Grove's gas battery, together with some interesting and useful results respecting the relations between E.M.F. and temperature for batteries in which dilute solutions are employed.

The book concludes with a chapter on irreversible effects. The author reminds us that on the assumption that the properties of matter in motion, as considered in abstract dynamics, are sufficient to account for all physical phenomena, the irreversibility of any system must, as was first pointed out by Maxwell, be due to the limitation of our powers of manipulation.

The author then points out that just as we are unable to manipulate very minute portions of matter, so our senses are unable to separate events which follow in very rapid succession, so that we are at liberty, if convenient for purposes of explanation, to treat any phenomenon as the average effect of a series of rapidly changing phenomena of a different kind. He applies this to the explanation of electric resistance, and the consideration of the results of recent experimental investigations leads him to the conclusion that the passage of an electric current is really due to a series of discharges due to the splitting up of the molecules of the conductor. He adduces among other results in favour of this view Dr. Schuster's discovery that the electric discharge passes with great difficulty through mercury vapour, which is supposed to be a monatomic gas, and also the discovery of Hertz, which has recently been noticed in our columns, that the passage of the electric discharge through a gas is facilitated by exposing it to the action of the violet or ultra-violet rays, which, as is well known, have a strong tendency to split up the gaseous molecules. It is pointed out that the experimental evidence tends to show that when the E.M.F. is small the splitting up of the molecules takes place independently of it, but that in case of larger E.M.F.'s the E.M.F. itself assists this splitting up of the molecules.

The differences between metallic and electrolytic conduction

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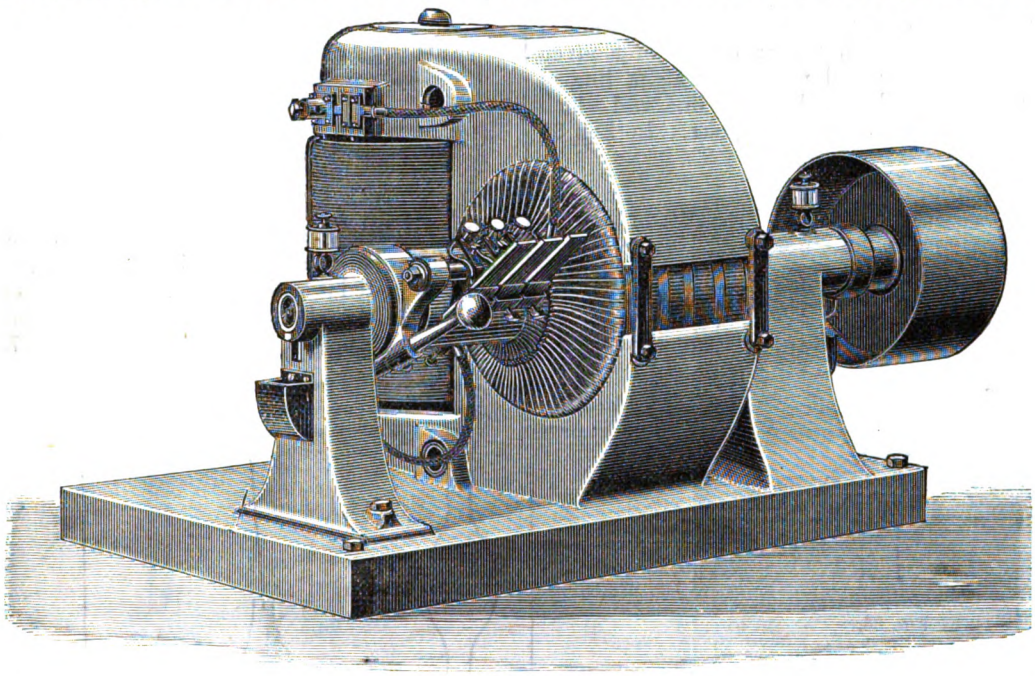
he considers to be merely differences of degree, and to be due to the vastly greater number of molecules taking part in the former. This theory of electrical conduction is shown to give an explanation of the general correspondence between the electrical and thermal conductivities of the metals, and appears to be in accordance with the most recent views on electrolysis.

We cannot conclude without recording our opinion that this work of Prof. Thomson's forms a most noteworthy and important contribution to the literature of mathematical physics and chemistry.

THE "LEEDS" DYNAMO.

In our recent account of the Cadogan Electric Light Company's Central Station, at Chelsea,* we mentioned that the "Leeds" dynamo is employed. As this machine is, perhaps, scarcely as well known as it deserves to be, we give the following additional particulars with which the makers have kindly supplied us :—

The "Leeds" dynamo is manufactured by Messrs. Greenwood and Batley (Limited), of the Albion Works, Leeds.



The "Leeds" Dynamo.

From the adjoining illustration, it will be seen that the field-magnets are of the single horseshoe type, the core of which, placed between the two pole-pieces, forms at the same time the yoke of the magnet. The magnet core is made of specially prepared wrought iron of the best and softest quality, carefully annealed. The massive pole-pieces are made of soft cast iron, and of a form and proportions which have been found in practice to give great steadiness in the magnetic field. The magnetic circuit, it will be noticed, is made as short as possible. The lower pole-piece and bed-plate of the machine are cast in one piece.

The armature is of the cylinder type, with Gramme connections, and is wound with carefully insulated wire. The core of the armature is built up of thin annealed charcoal iron discs, insulated from each other and firmly mounted on the shaft.

The armature has a large cooling surface and thorough internal ventilation. The armature shaft is of Bessemer steel, and revolves in long bearings of special white metal, provided with sight feed lubricators.

The commutator is made of a special metal which is said to possess very great durability. The segments (into one end of which the armature connections are securely soldered) are well insulated with mica plates ; being of a large diameter and great length, the commutator provides a maximum of wearing surface.

The brushes are adjustable in all directions, and the pressure on the commutator is regulated by springs ; the brush holders are provided with an arrangement for maintaining an even pressure of the brushes on the commutator, and also with thumb screws for keeping the brushes from making contact when not in use. The brush holders are attached to a rocker, which is free to move in either direction, backwards or forwards, according to the lead required, and can be readily locked in any position.

The electrical connections outside the machine, as may be seen, are simple and convenient; they are mounted on fibre and attached to the main frame at the most convenient place. All the materials employed are of the best quality, and the workmanship is of that high excellence for which the firm of Messrs. Greenwood and Batley are so well known.

The electrical efficiency of these machines is given as 93½ per cent., which is very high for machines of this E.M.F., especially considering the high current density allowed in the armature.

The following dimensions relate to the type of machine which is now in use at the Cadogan central station :—

E.M.F.	500	volts.
Current	70	amperes.
Speed	800	revolutions per minute.
Ampere turns on field	39,000	
Ampere turns per sq. inch	450	
Total length of magnetic circuit	85	inches.
Section of field-magnets	87	,,
,, iron in armature.	84	
Weight of copper in armature	115	
Watts per lb. of armature copper	305	
Current density in armature	3,750	amperes per square inch.
Length of armature coil	14	inches.
Diameter ,, ,,	18½	,,
Peripheral velocity	3,900	feet per minute.
Number of turns per commutator bar	7	
Number of commutator bars	80	

Air gap 345 sq. in. surface by ·57in. distance from polar surface to armature core.

* See *Electrician*, July 20th, page 334.

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The machines are separately excited, and are regulated by hand to give constant current.

The above numbers will be found to give an induction of about 14·4 Kapp lines per square inch in the armature core.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER IX.—*Magnetic Fields.*

(Continued from page 368.)

121. *Polar and Normal Lines of a Magnet.*—In a similar manner the magnetic intensity at points in the field lying in other directions may be found by the application of the parallelogram of forces and geometrical principles; but the two directions in which we have investigated the strength of field are those in which measurements of the magnet and its field are taken, and, therefore, are enough for our purpose.

For conciseness we shall hereafter designate these two directions the *polar line* and the *normal line* of a magnet. The *polar line* will be understood to mean a straight line of indefinite length passing through the two poles of a given magnet, while the *normal line* will mean a straight line of indefinite length at right angles to the polar line, and which also bisects the distance between the two poles. In Fig. 84

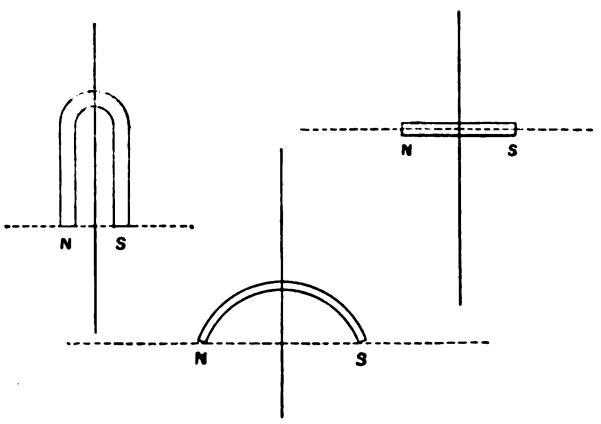

FIG. 84.

three common forms of magnets are shown, their polar lines being dotted, and normal lines shown plain.

122. *The Magnetometer.*—We have already seen (para. 119) that when two magnetic fields of intensities f and H are superposed at right angles to one another at a given point, the ratio $\frac{f}{H}$ is equal to the tangent of the angle between the direction of the field H and the resultant field—that is, the tangent of the angle moved through by a short magnetic needle from its position of rest in the field H. To measure this ratio, then, we require a suspended magnetic needle moving over a scale of degrees by which its movement may be observed. The conditions which are required in such an instrument are

1. Short, well-magnetised steel needle.
2. Long light pointer or mirror attached to same.
3. Long unspun silk fibre to suspend needle and pointer (the length being required to eliminate error due to stiffness or rigidity of fibre).
4. Glass covering over needle and suspension to avoid disturbance by currents of air.
5. Scale divided into natural tangent divisions.
6. Means of accurately levelling.

An instrument for the above purpose is known as a 'magnetometer," and the student will find it an excellent introduction to the theory and use of galvanometers to construct a magnetometer of the simple design here described, and carry out some measurements of magnetic fields with its aid. The following will be found quite simple to make:—A glass funnel, F, of thin glass (Fig. 85) stands inverted on a flat wooden baseboard, B, which should be provided with levelling screws; or a glass flask, with its lower half neatly cut off, answers the same purpose. Through the cork in the neck at the top is pierced a piece of No. 12 copper wire, bent into a ring at its upper end, so that it may be turned round with the finger and thumb, the lower end being filed flat, and a small hole

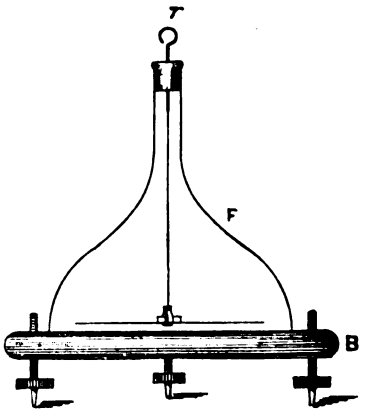

FIG. 85.

FIG. 86

drilled, to which the silk suspension may be tied (Fig. 86). This piece of wire should fit tight in the cork, so that when it is once adjusted it will not slip. The lower end of the silk is then tied to the stirrup. To make the latter stiff note paper does very well, cut to the shape in Fig. 87, the ends being

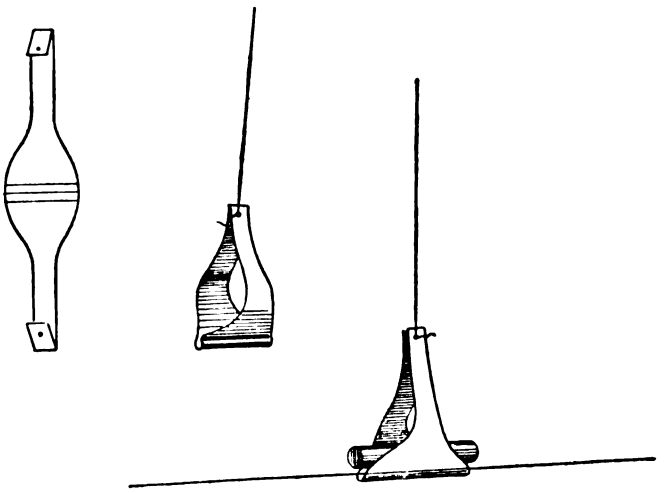

FIG. 87.

folded over as shown to make it stronger, where holes are pierced to which to tie the silk. The three lines across the centre indicate where it should be folded to form a narrow groove at the lower part of the stirrup in which to place the long pointer. This ensures the pointer being in the same line as the needle. The diagram also shows the needle and pointer as mounted in the stirrup. A more durable stirrup may be made in the same way with copper or lead foil. Before mounting the needle and pointer a brass or copper rod about 6in. long should be inserted in the stirrup, balanced, and left for some time till it comes to rest. During this operation the inverted funnel may be lifted off its stand and placed with its edges resting on two supports, so that the hands may conveniently reach underneath to the lower end of the fibre. This process will remove all twist

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from the fibre. Now the top of the fibre should be turned by turning the ring *r* until the length of the brass rod lies in the magnetic meridian, ascertained by its direction coinciding as nearly as possible with that of a compass needle placed close to the instrument. The brass rod may now be removed by the right hand, while the stirrup is held in the left to prevent it turning, and then the long pointer placed in the lower groove and balanced, and the short magnetic needle placed above it.

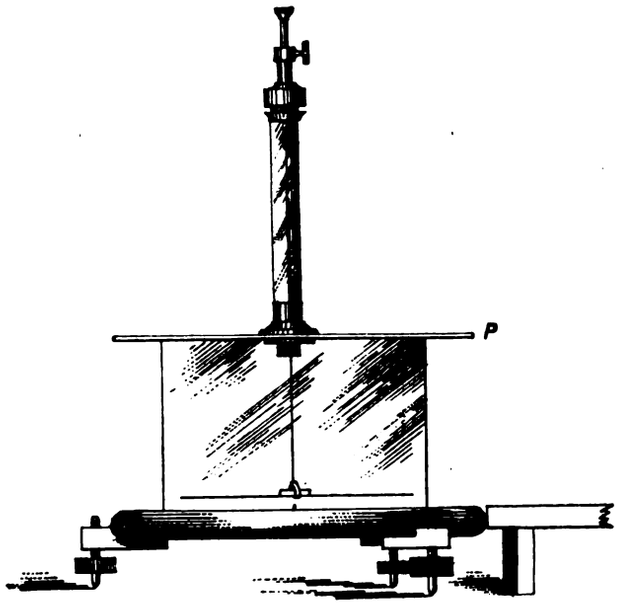


FIG. 88.

The magnetic needle should be about a centimetre long, but not more than 1½ centimetres, and of knitting-needle steel. It requires a little practice to draw out a good, straight, light pointer.

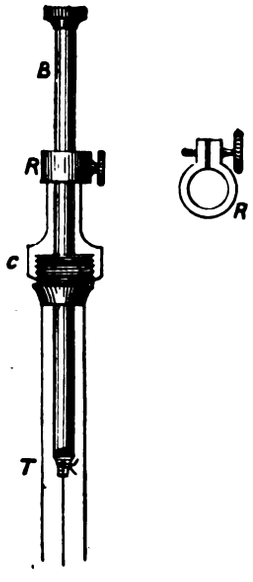


FIG. 89.

Some *thin* glass tubing, about $\frac{3}{16}$in. bore, should be procured, and a piece held by its ends over a Bunsen burner or spirit lamp flame with the two hands, turning it round to heat it evenly in one place till about three-quarters of an inch of it is perfectly red hot, and evenly hot all round. Then removing it from the flame the two ends are pulled, at first quickly, and then slowly, which draws out a fine capillary tube two or three feet long. After pulling out, the fine tube must be kept stretched tight till cool, for if the pull at the ends is relaxed immediately after pulling out, the tube will not cool perfectly straight. The straightest and lightest portion of the drawn tube must now be snipped off to the required length—say, five or six inches, and is then ready for use.

A more elaborate instrument fitted as a magnetometer is shown in Fig. 88, in which the suspension can be controlled with more certainty. The details of the suspension head are represented in Fig. 89, where a tubular brass cap, C, screw-threaded, is cemented on to the upper end of the glass tube T. Above this is a brass tube screwing on at its lower end to the cap C, and carrying at its upper end a split ring, R, through which passes the brass rod B supporting the suspension. The latter may therefore be turned round, raised or lowered as required, and then clamped fast by the screw on the split ring R. The glass tube at its lower end has also a tubular brass cap cemented to it and screw-threaded, a nut on the underside of the circular glass plate P clamping it to the same. A table about 2ft. long and the same height as the baseboard of the instrument will be required for placing magnets on whose fields are to be measured.

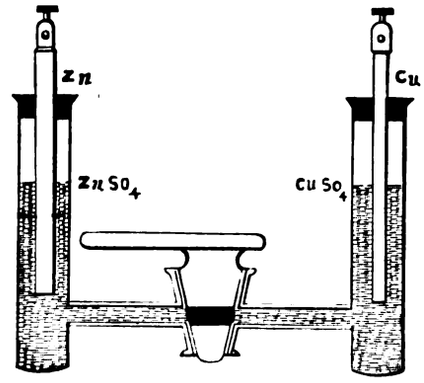
A graduated scale must now be made, by which the movement of the pointer, when the needle is deflected, may be observed. If this is marked out in degrees, the *angular* deflection of the needle will be observed, and the corresponding tangent of the angle must be ascertained from a table of tangents. It is better, however, to graduate the scale in divisions proportional to the natural tangents, the methods of doing which will now be given.

(To be continued.)

ON A CONSTANT DANIELL CELL, FOR USE AS A STANDARD OF ELECTROMOTIVE FORCE.*

BY COSMO I. BURTON, B.SC., F.C.S.

This cell consists of two tubes about three inches long and half an inch in diameter, sealed at one end, and connected together near the closed end by a glass tube about four inches long, having a glass tap in the middle.



The hole through the plug of the tap is filled with plaster of Paris, made as nearly as possible flush with the glass surfaces. This plaster plug serves as a porous septum between the two tubes, which represent respectively the two compartments of a Daniell cell—the one tube containing a copper rod immersed in a saturated solution of copper sulphate, the other a zinc rod in a solution of zinc sulphate, of as nearly as may be the same density as the copper solution. The cell is designed for use only with the quadrant electrometer, and must never be short-circuited.

When the cell is used the tap is turned "on," *i.e*, so that the ends of the plaster plug are opposite the two tubes containing solutions. Immediately that the observations are completed, the tap is turned off, and so diffusion of the solutions completely prevented. The tap is made of the peculiar shape shown in the diagram, in order that it may only be turned in one direction, and so the possible transfer of a minute quantity of the one solution into the opposite tube is avoided.

* From the *Proceedings* of the Royal Society of Edinburgh.

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Several years ago Mr. A. P. Laurie and I used this cell constantly for four months, and during that time it showed no change of E.M.F., as compared with a standard Latimer Clark, readings being made to three figures only. More recently Prof. Ayrton, of the City and Guilds Technical Schools, London, very kindly undertook to compare this cell with a standard Latimer Clark of his own construction, and also with Fleming's standard Daniell. The results of the comparison are given in the following table. E.M.F. of standard Latimer Clark is taken as unity.

On looking at the cell again, about eight months later, the copper wire was found corroded through, and contact broken. In order to avoid this accident, it is well to use copper rod not less than one-eighth of an inch thick, as copper is somewhat soluble in solution of sulphate of copper. (*See* Gray, *Phil. Mag.*, 1886, p. 389.)

Date.	Standard Fleming, E.M.F.	Experimental Cell, E.M.F.	Temperature of	
			Room.	Standard Latimer Clark.
1886.	0·7466	0·7476	18°·2 C.	16°·9 C.
May 13	0·7462	0·7476		
,, 20	0·7505	0·7485	18°·6	16°·1
	0·7500	0·7489	19°·6	18°·1
,, 31	...	0·7509	17°·9	16°·8
Oct. 7	0·7456	0·7468	...	16°·8

The corks used to support the copper and zinc rods should be carefully paraffined, and every precaution taken to prevent evaporation of the solutions.

The observation in the above table dated May 31 was taken rather hurriedly, and Prof. Ayrton considers it untrustworthy. Omitting this result, it is seen that the experimental cell has a very constant E.M.F., and that the change after about five months was very small.

THE REGULATION OF ARC LAMPS.*

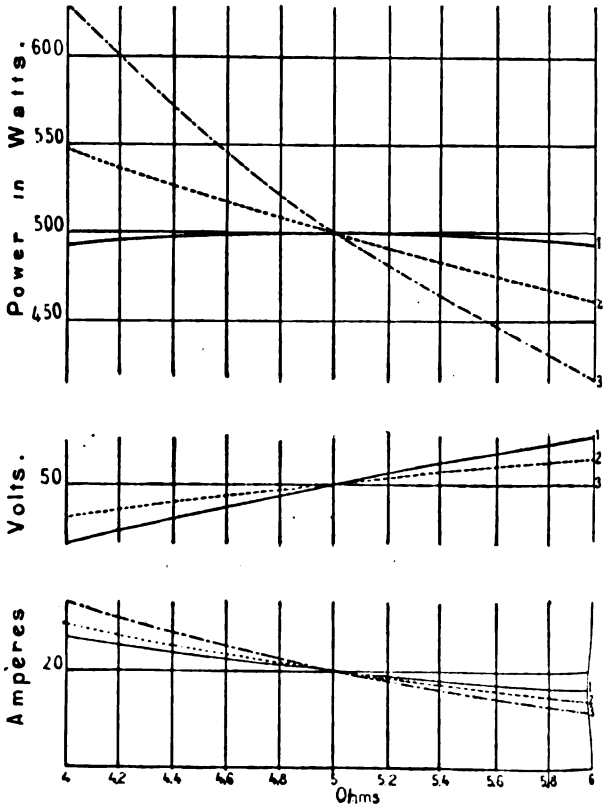
BY M. HOSPITALIER.

It is a matter of common knowledge that arc lamps run off constant potential mains regulate better the greater the difference of potential in the branch; and it is therefore customary to introduce a resistance in series with each lamp. Up to the present time it has, in fact, been impossible to get a steady arc if only that difference of potential is available which is strictly necessary to work the lamps; thus, if 50 volts is the absolute minimum, a tolerably good arc is obtained with 60 volts, and a very good one with 70 volts. Pushing this principle to the extreme, we obtain a perfectly steady arc with a difference of potential of 100 volts, the excess E.M.F. being absorbed by a suitable resistance. The employment of 100 volts with a 5-ohm resistance in series is a method which has been practised with considerable success in exhibition lighting, and it is not to be disdained where steadiness of arc is an absolute essential, as, for instance, in scientific investigations. The part played by this resistance has been misunderstood by some practical men, and consequently we have the erroneous notion that Bunsen cells are *better* suited for arc lighting than secondary batteries. The fact is simply that the internal resistance of a Bunsen battery is equivalent to the resistance which has to be added to the circuit where a secondary battery is used. It is easy to see what part is played by this "electric fly-wheel" by having recourse to diagrams. Suppose it is a question of maintaining an arc under the following conditions:—

Intensity of current C = 10 amperes.
E.M.F. at terminals E = 50 volts.
Power P = 500 watts.

And let us then study the variations of these three factors, when the apparent resistance of the arc, which is normally 5 ohms, varies from 4 to 6 ohms. The consideration of larger variations would not be of much practical use, since even smaller variations than these are quite sufficient to deprive the arc of any pretension to steadiness. In the above diagrams the curves numbered respectively 1, 2, 3 refer to three different sets of conditions. In curve 1 we have a generator giving a constant E.M.F. of 100 volts, the total resistance in circuit, exclusive of the lamp, being 5 ohms. In curve 2 we have a 70-volt generator, the external resistance, exclusive of the lamp, being 20 ohms. In curve 3 we have a 50-volt generator, having a negligible resistance (as in the case of a battery of accumulators) and with no resistance in circuit except the lamp.

On comparing the curves, representing respectively the values of E, C, and P, it is easy to see that with 100 volts at one's disposal all the conditions necessary to good regulation are present; while the exact contrary is the case with 50 volts. What these curves show very plainly is that the power supplied to the arc in case 1 remains sensibly constant as the resistance of the arc varies from 4 to 6 ohms; while if only the strictly necessary 50 volts are available the power supplied to the arc diminishes very rapidly as the arc lengthens, which is the exact reverse of what ought to be, since the arc should absorb more power as it lengthens, in order to compensate for the resultant cooling. These diagrams also show



that a regulator keeping E × C constant is not required in case 1, while it is of great use in case 3. Now the electromagnets which are usually employed only regulate for values of c, but the action of an electro-dynamometer is proportional to C^2; hence, if we could use an electro-dynamometer in lieu of an electro-magnet, we should increase the sensibility of the arrangement and should be able to work satisfactorily, if not with 50, at least with 60 volts, instead of the 70 volts usually employed in cases of mixed distribution. It certainly seems rather wasteful to produce 70 volts at the dynamo terminals and then to use only 50 volts at the most in the arc. The loss thus caused, representing 40 per cent. of the available power, can be reduced by the above device to 20 per cent. The economic advantages of the arrangement are obvious, and we have thought it worth while to call the attention of inventors to this special point of interest.

* From *L'Electricien*.

HUBERT DAVIES' ASTATIC AMMETERS AND VOLTMETERS.

We illustrate below a new form of ammeter that has lately been brought out by the United Electrical Engineering Company (Limited), London, and is the invention of Mr. Hubert Davies.

The chief advantages of ammeters and voltmeters of this type are constancy, non-disturbance by outside influences, and simplicity of construction. The conductor through which the current to be measured passes is wound in two coils, one on each side of the pivot which carries the needle system; but, contrary to the usual practice, these coils are so wound that the current passes round them in opposite directions. The pivot carries a system of two or three small soft iron wire needles, which is capable of turning in

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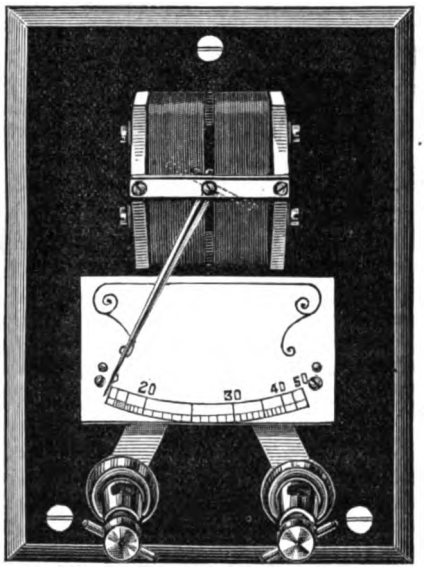
the space along the axis of the coils, and the motion of the needle system is indicated by a pointer attached near the front end of the pivot, which moves over a scale suitably divided. When the instrument is placed vertically on a switch-board or other support, the needle system is kept in a position slightly displaced angularly from the division between the two coils by the action of a suitably-disposed weight on the pivot, and the pointer then lies at the zero of the scale; but if a current is passed through the coils the soft iron needles become magnetically saturated with poles of the same sign at the two ends and a pole of opposite sign at the middle, and the system turns with its pivot, bringing the ends of the needles more into their coils, and their axis more nearly parallel to the magnetic axis of the coils. The amount of this motion is indicated by the pointer on the scale, as in other direct-reading instruments. The fact of the needle system being magnetised so as to have equal poles of like sign at its two ends prevents the instrument from being affected by outside magnetic influences; so much so, indeed, that it may be used quite close to a working dynamo without sensible error in the indications, and this is an advantage possessed by few other instruments. This magnetic arrangement of the needles is similar to that of an astatic galvanometer, except that the needles are practically placed end to end, instead of one above another; hence the name given to the instrument. In ammeters the coils are generally formed of copper strip, except in the very low reading instruments. For currents of 250 amperes and upwards the conductor is a copper casting of very solid construction, and ample section for the current to be carried. The design thus admits of ammeters of very high as well as ordinary ranges being made, and this applies to the voltmeter also.



Hubert Davies' New Form of Ammeter.

The instruments are mounted on enamelled slate bases, with glass-fronted covers, and appear to be reliably made, and particularly suited for switch-board and similar uses.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *July 28th*, 1888.

Telegraphic matters have been occupying considerable attention during the past week. The settlement of the cable war has been generally received with satisfaction, and, in fact, is looked upon as the beginning of a new era. At first a story got afloat, originating on the Pacific Coast, to the effect that Mr. Mackay had disposed of his Commercial cables to Mr. Gould for $11,000,000, and the report found a great many believers. It was, however, very flatly contradicted. The remarkable thing is that so far from Mr. Gould showing any disposition to buy telegraph properties, he is now said, on good authority, to be quite willing to sell them. The whole situation may be said to hinge, viewed from an outside standpoint, on the state of Mr. Gould's health. About this some most remarkable stories have lately been published. Mr. Gould has not been well for some time past, but the newspapers have credited him with all manner of sicknesses; some have even gone so far as to say that his mind has weakened under the load of business worry. One of the Sunday newspapers presented its readers recently with a most graphic account of Mr. Gould's sitting, lonely and disconsolate, among his flowers, and gazing vacantly at his pet orchids. Under such circumstances, he is said to be willing to release himself from some of his burdens, one of them being the Western Union Company. Stories by no means wanting in weight are afloat to the effect that Mr. Gould is willing and preparing to transfer his telegraphic interests to a very strong syndicate, including two or three rich banking houses, and some of the largest moneyed interests in the country. Of course, the plan may not be carried through, but events appear to be shaping themselves for its consummation. As usual, it will be seen, everything depends upon Mr. Gould, who has been known to do the contrary of what it was said he would do.

While this sensation is steadily working its way to the front, and will soon be occupying no small space in the papers, the United States Senate has passed a Bill which gives evidence of the popular temper with regard to the telegraph service. This Bill relates to the use of telegraph lines along railroads, which have received help from the country generally in the shape of land subsidies. Several of these roads have made exclusive contracts with the Western Union Company. The Bill provides that such contracts shall be at once cancelled. The railroad companies are to operate their lines themselves, and are to make equal rates to all competing telegraph companies without any discrimination. It is rather interesting to note that this movement was begun by the Baltimore and Ohio Company when in opposition to the Western Union Company, and that it now has its results after those two concerns have become one. The practical effect of the Bill is to place the telegraph system of all roads subsidised by the Government under the jurisdiction of the Inter-State Commerce Commission, and thus, for the first time, subjects our telegraphs to direct national interference and supervision.

The agitation for giving the Government a monopoly of the telegraph is little heard of at present; but now and then we get signs of its existence. One of the latest movements in this direction is that fostered by Senator Blair, who has secured for Mr. D. H. Craig, of this city, the use of one of the gallery corridors in the Senate wing of the Capitol at Washington, for the exhibition of certain inventions in rapid telegraphy. Mr. Craig, who will be known, probably, to some of your readers as one of the fathers of our associated press, has for a long time been interested in rapid telegraph schemes, and, so far as I can make out, the object of having this exhibition in Washington within the very walls of the national Capitol is to get the Government to buy the Craig system, and use it in its postal telegraphs. In obtaining the privilege for his *protégé*, Senator Blair informed his senatorial brethren that messages now costing from 25 cents to a dollar could be sent by the Craig system for from 15 to 30 cents, and that 2,000 words could be transmitted by it in the time now required for 400 words. I do not think that the Government will buy Mr. Craig's invention.

Mr. P. B. Delany, of synchronous multiplex fame, has just secured patents on a very interesting and promising system of electrical news bulletins. The arrangement is based on a simple visual telegraph system, which displays its bulletin on a board devised for the purpose, and which makes no record, being, in this respect, the very opposite of the ticker system, where a man has to tangle himself up in miles of tape to find out whether anything has happened that interests him. In the Delany electrical bulletin system, as now arranged, there are 25 type wheels, set all of a row in each board, each wheel carrying the entire alphabet. With 25-letter wheels any item of news likely to interest the public can be given in sufficient detail to make it thoroughly intelligible. Only about a minute is required to complete the spelling out of the bulletin despatch on the board, and then the message can be at once "wiped out," so as to make room for another, or it can stay on the board till such time as the

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central office has something ready to send and take its place. Of course, if a permanent record is wanted it can be had by transferring the message to a slate below the board, as is generally done here now in connection with sporting news. Every time a new bulletin appears on the board attention is called to it by a bell, and the type is large enough to allow at least 500 people in the room to read it. Such a device has many good features, and the electrical mechanism connected with it is so simple as to ensure the perfect operation of the instruments, of which as many as thirty or forty can be placed on a single circuit, all displaying bulletins simultaneously from a single transmitter. A bulletin of this kind will be a decided acquisition in all places of public resort, such as exchanges, club houses, restaurants, saloons, banking offices, and the like, and I believe that before many months are out we shall see a large number of Mr. Delany's bulletin boards in operation.

The consolidation of the phonograph and graphophone interest has now been formally announced. The price which has been paid to Mr. Edison for his phonograph is said to be half a million dollars, in four payments, and it is understood that this is about as good a return as Mr. Edison has ever had from any of his inventions, not excepting those connected with the electric light. All Mr. Edison's improvements on the phonograph during the next fifteen years are to go into the same hands, and Mr. Edison is still busily at work upon the machine, having recently effected a number of notable improvements on it. The graphophone people are also at work making their improvements, all of which go to the same company, and arrangements are now being perfected for the manufacture of the machine, of which a great many will soon be in use.

The cause of electric motors for street railways has received wonderful assistance from the address just delivered before the local authorities at Brookline, Mass., by Mr. H. M. Whitney, the president of the West End Street Railway Company of Boston. For some long time past this company has been seriously considering the introduction of the cable system for its road in Boston, where it has one of the largest street railway services in the world. Last year the company carried on a few experiments with the storage battery, but there its interest in the use of electricity seemed to end. Plans were accordingly prepared for a very elaborate cable system to be laid down in Boston. It goes without saying that it was no less expensive than it was elaborate. Meantime, however, electric railways were coming to the front, advancing rapidly in perfection of detail and magnitude of performance, and before they made a decision, Mr. Whitney and his associates felt that they ought to look at the latest examples of electric railroading. They accordingly did so, and visited the roads at Alleghany City, Richmond, Va., and Jamaica, L.I. The last-named road is a comparatively crude affair, but, as Mr. Whitney says: "The power was there. The cars were propelled rapidly over the track, and were under complete control." The whole application gave such promise of speedy development, that even before they went any further, the West End directors called a halt on the cable scheme. When they visited Alleghany City they were once more gratified at seeing improvement in this work, and especially with the application of a section of the Bentley-Knight conduit. The visit to Richmond was not less convincing. "What we found there," said Mr. Whitney, "was perfectly surprising and amazing to all of us. There in the City of Richmond, a city of 90,000 inhabitants, was a road 12 miles long over grades and around curves the like of which do not exist in the whole system of 250 miles of the West End Street Railway Company. It is operated by a system of overhead wires which is positively unobjectionable, the cars ascend grades of 9 per cent. at the rate of 6 miles an hour, and are under the most perfect control, carrying the people with the utmost despatch and satisfaction. It was the outcome of one of the hardest conflicts for victory that were ever fought in the industrial field." The result of all this is that the West End Railway Company are not adopting the cable system, and will resort to the electric system of direct transmission by overhead wires and conduit as something vastly superior, and this is the reason why they have appeared before the Brookline Board, in order to obtain permission to run one of their lines out thither from Boston. Such a change of front cannot but attract universal attention. It will convince the general public that the claims made on behalf of the electric railway are not exaggerated, but that the electric method, even as it stands to-day, commends itself to the approval of sober, shrewd and far-sighted men of business. As soon as the necessary permits have been obtained, Boston will thus furnish another demonstration of what electricity can do in facilitating urban passenger traffic, and in meeting one of the greatest demands of the time.

The American Bell Telephone Company has wiped out another opponent. The last contestant to succumb to the Bell patents is Dr. Cushman, against whose company a perpetual injunction restraining from infringement has just been granted in Chicago. I have mentioned in a previous letter the basis of Dr. Cushman's claims, namely, that in 1851, while experimenting with a lightning arrester, he accidentally discovered the principle of transmitting articulate speech, using the electric current as the medium, and that he constructed an operative telephone. The conclusion of the judge is that, however far Dr. Cushman may have gone with his device, it was certainly nothing better than the crudest of experiments, and that all the attempts made to improve the instrument had been complete failures. Hence the judge dismissed the Cushman plea on the ground that all that had been done must be treated as, at best, only an abandoned experiment. Of course there was talk of appeal, but I hardly think the defendant company will push the matter very far.

At the last meeting of the American Institute of Electrical Engineers, one of the speakers, in the discussion on standard resistances, referred to some alloys of Mr. Edward Weston which possessed some remarkable qualities. Recently two patents have been issued to Mr. Weston on these alloys. According to Mr. Edward Weston, the metal manganese imparts a very high electrical resistance, and, in fact, a higher specific electrical resistance than is observed by the addition of any other material to alloys into which it enters as a constituent; and further, the addition of manganese has another valuable property of rendering the electrical resistance of such alloys nearly, or quite, constant under varying conditions of temperature. The alloy mentioned by Mr. Weston consists of manganese and copper, which is prepared by melting together 70 parts of copper and 30 parts of ferro-manganese. This alloy can be rolled and drawn into wire in the usual way. In addition to this valuable alloy, Mr. Weston has obtained still another which has not less remarkable qualities, in that its resistance is lowered by increase in temperature. This alloy is composed of copper, manganese and ferro-manganese and nickel. It is designed to be used in connection with coils of copper or German silver, so that the combination shall form a compensating arrangement by which the resistance of the helix composed of the two shall remain constant, independent of the heating action of the current. With German silver and copper as one part of the coil, Mr. Weston prefers an alloy containing from 65 to 70 parts of copper, 25 to 30 parts of ferro-manganese, and $2\frac{1}{2}$ to 10 parts of nickel.

NOTES FROM PARIS.

(FROM OUR OWN CORRESPONDENT.)

August 7th, 1888.

Paris has hitherto been very scantily furnished with electric fire alarms; in fact, until quite recently, only the first three arrondissements were provided with this necessary apparatus. At the present moment, however, four more arrondissements are being fitted with fire alarms, and only last week the Municipal Council voted some 400,000fr. for the erection of 480 additional instruments, none of which are to be more than 300 metres apart. It is expected that within a year from now Paris will be thoroughly provided in this respect.

The second central station in Paris, that of the Compagnie Parisienne d'Eclairage Electrique, on the Place Ste. Geneviève, is now completed, and the company only awaits the necessary authorisation from the municipal authorities to get to work on the main

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cables. The plant comprises three dynamos, made by Messrs. Brown, of Oerlikon, each dynamo being driven direct by a separate engine. The station has a 2,000 light capacity.

At the last meeting of the session the Municipal Council voted funds for the erection of a municipal central lighting station at the Halles Centrales, and postponed to the next meeting, in October, the examination of the demands they have received for fitting up central stations in various parts of Paris from several electrical firms. In constructing this station, the cost of which will amount to £40,000, the authorities have a twofold object in view. One-sixth of the total available power only will be devoted to improving the lighting of the Halles, the balance (700 horse-power) will be used for the purposes of private lighting. The charge for the current is to be 15 centimes per ampere-hour. Tenders will shortly be advertised for—1st, boilers; 2nd, engines; 3rd, dynamos; 4th, electric lighting apparatus; 5th, cables. M. Popp has offered to supply compressed air as the motive power, and the authorities seem inclined to entertain the proposal.

THE BRUSSELS EXHIBITION.

(FROM OUR CORRESPONDENT.)

BRUSSELS, JULY 30TH, 1888.

MM. Mourlon, of Brussels, have given a very successful demonstration of the Van Rysselberghe system at the Brussels Exhibition. They have erected two telephone offices, in each of which there is a complete set of Morse apparatus by the side of the telephone transmitters; the two offices are connected by an overhead wire, and talking can be carried on from either end while the Morse apparatus is at work. As an instance of the extent to which this system is in use it may be mentioned that in Europe alone more than 1,300 miles of telegraph wires are so worked, not to speak of the lines in the United States, Egypt, Mexico, Colombia, China, Japan, Costa Rica, Venezuela, Brazil, Uruguay, and the Argentine Republic. The same firm also exhibit the Dejough microphone, which has been adopted by the Belgian Government, and is actually in use on the Paris-Brussels trunk line, over two hundred miles in length. According to a Report of the Société Belge d'Electriciens, this apparatus possesses the most exceptional qualities for the purpose of the transmission of speech. "An experiment frequently repeated and always most successful will give an idea of the value of the system. The listener at the Paris end of the line was able to repeat word for word the sentences whispered by the speaker at Brussels in such a low tone as to be inaudible two mètres off." The Dejough transmitter is on the multiple carbon contact principle, and needs no regulation. Several models of the instrument are shown adapted to various uses. One of these shows the Dejough transmitter in use with the anti-induction apparatus of Van Rysselberghe. This arrangement is intended for railway work, and meets a want long felt, namely, the installation of a number of telephones upon the same telegraph wire, so as to permit any office to talk to any other office. Another noticeable exhibit is the phonotelegraph of Renard Nothomb. This apparatus transmits telegraphic and telephonic messages under conditions which would be impossible in any other system. The currents induced are such that it is no longer necessary to take into consideration the length or, within limits, the insulation of the line. The wire may be of very small section (·001m. diameter), and may be carried along the damp ground, across small streams, and under roads. This instrument, whose compactness renders it very portable and easy to manage, is worthy the attention of the military authorities, since now, more than ever, field telegraphy and telephony has become of the first importance. MM. Mourlon also show one of the microphonic sounding-boards, such as are in use at the Théâtre de la Monnaie to transmit music telephonically to the Châlet Royal at Ostende and to the Palace at Laerken. It was on this occasion that songs and music were first sent some 80 miles over the lines without in any way disturbing the telegraph service. I must not omit to mention a very neat little electro-therapeutic apparatus of Dr. Laroche's, contained in a box about the size of a writing-desk, and comprising a dead-beat galvanometer capable of measuring currents from one milliampere up to one ampere, a battery and a commutator.

The electric lighting of the Exhibition becomes a bigger affair every day. No less than four fresh installations have been commenced, all of which are to be completed by the middle of August, so that M. Bandsept's responsibilities do not lessen; however, I have no doubt that he will continue to make the electric lighting as successful a feature of the Exhibition as hitherto. The Buffalo Bill show is to be lit by 24 2,000 candle-power Thomson-Houston lamps, of which 12 will be provided with reflectors. This installation was only ordered by the executive committee on the 23rd of July, and will be ready by the 5th August. The work is being carried out under the superintendence of M. Admiralli, chief engineer to the Société Belge Thomson-Houston. Another additional installation will comprise seven 7-ampere Poege lamps, run off a Lahmeyr dynamo, which is driven by a 12 horse-power Fétu gas engine. The large Mackenzie-Ross restaurant is now lit by 137 twenty candle-power incandescents, supplied with current alternately by a set of Khotinsky secondary batteries and a 150 volt 190-ampere Thury dynamo. The Khotinsky system of regulation is so perfect that the whole load may be thrown from one source of electricity upon the other without altering the speed of the dynamo or affecting the steadiness of the light. Finally, the large kitchens attached to the Exhibition have been lit up by a number of arc lamps.

In consequence of a few robberies committed after dark in the Belgian Department, the Commissaire-Général decided to close this portion of the Exhibition at 7 p.m., and the foreign sections having followed suit a large portion of the electrical plant lay idle. The technical staff consequently had to find means to utilise the light which the executive committee had agreed to pay for. Hence fresh re-arrangements of plant. Alone, among all the electric light contractors, the Bouckaert-Schukert Company refused to assent to these necessary alterations. In fact, the company are spending the subsidy granted to them by the authorities in a law suit, demanding damages for the alleged injury done to their business by these re-arrangements. I am informed that the Exhibition authorities will plead their contract and regulations, and will make a strong point of the insufficiency of the light supplied by the Bouckaert-Schukert Company.

CORRESPONDENCE.

THE DELANY AND THE WHEATSTONE-STROH CABLE KEYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In *The Electrician*, July 13th, Mr. F. Higgins states that my cable key "was anticipated by a similar key for the same purpose which was invented by Sir Charles Wheatstone or Mr. Strob, and successfully tried between London and Amsterdam 20 years ago." Mr. Higgins' brief reference to three different systems makes it difficult to understand the order of their era, while his description of the instrument invented by Sir Charles Wheatstone or Mr. Stroh shows clearly that it was in no respect "similar" to mine, but, on the contrary, about as dissimilar as it could possibly be. It may have been "for the same purpose," as it is quite probable that numerous attempts have been made to accomplish the same results; but if, as Mr. Higgins states, the Wheatstone-Stroh invention was tried "successfully" at that time it is certainly very strange that it was abandoned for what Mr. Higgins himself acknowledges to be an inferior method of operation. I think Mr. Higgins has overlooked the intermediate segments in my key and their function, which still further removes it from similarity to the Wheatstone-Stroh instruments. Recent experiments have shown that notwithstanding the fine results obtained by my key, the polarised transmitter with key combination is much superior, inasmuch as the time of contact, making and spacing, is absolutely equal, regardless of the operator's manipulation.

I would be glad if Mr. Higgins will state where a full description of the instrument he refers to can be found.—Yours, &c., PATRICK B. DELANY.

New York, July 25th, 1888.

[The Wheatstone-Stroh key was illustrated and described in our last issue, August 3rd.—ED. *E.*]

TESTS OF THE DELANY CABLE KEY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the account of a test made with my cable transmitter in your paper of June 29th, I wish to correct a few errors. The cable over which the unprepared test was made is 840 knots, 13,000 ohms resistance, and 240 microfarads capacity. Ordinarily this cable is worked with 15 cells of Fuller battery, about 30 volts. With my transmitter this battery was divided in the middle, giving about 15 volts on each reversal. The speed obtained was 340 complete reversals,

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or 680 alternating impulses per minute. The strip shows 14 alternating impulses to the inch, and a perfectly uniform undulation of a thirty-second of an inch. No effort was made to ascertain the limit of speed as, on account of lack of battery facilities, it was not expected that any satisfactory results could be obtained.—Yours, &c., PATRICK B. DELANY.

84, Broad-street, New York, July 26, 1888.

UNIPOLAR INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Snowdon's letter I may observe, in the first place, that according to the vortex-whirl theory of magnetic action a displacement of the lines of force must correspond to an actual displacement of the vortex filaments themselves, including whatever it is that is in motion.

In Mr. Snowdon's figure, when one of the magnets begins to rotate, the systems of lines of force must be separately considered for the two magnets; the line N S N′ S′ A N, for example, must be considered as consisting of the two closed lines N S A N and N′ S′ A N′, one of which remains fixed, while the other rotates. At any given moment the portion A N′ of a rotating line will coincide with the portion A S of a fixed line of opposite sign—viz., in which the rotation is in the opposite direction—and they will neutralise each other's effects on any magnetic body in the field; but the fixed galvanometer circuit is cut twice at each revolution by each of the rotating lines. I may point out that it is impossible for a vortex filament to terminate in free space, as appears to be suggested in Mr. Snowdon's letter. In the last example, when the core of an electromagnet is made up of two concentric iron cylinders, one of which rotates while the other is stationary, one set of lines must certainly be supposed to rotate while the other remains stationary.

If Mr. Snowdon wishes to maintain the theory that the lines of force of a revolving magnet remain stationary, I must ask him to answer the objections which I have urged on general considerations against this view, in Article IV., pages 232 and 233, and to give an explanation on his theory of the experiments of Exner and Czermak, described in the fourth paragraph of Article III., page 203. The latter appear to me to be quite conclusive in favour of the theory which I have advocated.

I would propose a further question to the advocates of the stationary theory.

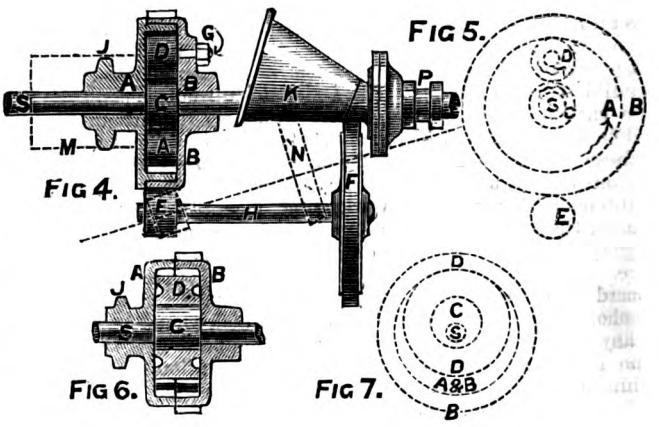
If a magnet can rotate among its own lines of force it will give rise by its own rotation to a difference of electrification of its equatorial and polar portions, so that if these are joined by a wire rigidly attached to the magnet a current will be maintained through the wire and magnet. According to Exner and Czermak's experiments no such current is produced, and I think it can be shown that the existence of such a current would be in contradiction to the admitted principles of dynamics.

Suppose the magnet and rigidly-attached wire to be rotating in space, then the only possible source from which the energy required to maintain the current could be derived would appear to be the energy of rotation of the system. The moment of momentum of the system would therefore be diminished, and ultimately reduced to zero, by its own internal action, which is in direct conflict with fundamental dynamical principles.—Yours, &c., G. W. DE TUNZELMANN.

THE BEAUMONT EPICYCONOIDAL GEAR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I overlooked the letter in your impression of the 27th ult., in which Mr. Arnall explains what he conceives to be an objection to the epicyconoidal gear described in your impression of the 29th of June. With the velocity ratio and relative diameter of wheels which he has taken for example there would be the high-speed rotation at which he arrives. This has, however, been anticipated, and, as shown in your impression of the 10th September, 1886, the epicycloidal gear is replaced by epicyclic gear, combined with the ex-axial cone when a lower velocity ratio is required. Neither of these forms of gear are original with me, my invention being confined to the combination with such gears of the ex-axial cone, in such a manner as to give to the controlling wheel a variable rate of rotation. In the accompanying engravings, reproduced from your impression of the 10th Sept., 1886, a very common form of internal gearing is shown. The wheel A (Figs. 4 and 5) alone has internal teeth, and is loose upon the shaft S. A pinion, C, is fixed to the shaft, and drives the wheel A by means of the pinion D, which runs upon a stud spindle, G, fixed in the wheel B. The latter wheel is provided with external teeth, with which is geared the pinion E fixed on the spindle H, upon which the friction wheel F is also fixed. When the gear is applied to a tramcar the wheel A runs at its maximum and normal speed when the wheel B is held fast by the pinion E and brake which holds the wheel F, the cone K not being in contact. When it is desired to reduce the speed of the wheel A, with its chain wheel, J, the speed of the shaft S remaining constant, the brake is removed from the wheel F, by a lever which at the same time moves the cone into contact with the periphery of F. The pressure upon the fulcrum spindle G then causes the wheel B to revolve in the same direction as the wheel A, and at a speed which is proportional to the diameter of the part of the cone in contact with the wheel F. The velocity of the wheel A is thus reduced by the velocity of wheel B. When the wheel B is allowed to rotate at the maximum velocity which would be given to A were B fixed, A would receive no motion at all. Fig. 5 shows the directions of movement of the several wheels. Figs. 6 and 7 show one form of the epicycloidal gear not now under consideration, but of the kind shown in the larger engraving in your impression of the 29th ult., and referred to by Mr. Arnall.



With the epicyclic gear, shown in Figs. 4 and 5, any velocity ratio, as between the shaft S and the wheel A, from about 2·5 to 1 to 5 to 1, may be practically obtained, and such gear is very largely in use at high and at low velocities, transmitting small and large powers. It is in use in highly-finished machinery and in roughly finished and roughly handled agricultural machinery, and no difficulty is experienced with it, either with respect to lubrication or to wear. With a tramcar axle running at 100 revolutions per minute this form of gear easily lends itself to the use of a motor running at from 800 to 1,200 revolutions per minute, the normal velocity ratio being from about 3 to about 4·5 respectively, as the chain wheel J would never be made as large as the wheel on the driving axle. The shaft S may be a continuation of the motor shaft, or, where there is not room for the apparatus in this position, S may be a second motion shaft—a better arrangement for numerous reasons.—Yours, &c., W. WORBY BEAUMONT.

Norwood-road, Herne Hill, 7th August, 1888.

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RRITISH ELECTRIC COMPANY, LIMITED (IN LIQUIDATION).

A meeting of the creditors of this Company (convened by the official liquidator) was held at the Inns of Court Hotel, Holborn, London, W.C., yesterday (Thursday), to consider the desirability of resuscitating the concern. We are unable to give a report of the proceedings, as reporters were not admitted to the meeting. The official liquidator's report says:—

It has recently transpired that there are good grounds for believing that the interest of the Company under two licenses—one from the Edison Electric Light Company (Limited), and one from the Manchester and District Edison Electric Light Company (Limited), is now of considerable value, and that the licenses may be operated with at a profit, and that it will be beneficial to the creditors of the Company, both secured and unsecured, as well as to the shareholders, that an arrangement should be made between the Company and its creditors, both secured and unsecured, for the satisfaction of the Company's debts with a view to the resuscitation of the Company as a going concern for the purpose of working under these licenses.

For the purpose of carrying out the two objects above mentioned, namely, (1) the satisfaction of the Company's debts, and (2) the resuscitation of the Company as a going concern, a scheme has been prepared, an outline of which is as follows:—(A) The existing debenture holders are to surrender their debentures and abandon their claim for past interest upon receiving new debentures of the Company for amounts equal to the balance of principal moneys due in respect of and secured by the existing debentures held by them, which new debentures will become payable at the expiration of five years after the date of issue, and in the meantime carry interest at the rate of 5 per cent. per annum, and are a first charge by way of floating security upon all the properties and assets of the Company; (B) the other (unsecured) creditors of the Company are to receive fully paid-up Preference shares of the Company carrying interest at the rate of 10 per cent. per annum for amounts equal to 50 per cent. (or one half) of the debts and claims of such creditors against the Company in full satisfaction and discharge of such debts or claims; (C) the Company is to be at liberty to borrow further moneys by issuing debentures; (D) the winding-up proceedings, and also the proceedings taken on behalf of the debenture holders, are to be stayed; (E) Directors are to be elected, and the Company is to proceed to carry on business. A full copy of the proposed scheme may be seen at the offices of Messrs. Clarke, Woodcock and Ryland, No. 11, Lincoln's Inn-fields, London, W.C., solicitors to the official liquidator, on any day between the hours of 10 in the forenoon and 5 in the afternoon, or a full copy will be sent by post upon receipt of a postal order for 5s.

In anticipation of such scheme being carried through, certain provisional agreements have been entered into on behalf of the Company, which it is expected will produce considerable pecuniary returns to the Company.

Mr. Justice North, the Judge to whom the winding up of the Company is attached, has, in pursuance of the powers given him by the Joint Stock Companies Arrangement Act, 1870, directed separate meetings to be held of the debenture holders and of the other creditors of the Company, for the purpose of submitting to them the above-mentioned scheme, and of procuring the passing of such resolutions as may be necessary to give effect thereto.

The following resolution was to be put to the meeting:—

"*1. That this meeting approves of the scheme of arrangement between the British Electric Light Company (Limited) and its creditors, and for the resuscitation of that Company, which has been produced and read and explained to this meeting by Mr. A. A. James, the Chairman hereof, and hereby on behalf of all the creditors (other than debenture holders) of the said Company, agrees to accept fully paid-up Preference Shares in the Company, carrying interest at 10 per cent. per annum, for amounts equal to 50 per cent. or one-half of the respective debts or claims of such creditors against the Company in full satisfaction and discharge of such debts and claims respectively. And hereby further agrees that all the creditors (other than debenture holders) of the Company shall in all respects be bound by the provisions of the said scheme of arrangement, and hereby desires that the said scheme shall be sanctioned by the Court, and rendered binding upon all the creditors of the Company.*"

LEGAL INTELLIGENCE.

EDISON AND SWAN v. HOLLAND AND OTHERS.

In the Chancery Division of the High Court of Justice, yesterday, before Mr. Justice Kay,

Mr. BREMNER, on behalf of the plaintiffs, applied for an order to vary the minutes of the judgment. The registrar had inserted in the minutes an order for an injunction restraining the defendants from further infringing the Cheesborough patent, but, as the defendants' solicitor did not consent, he had refused to insert any order for an inquiry as to damages or for the delivery up of the lamps.

Mr. JUSTICE KAY: Was that asked for at the time?

Mr. BREMNER: It was not mentioned to your lordship at the time, because I assumed that it followed your lordship's judgment in favour of the plaintiff on this point. If I was wrong in making that assumption, I respectfully ask to be allowed to set the matter right.

Mr. JUSTICE KAY: This is asking me to make a different decree; the time for doing that was when I delivered judgment. Does anyone appear for the defendants.

Mr. GRAHAM said the defendants objected to going into an inquiry as to the lamps.

Mr. JUSTICE KAY: If they insist upon it as to that part of the case on which you failed they are entitled to all relief.

Mr. GRAHAM: They are entitled either to an inquiry as to damages or to account to the Court in the alternative.

Mr. JUSTICE KAY: And they elect to take damages. Where the defendants fail on one part of the case, it is not right that the plaintiff should not have all the relief on the other part if he insists upon it. Therefore there must be an inquiry as to the damages, and delivery over of the lamps that infringe that patent.

Mr. GRAHAM then referred to the order as to costs. In connection with the Cheesborough process, they were to be taken as between solicitor and client; but were they to be taken on the higher or the lower scale?

Mr. JUSTICE KAY: Why should I give part of the costs on the higher scale and the rest on a different scale? I understood the higher scale was certainly to apply to all the costs in the action.

Darcy v. The Liverpool Electric Supply Company.

At the sitting of the Chancery Court for the County Palatine of Lancaster, held at St. George's Hall, on Wednesday, before Vice-Chancellor Bristowe, judgment was given in the action Darcy *v.* the Liverpool Electric Supply Company (Limited).

This was an action for an injunction to restrain the defendants, their servants and workmen from working certain steam engines and electrical machines in such a way as to cause a nuisance or injury to the plaintiff and his premises, No. 11, Highfield-street, Liverpool. The plaintiff was, and is, lessee and occupier of the premises mentioned, which consist of a fully-licensed public-house, held for the residue of a term of fourteen years from the 1st December, 1886, created by a deed dated 11th January, 1887, made between John D. Fox on the one part and the plaintiff on the other part. In answer to the claim, the defendants said by an agrement with the plaintiff's landlord (Mr. Fox) the company had leave and license to do that which was now complained of.

The VICE-CHANCELLOR, in giving judgment, said that he came to the conclusion that this was so, but if he should be wrong in this view—after having heard the evidence, and having personally visited the premises—he was of opinion that the evidence of the plaintiff had been greatly exaggerated. He could hear no noise, and he could detect no vibration which could in any way be prejudicial to the comfort and enjoyment of the premises. He therefore dismissed the plaintiff's claim with costs.

PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

10,524. B. J. B. MILLS. London. Improvements in electric railways (the Bentley-Knight Electric Railway Co., United States). July 20, 1888.

10,568. F. H. ROYCE. Manchester. Improvements in the manufacture of electric bells. July 21, 1888.

10,572. J. H. WOODWARD, B. M. DRAKE, and J. M. GORHAM. London. Controlling train-lighting dynamos. July 21, 1888.

10,584. F. R. WELLES. London. Improvements in and relating to switch-boards or apparatus for connecting circuits and signalling in telephone exchange systems. July 21, 1888.

10,604. I. A. TIMMIS. London. Improvements in the elements for secondary batteries. July 21, 1888.

10,654. W. R. MORTIMER and J. HOLLOWAY. London. Improvements in electric arc lamps. July 23, 1888.

10,666. H. RIDLEY and J. SKELDON. Bolton. Switchback telegraph. July 24, 1888.

10,690. A. H. GLADWIN. London. The automatic alternatable position flushing and draining in and out of action electric battery, and system for electric batteries. July 24, 1888.

10,730. A. NOBLE. Newcastle-on-Tyne. Improvements in electric firing gear for guns. July 24, 1887.

10,782. H. W. MILLER. London. An electric meter. July 25, 1888.

10,813. W. J. WOODWARD, of Judson and Co.'s (Limited). London. Improvements in and relating to apparatus for receiving payment and administering electricity for medical or other purposes. July 26, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

July 28, 1888.

10,200. H. C. BULL AND CO. (LIMITED) and H. C. BULL. London. Improvements in dynamo-electric generators and motors. July 21, 1887.

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11,938. J. G. Lorrain. London. Improvements in or connected with clocks and apparatus for winding the same by electricity. September 2, 1887.

13,207. A. Morley and H. W. Wilson. London. Improvements in indicators for electric bells. September 29, 1887.

13,221. J. H. Holmes. London. Improved means or apparatus for controlling in an automatic manner reciprocatory, vibratory, or oscillatory movements of armatures and other electrical apparatus. September 29, 1887.

13,333. J. D. Gibbs and E. Fesquet. London. Improvements in secondary generators, transformers or converters of electricity. October 1, 1887.

13,338. W. Hartnell. Leeds. Improvements in electric lamp attachments. October 3, 1887.

4,759. H. H. Lake. London. Improvements in and relating to telephonic apparatus (International Dudley Signal Company, United States). March 28, 1888.

9,332. F. Stitzel and C. Weinedel. London. Improvements in electrical connection of railroad rails. June 26, 1888.

9,401. V. D'Ostachiewicz and L. de Gerlicz. Paris. Improvements in the process of alcoholic fermentation. June 27, 1888.

10,875. W. G. Johnson. London. An improved surgical apparatus for electro-massage. July 27, 1888.

10,887. S. A. Day. London. Improvements in electric cartridges and primers. [Date applied for under Section 103 of the Patents, &c., Act, 1883, March 23, 1888.] July 27, 1888.

10,904. R. Sauerwald. London. Improvements in electric batteries. July 28, 1888.

10,929. E. Cox-Walker and A. A. C. Swinton. London. Improvements in magneto-electric generators and appliances for use in connection therewith. July 28, 1888.

PATENTS SEALED.

July 27, 1888.

6,809. J. Eshelby and E. Eshelby. Liverpool. Improvements in electric bell indicators. May 10, 1887.

6,918. W. E. Gedge. London. Improvements in telegraphy (A. Claude, France). May 11, 1887.

7,042. F. G. Chapman, F. M. Dearing and W. G. Chapman. Improvements in electric arc lamps. May 13, 1887.

9,829. T. Stanley. Cheshire. Improvements in dynamo-electric machines. July 13, 1887.

9,904. L. Grabau. Hanover. Improvements relating to the production of insulating coatings or linings in electrolytic apparatus. July 14, 1887.

10,057. E. de Pass. London. A process for the extraction of aluminium from its fluorides by electrolysis (M. Bernard and E. Bernard, Paris). July 18, 1887.

10,195. J. P. Hall. Oldham. Improvements in dynamo-electric machines. July 21, 1887.

10,575. W. Emmott and J. H. Rider. Halifax. Improvements in instruments for electric measurement. July 30, 1887.

15,717. C. A. Randall. New York. Electrical date and time stamp. November 16, 1887.

SPECIFICATIONS PUBLISHED.

5,931, 1888. Schonherr-Schoner, T. Electric batteries. Price 8d.

6,191, 1888. Schroeder, C. A. J. H. Preparing carbons for electric arc lighting. (Price 4d.)

7,851, 1887. Thompson, W. P. (Westinghouse). Switches for electric circuits. (Price 8d.)

7,853, 1887. Thompson, W. P. (Gibson). Storage batteries. (Price 8d.)

4,810, 1882. Crompton, R. E. B., and Kapp, G. Dynamo-electric machines. (Price 6d.) Third edition.

1,996, 1877. Jablochkoff, P. Electric Light. (Price 8d.) Fourth edition.

2,003, 1878. Hoddan, H. J. (Brush). Application of electricity. (Price 1s. 3d.) Fifth edition.

4,533, 1887. Ward, M. R. Electric locomotives and vehicles. (Price 8d.)

10,767, 1887. Lowrie, W. Instruments for measuring electric currents, &c. (Price 11d.)

11,751, 1887. Nicholl, A. E. Electrical signalling apparatus for railways. (Price 8d.)

11,853, 1887. Caws, F. Flexible supports for telegraph, &c., wires. (Price 8d.)

11,932, 1887. Abel, C. D. (Siemens and Halske). Electrical conducting cables. (Price 11d.)

11,950, 1887. Ross, J. S. and Baines, H. Electrical telephones. (Price 4d.)

16,554, 1887. Binter, G. Electric apparatus for indicating distant water level, &c. (Price 8d.)

1,128, 1888. Fortin, A. A. Galvanic batteries. (Price 11d.)

1,968, 1888. Tilley, W. Secondary battery. (Price 8d.)

4,456, 1888. Collingridge, A. Administering galvanic currents for curative purposes. (Price 6d.)

5,731, 1888. Lake, H. H. (Thomson). Measuring electric currents, &c. (Price 1s. 1d.)

5,732, 1888. Lake, H. H. (Thomson). Measuring electric currents, &c. (Price 8d.)

6,157, 1888. Keen, R. E. Electric arc lamps. (Price 6d.)

7,541, 1888. Thompson, W. P. (Sprang). Dynamo electric generators. (Price 8d.)

7,551, 1888. Kendall, J., and Cooper, O. Electrical coupling devices, &c. (Price 8d.)

7,850, 1888. Thompson, W. P. (Westinghouse) Alternate-current electric distribution. (Price 8d.)

7,977, 1888. Morris, H. G., and Salom, P. G. Filling secondary battery plates. (Price 6d.)

8,171, 1888. Ghegan, J. J. Magneto-electric liquid level indicators. (Price 8d.)

12,111, 1887. Thompson, W. P. (Dumas). Electric fuses for mines. (Price 8d.)

12,116, 1887. Read, H. K. Making, breaking, &c., an electric circuit. (Price 8d.)

12,325, 1887. Fairweather, W. (Western Electric Co.). Telephonic apparatus. (Price 8d.)

7,805, 1888. Allison, H. J. (Fritts). Producing, &c., electric currents. (Price 11d.)

8,223, 1888. Reed, A. H. (Conkling). Magnetic separator for extracting ferruginous matters from ores, &c. (Price 6d.)

8,596, 1888. Johnson, J. Y. (Ma'let). Automatic telegraphy. (Price 1s. 1d.)

CRICKET.

Eastern Telegraph Company v. Enfield.

This annual match was played at Bush Hill Park, on Monday, the 6th inst., and resulted in a win for Enfield. Mr. M'Millan's bowling was remarkable; in the first innings he took eight wickets for five runs, and in the second five wickets for eight runs. Mr. Gardner also bowled well in the second innings, taking five wickets for 11 runs. Mr. Capel played a dashing innings, and Mr. Collyer batted with great care. Mr. Hibberdine was captain of the Enfield team and Mr. A. O. Penney of the Eastern. Scores:—

Eastern Telegraph Company.—*First innings:* A. O. Penney, b Capel, 0; F. W. Penney, b Dodd, 1; E. Gardner, l b w, b Capel, 2; T. Richardson, run out, 1; W. Kerwin, b Capel, 1; J. Belbin, b Dodd, 0; G. Penney, b Dodd, 0; W. J. M. D. Wells, l b w, b Dodd, 0; J. Beavis, run out, 0; E. Blake, run out, 0; W. Brace, not out, 0; W. Chisholm (absent); J. M'Millan (absent); extras, 5—Total, 10. *Second innings:* A. O. Penney, c M'Lennan, b Wells, 22; F. W. Penney, run out, 0; E. Gardner, c Dodd, b Stewart, 3; T. Richardson, c Steward, b C. S. Collyer, 2; W. Kerwin, b Steward, 0; J. Belbin, b Steward, 1; G. Penney, c Caney, b Steward, 0; W. J. M. D. Wells, b M'Lennan, 0; J. Beavis, not out, 1; E. Blake, b Wells, 1; W. Brace, b M'Lennan, 15; W. Chisholm, b Dodd, 1; J. M'Millan, c C. S. Collyer, b Dodd, 2; extras, 4—Total, 52.

Enfield.—*First Innings:* J. M. Capel, c and b A. O. Penney, 76; W. Wells, b Gardner, 3; C. S. Collyer, c and b M'Millan, 55; C. Dodd, c Kerwin, b M'Millan, 8; J. A. Caney, b M'Millan, 7; A. T. Penney, b M'Millan, 0; P. O. Woollard, b M'Millan, 0; T. Steward, c and b Chisholm, 1; G. A. Collyer, b M'Millan, 4; G. H. M'Lennan, c Beavis, b Gardner, 0; W. Hibberdine, c and b Gardner, 3; W. S. Smith, not out, 0; extras, 7—Total, 164. *Second Innings:* J. M. Capel (absent), 0; W. Wells, b M'Millan, 8; C. S. Collyer, b M'Millan, 0; C. Dodd, c M'Millan, b Gardner, 0; J. A. Caney, b M'Millan, 3; A. T. Penney, b M'Millan, 5; P. O. Woollard, c Richardson, b Gardner, 1; T. Steward, b Gardner, 1; G. A. Collyer, b. Gardner, 0; G. H. M'Lennan, c and b M'Millan, 1; W. Hibberdine, not out, 0; W. S. Smith, b. Gardner, 0—Total, 19.

CHELTENHAM—REPORT OF THE LIGHTING COMMITTEE OF THE TOWN COUNCIL.

At the meeting of the Cheltenham Town Council, held on Tuesday last, the committee appointed some six months ago to report upon the advisability of lighting the town by electricity brought up the following report:—

"That in the opinion of the committee it is desirable to try the experiment of lighting a portion of the town with the electric light. That the area to be lighted be as shown on the plan now laid before the committee by the surveyor. It is considered that 36 lamps, each of 1,200 candle-power, will be sufficient to efficiently light this area, and that about 170 gas lamps will be thereby rendered unnecessary. Assuming that the lamps can be supplied, either by the Corporation itself or by contract at the price of the tender accepted by the Bath Corporation for 70 similar lamps for a term of seven years, viz., £18. 17s. 6d. per lamp, exclusive of the standards, the annual cost to the Corporation, exclusive of the standards or brackets, would be £679. 10s.; from this would have to be deducted the cost of the gas lamps superseded, which at the present cost per lamp of £2. 13s. 6d. would amount to £454. 15s. per annum. That it be referred to the Committee to consider and report as to the best mode of carrying out the foregoing recommenda-

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tion, whether by the Corporation itself or by contract, and if the former alternative is considered preferable, to report as to the best means of carrying the works into effect; if the latter to procure tenders."

Mr. GEO. NORMAN, Chairman of the Electric Lighting Committee, said that if they passed the report that day a more elaborate statement would be brought up at some future meeting—probably next month—and it would then be in the power of the Corporation to commend or reject it, as they pleased. Subject to this, the present minutes, he admitted, were of an important character. They asked the Council to say that the electric lighting of the streets was desirable, if a proper scheme were submitted; to approve of the experimental area which the surveyor had sketched out; and also to give the committee the freedom referred to in the concluding sentence, namely, to consider, whether, supposing the light was adopted, it could best be carried out by a private company, or by the Corporation themselves. Taking the second of these points first, as being the least important, he might say that the experimental area shown on the plans included the principal streets of the town, and it touched, he believed, every ward in the town. But the committee cared little about this matter of detail, and they were prepared, he believed, to curtail or extend the area, as the Town Council or applicants might think fit. Before passing from that part of the subject, it would be well to state that the figures given in the minutes were rather an illustration of the committee's proposal than a part of it. For instance, to be quite fair, there should be added to the cost of the electric light the cost of maintaining the posts upon which the lamps were placed. This, however, was a small matter; at Taunton the lamp posts and fittings cost only £3 each, and the interest on that expenditure was certainly slight. It should be further explained that the committee had taken their estimate upon the contract accepted by Bath, which was for a larger number of lights than that proposed in the present scheme; but they had done so because they anticipated that the number reached in Bath would also be reached in Cheltenham. It was difficult to realise that it was now some six or seven months ago since the committee was appointed, and perhaps it might be thought that they should have taken some earlier occasion to report. But the delay had not been a disadvantage to the subject of electric lighting, for during the time that had elapsed the committee had been able to make several interesting visits—namely, to Taunton and Eastbourne, which were both very successfully lighted, and also to electrical works in London, and the time thus spent had been useful to the committee, in that it had removed any doubt that members might have entertained, and enabled them to bring up their report with the weight of a unanimous body. That was something to be gained, and he hoped that before the question was done with it would be the unanimous resolve of the Town Council that the new, but now well-tried, illuminant should be publicly utilised in Cheltenham. There was, moreover, the further advantage which had sprung from delay, that the public had been familiarised with the subject; they had had it brought home to them, and many of them had been afforded opportunities of seeing what a beautiful light that of electricity was, and how superior to gas. The speaker then referred at considerable length to the progress of the electric light in London, Edinburgh, Dublin, Birmingham, Bradford, Southampton, Ilfracombe, Leamington, Bath, and other places. There was one highly important direction in which he hoped Cheltenham would see its way to improve upon the course taken by Bath. He was quite sure that if it could be effected at anything like a similar cost, or at anything like a reasonable cost, it was far better to have underground wires than overground wires, and even more strongly did he hold that this work should be in the hands of the Corporation. That was a question which would come before them at a future time, when the Council would be in a better position to discuss it; but if the Corporation decided to take up this question he should not in the least fear to ask the ratepayers to put up with a loss, perhaps a considerable loss, upon the early lighting of the town by electricity. It was fair to remind them that when the gas company started the gas company had to put up with a loss, and what Corporation would not go through a similar experience to possess such a noble property as the gas undertaking in Cheltenham now was? He wished he felt strong enough at the Council to initiate some practical measure, and he should be glad to follow anyone who led in that direction, for he was bold enough to think that the gasworks, equally with the supply of the electric light, ought to be in the hands of the town. If the Council gave the authority which the Electric Lighting Committee asked of them to-day, he hoped that when they next reported they would show by the data which they would then have collected that they had paid due attention to the subject, and that they were fully sensible of the weight of the responsibility which the Corporation had placed upon their shoulders (applause).

Mr. WAGHORNE seconded.

The resolution was then put to the meeting and carried unanimously.

COMPANIES' MEETINGS.

The Cuba Submarine Telegraph Company (Limited).

The thirty-fourth ordinary general meeting of this Company was held on Wednesday last, at the offices of the Company, 61, Old Broad-street, E.C., under the presidency of Joaquin de Mancha, Esq., chairman of the Company.

Mr. JAMES SCOTT (the secretary) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN: Well, gentlemen, it is again my pleasing duty to meet you with a very favourable report, and in consequence there is very little to be said. I think it speaks for itself. You will find that the increase is going on very favourably. We have about 10 per cent. increase in the number of messages, and the income has also increased in the same proportion. The expenses are very much the same as before, and you will see, although we have repaired our cable, under the direction of our manager abroad (Mr. Keith), we are still able to show a very good result. The only extra charge that we have had has been what we have paid to the Spanish Government for the use of their land line whilst our cable was in course of being repaired. The cost has been very insignificant, only £180, and it did our business very satisfactorily for us. The accounts show that we have made, together with the amount brought forward, £24,274. After paying all expenses, which have amounted to £6,879, there is left a balance of £17,395 for us to dispose of. That will enable us to pay the usual dividend of 10 per cent. on the Preference shares, and we will propose that that be paid and also a dividend at the rate of 9 per cent. on the Ordinary shares. I think that, taking everything into account, we cannot be other than satisfied with such a result, and only hope it will continue for some time to come. Our cables are all in good working order, but as our old cable has been now laid for so many years, it may require one of these days to be thoroughly overhauled. That will entail, of course, a certain expense, which makes us the more careful to make our reserve fund as strong as possible. I am sure it is to the advantage of the Company that our reserve fund should be strong, so that in the event of any emergency we may be prepared to meet it without diminishing our dividend (hear, hear). If there is any gentleman who wishes to have any further explanation I shall be very glad to give it him. As regards this year, for the last month's traffic, I am glad to tell you that there is still an increase, and we have had 570 messages more than we had at the same time last year (cheers). I have much pleasure now, gentlemen, in moving that the report and accounts as presented for the half-year ended 30th June, be received and adopted (cheers).

Mr. ALEXANDER F. LOW: I beg to second that.

Mr. WILLIAMS: There is one question that I should like to ask, and that is that I see that our reserve fund, or the greater part of it, is deposited in various banks; I should like to know at what rate of interest. I am a shareholder in the Eastern and Eastern Extension Companies, and we invest our reserve fund in debenture stocks. I am merely asking for information. I do not wish in any way to reflect upon the Board.

The CHAIRMAN: Well, sir, the reason is that debenture stocks do not pay so much. We have been getting 5 per cent. from most of the banks. Times, however, are not so favourable now for money, and the interest has been reduced in some cases.

Mr. WILLIAMS: I see that by London banks a very small rate of interest is paid.

The CHAIRMAN: We are getting 4, 4½, and in one or two cases 5 per cent. I will give the names of any of the banks if you would like to know.

Mr. WILLIAMS: No, no.

The CHAIRMAN: I assure you we take the greatest care in selecting the banks. We have diminished some of the amounts. The sole reason is we get a little more than we should from debenture stocks.

Mr. WILLIAMS: You think, then, it is a better plan than to invest money in debenture stocks, as other companies have done?

The CHAIRMAN: I am connected with one or two other companies, and we find the policy of leaving our money in the hands of our bankers a satisfactory one. We only do it for a year or two, and can always call it out whenever we want it.

Mr. WILLIAMS: I would like to ask one other question. Have you any idea of doubling our cable at all, as I see when anything happens to our one cable we are "hung up"?

The CHAIRMAN: I mentioned that one of these days it might be desirable to entirely overhaul and make thoroughly in good condition our Batabano cable, not to double it entirely, and therefore we wish to be strong and ready in case such a course should arise.

Mr. WILLIAMS: Quite so.

The motion was then put and carried.

The CHAIRMAN then moved—

"*That the following dividends for the half year be now declared upon the shares of the Company, viz., at the rate of 10 per cent. per annum, subject to income-tax, on the Preference shares, and 9 per cent. per annum, free of income-tax, on the Ordinary shares, payable on and after to-morrow.*"

Mr. LOW seconded the motion, which was carried.

The CHAIRMAN then said that his next duty was to propose the re-election of Mr. Horatio J. Perry as a Director of the Company. It was usual for one to retire by rotation each year. Mr. Perry had been connected with the Company since its formation, and his colleagues found him very useful. He resided abroad, in case they wanted anything done at Madrid. He looked after things efficiently. He begged to formally move—

"*That Mr. Horatio J. Perry be re-elected a Director of the Company.*"

Mr. WILLIAMS seconded the motion, which was carried.

The CHAIRMAN said that the next motion was for the re-election of an auditor, and it properly came from the other side of the table. He could assure the shareholders that they possessed in Mr. Greenwood a thoroughly efficient auditor, and he did not think that they could do better than re-elect him. No one could look after the accounts more carefully than he did.

Mr. WILLIAMS said he should be very glad to propose—

"*That Mr. Thomas Greenwood be re-elected Auditor of the Company for the current year at a salary of twenty guineas.*"

Mr. SQUIRE begged leave to second Mr. Greenwood's nomination.

The motion was carried.

Mr. THOS. GREENWOOD: Gentlemen, I thank you very much for re-electing me to the office of auditor, and I shall do my duty as before.

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The CHAIRMAN said that concluded the business.

Mr. SQUIRE said that before they separated he thought that they should thank the Chairman and Directors for the manner in which they had conducted the affairs of the Company during the past six months, and he specially endorsed their principle of increasing the rest by the substantial amount they had done (hear, hear). He quite agreed with the Chairman that that was their sheet anchor, and it was better to forego a small present increase of dividend rather than put that amount in peril (hear, hear). He begged to move that they return thanks to the Chairman and Board of Directors for their good management and exceedingly good report that they had been able to present to the shareholders.

Mr. GREENWOOD wished to be allowed to second that. He should be very glad to do so. He had had the pleasure before of speaking as to the satisfactory manner in which the business was conducted. The accounts were exceedingly sound, and the dividend extremely good.

The motion was carried.

The CHAIRMAN said that on behalf of himself and colleagues he wished to thank the shareholders for their kind vote. He trusted that he would be allowed to include in it the name of their worthy secretary (Mr. Scott), who was almost daily at his (the Chairman's) office, consulting him respecting the interests of the Company. He would like also to include the name of Mr. Keith, who was present that day, on leave of absence. Mr. Keith was most valuable to them. If any repairs were found to be required he started off at once and conducted the operations in a most efficient way. He had saved the Company, he (the Chairman) was going to say, thousands of pounds, but, at any rate, a great deal of money. Mr. Keith was a Scotchman, and they were usually ready men; but Mr. Keith seemed to be more than usually ready. He would move, with the approval of the meeting, a vote of thanks to Mr. Keith, their worthy secretary, and the rest of the staff, for the efficient way they had carried out the Company's affairs.

Mr. SQUIRE: Perhaps I ought to have included them in the vote of thanks to the Chairman and the Board.

The CHAIRMAN said he was glad to have the opportunity of moving the resolution himself, as the Directors saw more of the staff and their work than the shareholders did. They liked to bestow merit were merit was due (cheers).

Mr. GREENWOOD was pleased to second the resolution and to give his testimony as to the manner in which the affairs of the Company were conducted. A considerable amount of care was taken by their Secretary in the conduct of their business. He (the speaker) had not seen Mr. Keith before, but he had often seen his signature, and read his letters. Mr. Keith seemed to anticipate everything that required to be done.

The motion was unanimously carried.

Mr. KEITH said he had to thank them for the very flattering way in which his services had been referred to. He begged to thank them very much on his own behalf and that of the staff. They always tried to do their duty.

Mr. J. SCOTT: I thank you, gentlemen, on my own behalf for your kind vote.

The meeting then separated.

National Telephone Company (Limited).

The eighth annual ordinary general meeting of this Company took place on the 4th inst., at the offices, Queen Victoria-street, under the presidency of Colonel R. Raynsford Jackson.

The SECRETARY (Mr. Wm. B. Campbell) read the notice convening the meeting; and the report of the Directors was taken as read.

The CHAIRMAN then said: The report, gentlemen, speaks very much for itself, and the remarks I shall make to you will be mainly with the view of bringing more prominently to your notice some of its salient features. The first point to which I shall call your attention is that the revenue which the Company had reached on the 30th of June amounted to £109,572. 12s. 7d. and that this was an increase upon the revenue reached at the same period in the previous year of £17,235. 10s. 3d. Of that increase of revenue a certain proportion, namely, £1,200, is due to fee messages. If you look at the abstract, you will see that we have somewhat altered the first divisions. Last year we did not distinguish between annual rentals and fee messages, and we headed that column with "gross revenue." I believe the heading "gross revenue" was somewhat misleading. Some thought it was the gross revenue realized for that year. We have altered the heading, in order to prevent the possibility of similar mistakes. It is the annual gross income arrived at on the 30th of June last. Then I will ask your attention to the heading "trunk wires." The length of pole lines is now 842 miles, or an increase of 199 miles during the year. The length of wires carried by these poles is 2,509 miles, or an increase of 590 miles on the length of the previous year. Then, under the heading of "new exchanges," you will find that we have increased the number of exchanges by 26, and the number of lines by 1,470; and if you look at the second page of the report you will see a minute statement showing the number of subscribers in our various centres, and that the total number of lines is now 9,324. I ask you to examine this a little carefully. The towns bracketed together are in communication with each other by trunk wires, and it may be interesting to you to know that before the middle of next month we anticipate to have the trunk line completed between Sheffield and Birmingham, which will put Nottingham, Derby, and the Birmingham district into communication with Yorkshire and the Lancashire and Cheshire system. When we meet again I hope also to have the Potteries district connected with Birmingham as well as with the Lancashire and Cheshire system, giving communication with Manchester in almost a straight line from Birmingham, which will enable us, when the Birmirgham and London line is completed, to have direct telephonic communication between London and Manchester. I will ask you next to look to the item "debenture" stock in the capital account. We have converted our debenture bonds (at all events, to the extent of £70,700 out of £75,000) into debenture stock. £60,900 of the debenture bonds were at 6 per cent., and £14,100 at 5 per cent, and the debenture stock has been placed at 4½ per cent., thus diminishing the charge upon the company for interest. This is all I shall say upon the progress of the company, but I wish to point out that that progress would have been quite impossible but for the change made by the late Mr. Fawcett in the powers granted to the company on November 29, 1884, and I will ask you to cast your eyes at the map on the wall. It is different from the other maps in this respect—you see that the outline in red represents the boundary of the National Company's districts, and that the little red spots show the small parts of the whole area that we were allowed to give the telephone to under our old licenses. Take for example the Yorkshire district. We were allowed to exploit towns with small contiguous areas—say four miles around Bradford, five around Leeds and a smaller area around the other towns—and we were not allowed to connect these towns with each other. Even when the districts overlapped we were not permitted to run trunk wires from town to town, as so much desired by the community, as giving a larger range to telephonic conversation. The fact is that these little spots represent the oases in a great waste which alone were allowed to have the benefit of the telephone. Mr. Fawcett, a large-minded and liberal statesman, saw that the restrictions upon the use of the telephone which then existed were not for the advantage of the community, and granted us licenses which have enabled us to enlarge the system to the extent I have described, and to connect nearly all our centres with each other, giving altogether a telephonic system which has the merit of being extensive and effective, and of supplying almost all the telephonic wants that are as yet developed. Had we remained under the old licenses telephonic enterprise in this country would have been a disgrace to a nation which professes to be in the van of commercial progress. I ask your attention now to the subject of amalgamation. I have nothing to add to what was said by the chairman of the United Telephone Company upon that subject. I think he put the position of the companies towards each other on that question very fairly before his shareholders. There is one point he dwelt upon and recurred to a second time about which I want to say a few words. I will give you his exact observations. He said, "It would be idle, however, to shut our eyes to the fact that questions may arise on which different opinions may legitimately be held, and of course may be more or less difficult to solve. The question as to the value to be attached to undeveloped business is an apt illustration of what I mean." Upon that point I will merely observe this, that as far as we are concerned we shall have to guard ourselves against the possibility of having to pay dividends upon capital awarded to other companies, on account of what may be supposed to be their prospects, out of the actual earnings of this Company. I do not apprehend that we shall find the difficulty insuperable. My own experience is that where people approach each other in a fair state of mind, with a desire to accomplish a given object, not dealing with each other in a grasping spirit, but on the principle of give and take, difficulties in negotiation are generally overcome, and I cannot see why our case should be an exception to that rule. That is all I think it necessary to say to you to-day, excepting this: that our relations with the Post Office are, as hitherto, most amicable. It is perhaps desirable to repeat that fact, because when we have so much to do in various ways with a great public department our shareholders may necessarily wish to know how we stand with that department. I shall be prepared to answer any question that may be put to me, and now I will propose—

"*That the report and accounts for the year ended the 30th June, 1888, be received and adopted.*"

Colonel HARRISON briefly expressed his pleasure in seconding the motion.

The CHAIRMAN: If no questions are to be asked I will put the resolution. Having put the motion in the usual manner, he declared it carried unanimously. Continuing, he said: The next resolution is—

"*That a dividend at the rate of 6 per cent. per annum, less income-tax, be paid upon the First Preference stock for the six months ended 30th June, 1888.*"

Mr. SAMUEL H. SANDS seconded the motion, which was carried unanimously.

The CHAIRMAN: I now move—

"*That a dividend at the rate of 6 per cent. per annum, less income-tax, be paid upon the amount paid up on the Second Preference stock for the six months ended 30th June, 1888.*"

Mr. S. D. WILLIAMS seconded the resolution, which was carried unanimously.

The CHAIRMAN: I have now to move—

"*That a dividend at the rate of 5 per cent. per annum, free of income-tax, be paid on the Ordinary stock.*"

Mr. T. A. DICKSON, M.P.: I have great pleasure in seconding the resolution just proposed, and I think it is only right to say that in getting a dividend of 5 per cent. now on the Ordinary stock, I regard such a distribution as a very remarkable fact in connection with the development of this telephone company. I remember five or six years ago, when I first became connected with the Telephone Company, that I had little idea of seeing 5 per cent. paid upon the Ordinary shares of the company, but under the able management of Colonel Jackson—who is deserving of all praise from the shareholders of the Company, and whose whole thoughts night and day are, I believe, connected with our interests—we have reached the position of getting 5 per cent. upon the Ordinary shares. I think such results as we have obtained are entirely due to the able management of our Chairman. I have great pleasure in seconding the motion.

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The CHAIRMAN put it, and it was carried unanimously. He afterwards proposed the re-election as a member of the Board of Mr. John Bruce, observing that that gentleman was a very active, able, and useful Director of the Company.

Colonel HARRISON seconded the motion, and it was carried unanimously.

The CHAIRMAN next proposed the re-election as a Director of Mr. Jeremiah Garnett, whom he described as an active and energetic member of the Board.

Mr. SANDS seconded the resolution, which was carried unanimously.

On the motion of Mr. DICKSON, M.P., seconded by Mr. JOHN LEAKE, Messrs. Quilter, Welton, and Co., were reappointed auditors to the Company.

Mr. DICKSON: Before we separate I think it is only right that we should accord a vote of thanks to Colonel Jackson, our Chairman, and to the Directors for the manner in which they have conducted the business of the Company during the past six months. I have already referred to the services of Col. Jackson in pioneering this Telephone Company so successfully upon its path hitherto. I believe that telephone enterprise is only yet in its infancy in this country. We are far behind America and many other countries, and I look forward to the time—not many years hence—when our revenue shall be 50 per cent. more than to-day (hear, hear). I have no hesitation in saying that our prosperity and position to-day in this Company are mainly, or entirely, owing to the unwearying zeal given to our interests by our Chairman and his colleagues on the Board. I have very great pleasure in proposing that the best thanks of this meeting be given to Col. Jackson and the Directors, and I think I should couple with their names the name of our secretary, Mr. Campbell. I have known Mr. Campbell for some years as secretary of this Company, and I can only say, from my personal knowledge of him, that he is worthy of a vote of thanks. I have great pleasure in proposing this vote to those gentlemen.

Mr. JOHN LEAKE seconded the motion, and it was carried unanimously.

The CHAIRMAN: Gentlemen, I thank you for the vote of thanks which has been so kindly proposed by Mr. Dickson and accepted by the meeting. I wish to say that it gives me infinite pleasure to see a larger assemblage of our shareholders to-day than we have ever had before. Generally the number of shareholders attending our meetings is much more limited. Now I am glad to see that the shareholders are beginning to take more interest in our progress, and I hope in another year we shall have a still larger muster if the National Telephone Company continues at that time to have a separate existence. I thank you for myself and colleagues.

The SECRETARY also acknowledged the vote, and the proceeding then terminated.

NEW COMPANIES REGISTERED.

MONTEVIDEO TELEPHONE COMPANY (LIMITED).—This company was registered on the 31st ult., with a capital of £180,000, in shares of £5 each, to carry on the business of a telephone company in all branches. The first subscribers are:—

	Shares.
F. A. Christie, 4, Albion-villas, Stoke Newington, London, N, clerk	1
J. B. Munro, 35, Linton-street, London, N., clerk	1
H. C. H. Gibbs, 2, Abbeville-road, South Clapham, clerk	1
R. Matthew, 54, Wharton-road, West Kensington-road, W., clerk	1
G. Jackson, 34, Gloucester road, Holloway, N.	1
D. R. Crane, 3, Earlam-road, Cliftonville, S.E., shorthand writer.	1
H. B. Clifton, 2, Shanklin-road, Crouch End, N.	1

The number of directors is not to be less than three, nor more than seven; and the first are to be elected by the subscribers; qualification, the sum of £250 in stock or shares of the company; the remuneration of the directors is to be the sum of £150 per annum each, with a further sum of £50 to the chairman.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 3rd, 1888, amounted to £5,601.

CHELSEA ELECTRICITY SUPPLY COMPANY.—Letters of allotment in this company have been posted.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of July was 3,850, estimated to produce £3,100, against 3,280 messages, producing £2,607, in the corresponding month of last year. The traffic receipts for the month of April, estimated at £3,700, realised £3,705.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the month of July, 1888, amounted to £1,518, against £1,538 in the corresponding period of last year.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of July, 1888, amounted to £35,233, and to £38,520 in the corresponding period of 1887.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of July, 1888, amounted to £48,735, and to £45,805 in the corresponding period of 1887.

GREAT NORTHERN TELEGRAPH COMPANY.—Traffic returns: Receipts in July, 1888, £24,000; 1st January to 31st July, 1888, £156,000; corresponding months, 1887, £150,520; ditto, 1886, £147,560.

METROPOLITAN ELECTRIC SUPPLY COMPANY.—Letters of allotment and regret in this company have been sent out. We understand that the applications were largely in excess of the amount of the issue.

MONTE VIDEO TELEPHONE COMPANY.—The English Bank of the River Plate invite subscriptions for £180,000 of share capital, divided in 24,000 six per cent preference and 12,000 ordinary shares of £5 each, of the Monte Video Telephone Company (Limited), which has been formed to acquire as a going concern the concession, rights, patent privileges, plant, exchanges, and other property belonging to the telephone company known as La Sociedad Anonima Compania, Telefonica La Uruguaya, in the city of Monte Video. The Uruguay Company was incorporated in the month of April, 1885. It commenced operations with about 450 subscribers; since which it has made rapid progress, and by the latest information received from Monte Video, the total number of telephones now working are 1,610. A telegram from Monte Video states that the net receipts for the first four months of the Uruguay Company's current year, ending 30th June last were $18,800, or at the rate of $56,400 per annum, equivalent to £12,000.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 2nd, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £4,673.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this company for the month ended July 31st, 1888, amounted to £4,550.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, August 8, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending August 8, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	41 42	3 5 6	Jan., Apr., July, Oct.	41	...
2,614,320	Stock	10/0	Do. Preferred	68 69	3 19 9	,, ,,	69¼	68⅜
2,614,320	Stock	nil.	Do. Deferred	13⅜ 14½	...	February	14	13⅜
130,000	£10	3/0	Brazilian Submarine	12⅜ 13	5 7 8	Mar., June, Oct., Dec.	13	12⅜
16,000	10	9/0	Cuba Submarine	13½ 14	6 1 3	February and August	14	...
6,000	10	10/0	Do. Preference	18½ 19½	5 2 6	,, ,,	...	...
12,931	5	4%'87	Direct Spanish (£4 paid)	3⅜ 4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference	9⅜ 10⅛	4 15 3	April and October	...	...
60,710	20	2/0	Direct United States	9⅛ 9⅜	4 5 3	Jan., Apr., July, Oct.	9⅜	9⅛
380,000	10	4/6	Eastern	12⅛ 12⅜	4 8 11	,, ,,	12⅜	12⅛
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜ 15½	3 19 0	,, ,,	15	14⅜
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 109	3 16 3	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅞ 13⅛	4 19 0	Jan., Apr., July, Oct.	13⅛	12⅞
22,050	10	8/3	German Union Telegraph and Trust	9 9⅛	7 7 4	January and March	...	...
179,177	10	3/0	Globe Telegraph and Trust	6⅜ 7	5 0 0	Jan., Apr., July, Oct.	7⅛	6⅛
178,992	10	3/0	Do. 6 per Cent. Preference	14 14½	4 4 3	,, ,,	14½	14
150,000	10	7½%'87	Great Northern	13⅜ 14½	5 5 3	Jan., July, and April	14 1/16	14
17,000	25	37/6	Indo-European	36 38	6 11 9	April and October	...	...
33,348	10	8/0	London Platino Brazilian	5⅜ 6½	...	May and November	...	...
9,000	8	4/0	Reuter's	7⅜ 8	5 0 0	April and October	...	...
338,225	Stock	13½%	Submarine	140 150	9 13 4	February & August	...	...
30,000	10	4/0	West Coast of America	6½ 7	7 3 0	January and July	...	...
150,000	Stock	8%	Do. Debentures	110 115	6 19 2	June and December	97⅜	...
88,321	10	nil.	West India and Panama	1⅜ 1⅝	...	...	1 3/16	1 1/16
34,563	10	10/0	Do. 1st Preference	11½ 11⅝	...	April and October	11½	...
45,181	15	9/0	Western Brazilian	11⅛ 11⅜	5 12 3	March & September	11 7/16	11⅛
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	102 104	5 15 5	March & September	...	...
			TELEPHONES.					
224,850	14/0	$5 7s.% '87	Consolidated Telephone and Maintenance	1/16 1⅛	5 10 0	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	⅛ ⅜	5 13 6	...	...	...
80,000	5	10/0	United	13½ 13⅝	5 9 1	June and December	13⅝	13 5/16
50,000	5	2/6	United River Plate	5¼ 5⅜	...	April and October	...	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3 3⅛	...	...	3⅛	...
23,692	5	nil.	Do. (fully paid)	4¼ 4⅜	...	February & August	4	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2⅜	...	...	2⅜	2¼
312,000	½	5% '86	Maxim-Weston	1/16 1/16	...	February	⅛	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39 40	5 19 9	March and July	39½	39⅛
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works xd	17 18	5 14 3	February & August	17⅜	17¼

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

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The principal objects of the Corporation are:—

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2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

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GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

The arrangements for the meeting of the British Association at Bath are rapidly advancing towards completion; and although the meeting will scarcely compare in scientific interest with that of last year, when so many distinguished foreign members were present, yet there is every reason to anticipate a very interesting and pleasant gathering. We have already announced that special arrangements have been made for a discussion on Lightning Conductors, in which Sections A and G will take part. Mr. Preece, in his Presidential Address in Section G (Mechanical Science), will pass under review the various practical applications of electricity, with most of which Mr. Preece has himself been associated from the very first. He will also say something about the theory of electricity which can hardly fail to be of considerable interest. Prof. Forbes will read a Paper on "The Westinghouse System of Electrical Distribution," which he has had exceptional opportunities of studying. In the absence of Mr. Cowles, Mr. Crompton will read a Paper on the Cowles process for the reduction of aluminium; and about half-a-dozen other electrical Papers have so far been arranged for in this section.

In Section A (Mathematics and Physics) Prof. Fitzgerald has accepted the Presidency in the place of Prof. Schuster, whose health compelled him to decline the post. From Prof. Schuster, had he been able to occupy the Presidential chair, we should no doubt have heard something of the highest interest and importance on the phenomena of electrical discharges in rarefied gases, or on terrestrial magnetism—questions to which Prof. Schuster has devoted long years of labour. Prof. Fitzgerald, on the other hand, will probably summarise the latest results of mathematical and physical research in the electro-magnetic theory of light, and as this is a subject in which some remarkable experimental advances have quite recently been made, the address will be looked forward to with special interest.

The proposal of the United Telephone Company to establish a local exchange system and call stations, for what may be called "domestic" purposes, in the Kensington district, has, on the whole, been received with favour. The experiment will certainly be watched with interest, as likely to afford conclusive evidence as to whether such popular applications of the telephone service can be made to pay in the metropolis—a point on which, apparently, the company itself has long remained sceptical. The experience of provincial towns and districts justifies a sanguine view of the result; and there is no excuse for the adverse criticism which has already been offered to the scheme on the score of its excessive charges. Telephone extensions are very costly affairs, expenses increase quite disproportionately with increased business, and there is no known method of increasing the capacity of the telephone wire. Those who complain of the charge of 6d. for three minutes' conversation by telephone are perhaps ignorant of what can be earned on a telegraph wire in the same number of minutes—ordinarily ten times, possibly twenty times, as much. Particulars of the Kensington scheme may be found in our advertisement columns.

The following extract from a private letter to the Editor, written by M. Gaston Planté, and which we have obtained his permission to publish, will certainly be read with interest. The reference is to a note which appeared in the same issue (August 3rd) in which we reviewed M. Planté's work on "Atmospheric Electricity." He says:—

"I have read with interest the experiment which you cite, and which was made by Mr. Mordey at the works of the Brush Company. If the arc produced between the carbon electrode and the salt water did not appear to take a globular form, probably the light of the arc was too dazzling, or else the E.M.F. of the current was not sufficiently high. It is better to employ an electrode of platinum or *d'amiante humide* (? moistened asbestos), when the globular heaping up of the *liquid* may be observed in salt water with an E.M.F. of 500 volts. To produce the globular form of the arc above distilled water an E.M.F. of 2,000 volts is necessary. I shall be very glad indeed if those who have machines of high tension at their disposal will repeat my experiments, but every precaution should be taken to avoid the dangers which attend the handling of such high E.M.F.'s. In all cases it is better to employ a shunt circuit, for a large current is not necessary. It is *tension*, not quantity, which we require."

The experiments of Wheatstone, and the fact that rapidly-moving bodies when illuminated by lightning appear as if at rest, have led to the belief that the duration of the lightning flash is almost infinitesimally small. M. Trouvelot has, however, obtained evidence, apparently of an unimpeachable character, which shows that, at least in a particular case, the flash had a duration of several seconds, during which it preserved the same form. Writing in *La Lumière Electrique* he says:—

"Lightning does not possess the instantaneousness generally attributed to it. One of the photographs which I obtained during the storm of the 22nd of last month clearly proves this, showing

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that this particular flash, at any rate, was by no means instantaneous, but lasted several seconds. At the moment of the flash I gave the photographic apparatus a slight horizontal motion, lasting at least three seconds. Now, this movement is faithfully reproduced in the photograph, the image of the flash being displaced some six millimetres. This being the case, we ought to be able, by means of suitable mechanism, giving the camera a uniform motion, to measure accurately the duration of flashes. The photograph shows that the flash had already lasted some time when the apparatus was moved, and also that it lasted some time after the motion had ceased, the edges of the illuminated belt being more sharply defined than the intervening space. This flash, like all which I have hitherto succeeded in photographing, is ribbon shaped, and is traversed by a number of streaks. The displacement of the camera also shows that the form of the flash did not sensibly alter, for the sinuosities are identical at the two extremes of the photograph, three or four seconds having elapsed."

THE lack of a simple and expeditious means of measuring the strength of the magnetic field has long been felt. LIPPMANN'S method (depending on the alteration in the height of a balanced column of mercury placed in the field to be measured, and through which a current is passed), although remarkably ingenious, is open to serious objection. The employment of glass tubing is of itself almost fatal to its usefulness in practical measurements of dynamo machines. At last, however, it would seem that a method is available which promises to fulfil every reasonable condition, and for which we are inclined to anticipate a considerable field of usefulness. It has long been known that the electrical resistance of bismuth is increased when it is placed in a magnetic field, and LEDUC proposed to employ this property to measure, empirically, the strength of the field. But the increase of resistance observed in ordinary bismuth is not so marked as to render the phenomenon very readily available. Now, however, Drs. LENARD and HOWARD have succeeded in preparing flat spirals of bismuth wire in which the resistance increases from about 10 to about 20 ohms in a field of 17,000 C.-G.-S. units. An ordinary Wheatstone bridge measurement and a table of reference will therefore enable the dynamo manufacturer to measure any field into which a thin flat spiral can be inserted. For full details the reader is referred to an article on another page.

THE important electrical patent litigation between the proprietors of the "Thomson-Houston" and "American" systems of electric lighting has just been decided by the United States Courts in favour of the former, as holding the only fundamental patent on automatic current regulating machines. We understand that this may be expected to be followed by a similar trial of strength between the Thomson-Houston Company and their rivals in this country.

IT is impossible not to sympathise with Admiral FIELD and others—not, perhaps, including Dr. TANNER—in their opposition to, or, rather, in their demand for further time to consider, the Bill empowering LLOYD'S to acquire land and establish electrical communication with lighthouses, lightships and signal stations for life-saving, and maritime signalling purposes. There is, on the face of it, a grave practical objection to conferring on a private corporation powers which ought to be exercised by the Post Office, and which, in time of war, must confessedly be surrendered to one or other Department of the State. Our own criticisms of the Bill would be somewhat different, namely, that it leaves to voluntary action, determined by considerations of profit, a duty which ought to be discharged with more exclusive regard to the safety of the nation and its commerce. As, however, the Government is not prepared to establish a complete system of telegraphic communication round the coast, we may be thankful for even the limited promises held out by LLOYD'S. The House of Commons finally adopted this view, and the Bill was read a third time last Friday night.

WHEN the City and Southwark Subway Company first came into notice we strongly urged that the line was particularly well adapted for working by electricity. Moreover (as is our invariable practice in such cases), we took especial care that our arguments should come under the notice of those for whose immediate benefit they were intended. It has now for some time been practically settled that electric traction is to be adopted, and at the meeting of the company on Tuesday last (which we report more fully in another column), the chairman announced that the line would probably be in working order by this time next year. Although, as we have said, the employment of electric traction is practically settled, the particular system to be selected is still an open question. Both a parallel and a series system have been, and we believe still are, under consideration, but in any case accumulators will not be employed —in fact, they have not even been suggested. It is, perhaps, not too late to add that we are a little sorry that the company, in seeking for technical advice, should have called in the services of a gentleman who, however eminent as an engineer of railway telegraphs, has not hitherto devoted special attention to electric traction. The applications of electricity are now far too wide for any one man, however clever, to cover the whole ground. Submarine Cable Companies do not go for advice to Mr. KAPP or Mr. MORDEY, and even Mr. PREECE is not, we believe, an eminent authority on the subject of electro-metallurgy.

THE applications of electrical science form no exception to the general rule that there are at least two ways of doing things—a right way and a wrong way. But we cannot help thinking that the people who prefer the wrong method of treatment are somewhat excessively numerous where electricity is concerned. There are people, as we all know, who are anxious to work heavy railway traffic with secondary batteries; there are others who prefer incandescent lamps of 16 candle-power for lighting open spaces, and still others who like to see powerful arc lamps in small retail shops. Cases are even on record where alternating currents have been preferred to continuous currents for working direct from the machine, while the devotees of the art and mystery of electric lighting by primary batteries we have ever with us. To this day there are London banks who prefer to communicate with their branch offices by means of the Wheatstone A B C instrument at three words a minute.

But by far the most inexplicable and indeed astounding instance of the kind which has yet come under our notice is to

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be found in a recently published "interview" in the *Pall Mall Gazette*. Sir EDWARD WATKIN, who on this occasion was the victim, expressed to the reporter a very reasonable surprise that such an enterprising line as the London and North-Western still adhered to the archaic method of signalling from the passenger to the guard by means of a piece of string fastened outside the window. It is not in this instance, however, the string, but the substitute proposed, that fills us with astonishment. Sir EDWARD was able to point with conscious pride to the fact that the South-Eastern—as befits a model railway company—had long ago adopted an electrical method of communication. Yet, ever anxious to perfect any trifling defects which may still be found upon the South-Eastern line, Sir EDWARD "has been trying for some years, to use for this purpose, the telephone" (!)

"What I shall do, I think," Sir EDWARD magnanimously proceeded, "is to offer a little prize of a hundred guineas or so for a solution of the problem of talk between passenger and driver, and talk between passenger and guard. Of course there are many difficulties, vibration and so on, but in my judgment there is nothing that cannot be overcome. If it could be done, that would be a revolution. When an old woman feels she can talk to the guard and her conversation will be registered by the telephone company [here Sir EDWARD becomes a little incoherent]—we should have to carry telephone boys on the engine or in the van—she feels it a comfort; she is no longer, as she fancies, between a certain person and the deep sea. At present, of course, it would not do to stop a train because a man thinks the carriage is shaky when it is perhaps only his nerves. With a telephone he could talk away, and properly explain whatever he wished. That," Sir EDWARD added, "is one of my pet projects, and another is the electric locomotive."

The spectacle of some "poor devil of the public" (as Sir EDWARD WATKIN phrased it in the same interview) trying to communicate with the guard by telephone, while attacked by garotters on the South-Eastern Railway is one which the imagination positively reels to contemplate. We have, however, one hope to buoy us up; we believe that Sir EDWARD made a fatal mistake in introducing that reference to the old woman, and on the day when the one hundred-guinea prize is awarded we confidently anticipate a strike amongst the passenger guards of the South-Eastern. Nevertheless, all this furnishes no excuse for the North-Western and other railways who have neglected to provide electrical communication.

SOME of us have laughed at the schoolboy who, when asked to compose a theme On Pins, wrote "Pins have saved a great many lives by not swallowing them." Perhaps the Pitsville workman who, a little while ago, fell from the roof of a house and was saved from being dashed to pieces by a pair of electric lighting wires would take the story more seriously. It is said that the two leads were carrying a current of 1,000 volts, alternating current, which effectually prevented him leaving go until some one came with a long ladder and helped him down. Thus it would appear that the full force of a powerful current, so far from killing him, actually saved the man's life; but he is probably the first person who has received such a current and been thankful for it.

Cowpen, Northumberland.—The Cowpen District Local Board are inviting tenders for arc and incandescent lighting. Particulars may be found elsewhere in this issue.

Vicenza.—The Municipality of Vicenza has granted a nine years' concession to M. Conti to establish a central station for the purpose of lighting the private houses of the town by electricity.

The Telephone in Burmah.—The *Indian Engineer* says that a rival telephone company in Burmah has obtained sanction from the Local Government to open out a new line in opposition to the Oriental Telephone Company.

Pekin.—It is stated that the Chinese Emperor is expending £1,400 on an installation in his palace grounds at Pekin, and should this prove a success we may expect to see his august example followed by the notabilities of the empire.

Madrid.—The city of Madrid will soon have a large central station of 1,000 horse-power capacity, constructed by a local company called "La Luz Natural." The wires will be run overhead, and the charge is to be five centimes per hour per lamp of 16 candles.

Sale of Electrical Plant by Tender at Bournemouth.—We would call attention to the notice which will be found in our advertisement columns respecting the electrical plant which is offered for sale by the liquidators of the Bournemouth Electric Light and Power Company.

Yacht Lighting with Accumulators.—In addition to the Queen's yacht, "Victoria and Albert," we understand that Messrs. Drake and Gorham have recently fitted a set of accumulators on the Prince of Wales's yacht "Osborne." The cells are found to answer their purpose well, and are naturally felt to be a great convenience.

Belting.—According to experiments recently made at the Royal Polytechnic School at Munich, the strength of camels' hair belting reaches 6,315lb. per square inch, whilst that of ordinary belting ranges between 2,230lb. and 5,260lb. per square inch. The camels' hair belt is said to work smoothly and well, and it is unaffected by acids.

Plumstead District Board.—At the last meeting of this Board it was resolved, on the recommendation of the General Purposes Committee, to inform an electric lighting company who had served Parliamentary notices, that, subject to the rights of the public being protected, they would look favourably upon the introduction of electricity into the district.

Bank of England.—We are glad to hear that in addition to the 500-light installation recently erected, the Bank have now decided to make a further extension, and Messrs. Drake and Gorham have received instructions to put down two additional engines. Two more Elwell-Parker dynamos will be fixed, and two batteries of cells made to Messrs. Drake and Gorham's specification.

Electric Traction.—The American *Street Railway Journal*, which has recently described numerous electrical tramway systems more or less under trial, says:—"That the science of electrical propulsion has reached perfection no man will attempt to maintain, but that it has reached the stage of practical and economical utility every unprejudiced person should freely admit."

SS. "Norham Castle."—The Castle line Royal Mail Steamer "Norham Castle" has lately been fitted throughout with the electric light by the Anglo-American Brush Corporation. The installation comprises two 180-light Victoria dynamos, driven by two independent engines, and 320 16 candle-power incan-

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descent lamps. The circuits are so arranged that in the event of a partial breakdown the most important parts of the ship can still be lighted. The electric light has further been applied to the side and masthead lights, and also to a submarine lamp, by means of which the ship's hull and propeller can be easily examined by the aid of a water telescope.

Chelsea Vestry.—At the last meeting of the Chelsea Vestry the Electric Lighting Committee submitted a letter from the Chelsea Electricity Supply Company, Draycott-place, Cadogan-street, Chelsea, stating that the whole of the amount required as capital (£32,000) had been provided, and that the company would begin work without delay.—The report of the committee was adopted, on the motion of Mr. C. Mossop.—The Surveyor said he had received from the company a list of the streets on Schedule A in which the company proposed to lay wires without any unnecessary delay. The surveyor added, in answer to a question, that all the wires would be underground.—The assent of the vestry to the intention of the company was given.

The Rates for Press Telegrams.—In the House of Commons, on August 10th, Mr. Cochrane-Baillie asked the Postmaster-General whether, in view of the report of the Committee on the Revenue Departments, he could state that the Government would bring in further legislation to relieve the country from the loss incurred by the present agreement in connection with the sending of press telegrams. Mr. Raikes said, having regard to the fact that the charges for press messages were fixed by statutory power conferred by the Telegraphs Act of 1868, and that the charges levied had been in operation upwards of eighteen years, he feared it would be difficult to make any change. The question of further legislation was, however, one more for the First Lord of the Treasury than himself.

Automatic Gas Lighting.—At the annual meeting of the North British Association of Gas Managers, Mr. G. Keillor, of Nairn, read a Paper on a method of automatic gas lighting which he had successfully carried out. The actual lighter contained nothing novel, the well-known form supplied by the Woodhouse and Rawson Company having been found perfectly efficient. The novelty consisted in the combination with this apparatus of a delicate governor actuated by the pressure in the main, and by which the circuit of the battery is closed or opened whenever the pressure is increased or diminished to the point for which it is set. In this way, by the mere regulation of the pressure at the gasworks, any number of lamps supplied with the electric lighter may be simultaneously lit or extinguished.

Interruption of Cables to the East.—The Eastern Telegraph Company notifies the interruption of its Aden-Bombay cables. The repairing ship will be in the locality of the fault in a few days' time. Until the communication is restored, telegrams for India, China, &c., should be sent through the lines of the Indo-European Telegraph Company.—The Indo-European Telegraph Company announce that one of the cables of the Indian Government, between Bushire and Jask, in the Persian Gulf, broke down on the 13th inst. at noon. The Indian Government have now, therefore, only one working cable by the Indo-European route. The Government repairing steamer "Patrick Stewart" is on her way to the fault, and the repairs are expected to be completed between the 20th and 22nd inst.

Dalkeith.—At a meeting of the Police Commissioners of Dalkeith on Monday last—Provost Gray presiding—Baillie Watson said that as the town was now in possession of a powerful gas engine, he believed it would be beneficial for the community at large if it could be utilised for the purpose of producing electric light as well as pumping water. He believed the engine to be capable of doing both; and then the business premises and dwellings of the townspeople, to the surprise and admiration of all, would be lighted with a light somewhat approaching the light of the sun in purity and splendour; and for this end he proposed that they appoint Messrs. Alison, Liddell, Baillie Murdoch, and himself a committee to make the necessary inquiries with a view to accomplishing so desirable an object. The motion was agreed to, and Bailie Watson was appointed convener.

St. James's Vestry.—At the last meeting of the Vestry of St. James's it was resolved, on the motion of Mr. Keevil, with respect to the Electric Lighting License—(1) That no overhead wires or cables shall be placed within the jurisdiction of this Vestry; and as to clause 14, after the word "street," this clause shall end. (2) That this Vestry will not approve of any concession or license being granted to any electric light company to supply such light to this parish, unless the license provides that after the shareholders of such company have received an annual dividend of ten per cent. one half the surplus shall be set aside and applied towards the funds of this parish, or in diminution of the charge for lighting by electricity the public streets. (3) That all correspondence and matters in reference to granting a concession by this vestry to any electric lighting company shall be submitted to the legal advisers of this vestry to report thereon before being finally confirmed.

The Crystal Palace School of Practical Engineering.—On Saturday, August 11th, the certificates awarded to the students in this school as the result of the examination on the work of the past term were distributed by Mr. A. T. Walmisley, C.E., President of the Society of Engineers. In the electrical section Mr. Sydney Evershed officiated as examiner, and presented the following report:—"I have visited the School during the past session, and also looked over the papers worked by the students at the summer term examination. The electrical section is conducted on an excellent system, by which, in addition to a thorough grounding in the theory of electricity, the students receive practical instruction in the management and working of electrical plant. The inspection and repairs of the machinery used for lighting the Palace and grounds being entrusted (under supervision) to the students, they have exceptional facilities for acquiring most valuable technical skill and experience."

City and Guilds of London Institute.—The Report on the Technological Examinations held in May last connected with this Institute has just been issued, and shows a steady progress in every department of technical instruction. During the past year 10,404 students were under tuition in 475 classes, spread over 183 different towns in the United Kingdom. The corresponding numbers for the previous year were 8,613 students, 365 classes, and 121 towns. These numbers do not include the students at the Finsbury and provincial colleges, the candidates from which are classed as "external." Of the provincial towns, Manchester as usual heads the list with the largest number of candidates passed, Glasgow occupying the second place. Of the 10,404 students at the registered classes, 5,240 came up for examination, and 2,892 of these succeeded in passing. Including the external candidates, trained at colleges or in private, the total number of passes was 3,516, of whom 2,510 passed this year for the first time. We regret to notice that the percentage of failures among candidates in the several branches of electrical engineering has slightly increased.

Electrical Communication with Lighthouses.—Sir Michael Hicks-Beach presided on Thursday, the 9th inst., at a meeting of the House of Commons Select Committee appointed to in-

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quire into Lloyd's Signal Stations Bill, the object of which is to enable Lloyd's to acquire lands compulsorily when required for the purpose of placing outlying lighthouses and islands in communication with the mainland by electricity. Sir Richard Wyatt, who appeared for the promoters of the Bill, said that it was the outcome of the investigation of a departmental committee who recommended it with a view to saving life at sea. The difficulty had presented itself to Lloyd's of persons trying to obtain an unreasonable price for a bit of land required for the purpose. The committee passed the preamble of the Bill. In the House of Commons on the following day, after a warm discussion, the Bill was read a third time. Exception was taken to it by several members on the Government side of the House because of the little time afforded for considering its provisions; but more especially because the task which the Government itself ought to carry out thoroughly would be very inadequately performed by a private company. Sir Michael Hicks-Beach, however, pointed out that the second clause of the Bill gave to the Postmaster General power to prescribe conditions which would secure the very objects which the critics of the Bill so anxiously desired.

Electric Lighting at the Exeter Asylum.—A report was made to the Exeter Town Council at their last meeting to the effect that the first cost of lighting the local asylum by electricity was £2,160 and the cost per annum £118. Under the contract Messrs. Woodhouse and Rawson were to supply storage batteries capable of maintaining 100 lamps of sixteen candle-power for fourteen hours without running the engine and dynamo. On the completion of the installation Mr. Massey, electrical engineer, reported that the storage batteries would run 100 Woodhouse and Rawson's lamps the specified time, but no other lamps then in use. Subsequently an injunction was granted against the use of Messrs. Woodhouse and Rawson's lamps as being an infringement of the Edison-Swan patent, and upon the lamps being changed it was discovered that the storage batteries would run 100 Edison-Swan lamps for nine hours only. The committee of the Asylum, having called upon the contractors to increase the power of the storage batteries, were met by the reply that they were advised that as the contract was for the erection of specified apparatus to the satisfaction of the architect they were not bound to provide additional storage batteries, those erected having been certified as complete and as having answered the test. They thought it was unfair to ask them to put in new cells, but they were willing to meet the Council to a small extent.

Ilfracombe.—A special meeting of the Ilfracombe Local Board was held on Friday last to consider the question of lighting the promenade. All the members were present with the exception of Captain Dennis and Mr. Lake, and Mr. Darbyshire presided. A letter was received from Mr. Woodley relative to the electric light. He said he could make no reduction from £150 stated, and this he understood from the chairman would only be for eight months out of the twelve. After he received this letter the surveyor said he had wired that the Board would not pay for gas for the engine, and he had received a reply stating that he (Mr. Woodley) would accept for eight months and find gas for £150. The letter received from the Gas Company at the last meeting was again read, by which it appeared that the company would supply gas at 1s. 3d. per hour, and charge £50 for the fittings. The total candle-power would be 2,500. The Surveyor said the electric light was 5,740 candle-power, but it was a question whether this was necessary.—Mr. Russell then moved that the question of lighting the whole town with electricity be considered; that tenders be invited for this purpose.—Mr. Thomas seconded.—Mr. S. Day considered that the tender should be thrown open to the Gas Company as well.—Mr. Thorold was of the same opinion, and it was resolved that tenders be invited both from the Gas Company and the Electric Lighting Companies. It was further resolved that notice be given to the Gas Company to terminate the present contract at Lady Day next. With reference to Mr. Woodley, the Surveyor was instructed to wire to him that the matter of lighting the shelter was still under consideration, and the Clerk was instructed to write to the Gas Company and ask them if they would be willing to fit up the shelter at their own cost with Wenham lights for one month, and supply a special meter, so that the Board could see the quantity of gas consumed and the quality of light produced.

Electric Traction on the City of London and Southwark Subway.—The eighth half-yearly ordinary meeting of the shareholders of this company was held at Winchester House, Old Broad-street, on Tuesday afternoon, Mr. Charles Grey Mott, the chairman of the company, presiding. The report stated that the construction of tunnels, both on the section to the Elephant and Castle and to Stockwell, had made considerable progress, and that the works were being carried on at all the station shafts along the route. Nearly the whole of the land and property required for the railway and stations had been acquired, and the directors were satisfied to record that the total cost will be somewhat less than the original estimate.—The Chairman, in moving the adoption of the report, after referring to the progress which was being made in the construction of the railway, said that the question of the best method of working the line, and the nature of the power to be used, had for some time past occupied the special consideration of the directors. It was essential that whilst the trains should be very frequent, and the transit rapid, the cost of running and maintenance should be kept as low as possible. In many respects the system of endless cable would seem to be the best, but it had certain disadvantages in its application to the working of the line which it was not easy to overcome. After much careful investigation the directors had arrived at the conclusion that electrical force, conveyed by continuous conductors, offered the best solution of the difficulty, and would give a motive power at once reliable and economical. Several firms had made proposals for the working of the line in this way, and negotiations were in progress for a practical trial of the system before a final decision was arrived at. The directors had been assured that the electrical working of the line in an efficient and economical manner did not present any difficulties; and, in fact, offers to undertake the working of the line at a fixed sum per annum had been received; but, as the directors were anxious to obtain the authorisation of the shareholders, a special meeting was to be held later in the day. It was necessary that the matter should be decided promptly, as the engineer hoped to get the work of tunnelling as far as the Elephant and Castle completed by the end of the year.—Mr. Walter Robinson having seconded the adoption of the report, it was unanimously agreed to, and the meeting was then made special in order to consider the question of empowering the directors to adopt electricity or any other motive power except steam, which is precluded by the Act, they might think desirable. Two or three shareholders expressed the opinion that the original idea of an endless cable should be adhered to, as they considered the adoption of electricity of too experimental a character. Eventually, however, the resolution proposed by the Board was adopted, and the proceedings terminated in the usual manner.

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THE EFFICIENCY OF THE EXCHANGE TELEGRAPH COMPANY'S HYDRAULIC POWER PLANT WHEN USED FOR CHARGING ACCUMULATORS.

BY F. HIGGINS.

The following description of the hydraulic apparatus employed by the Exchange Telegraph Company in the production of electricity for working over 600 of their telegraphic instruments in the City and East End of London will probably be of interest to the readers of *The Electrician*:—

The apparatus, as will be seen in the accompanying drawings, consists of a Brotherhood engine, a Gramme dynamo-electric machine, and electrical accumulators.

The motor and dynamo with countershafting are mounted upon a timber frame which is quite independent of the building, the whole platform resting loosely upon a thickness of boiler-felt upon a wooden floor. The motor cylinders, three in number, are 4in. in diameter, and the pistons have a stroke of 3in. The fly-wheel is 4ft. 6in. in diameter, and its relatively slow speed of 48 revolutions per minute is augmented by means of gearing to 930 at the dynamo, two belts being employed, the larger being a 5in. double and the smaller 4in. single. The dynamo is shunt-wound, and of the ordinary Gramme type, made by Johnson and Phillips.

The accumulators, 210 in number, are of the Electrical Power Storage Company, or E.P.S. form, in glass cells, mounted upon Johnson and Phillips's oil insulators, and connected in three series of 70 each for charging.

The E.M.F. produced by the dynamo at the before-mentioned speed is 194 volts, and the normal output of current is 15 amperes, the resistances of the various parts of the circuit being—

Armature, 1·256 ohm.
Field-magnets, 123·746 ohms.
One set of accumulators, 1·236 ohm.
The greatest potential observed of one set of the accumulators is 154·46.

From these data, and taking 746 watts to the horse-power, the power absorbed is:—

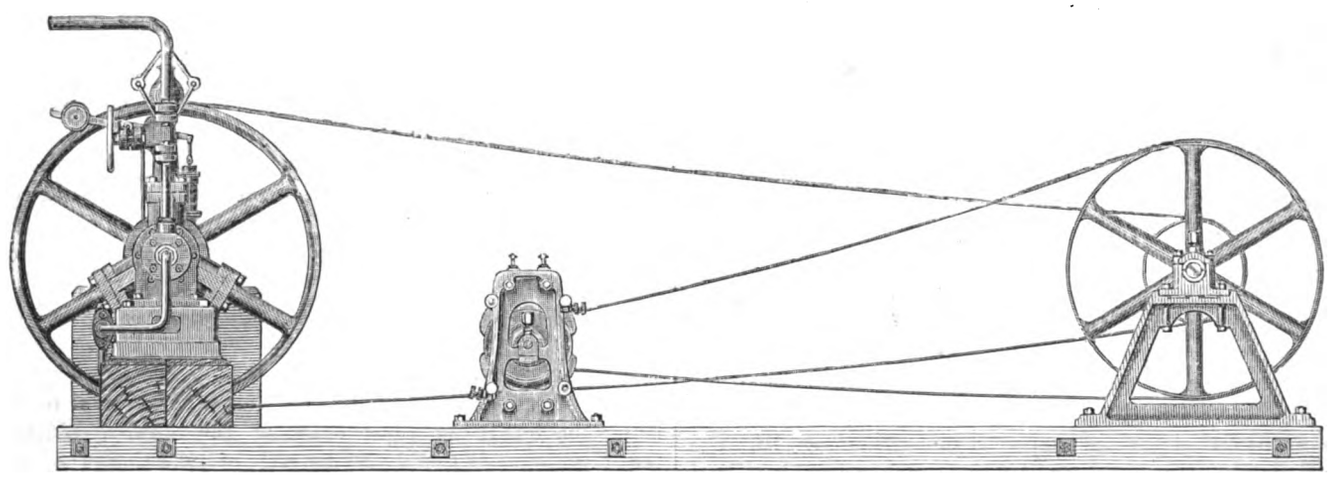
In the field and armature	0·781	horse-power.
In the exterior circuit.....	3·903	„ „
Or a total of.....	4·684	„ „

In order to ascertain the efficiency of the system the following observations of the charge and discharge were taken during a run of 6½ hours:—

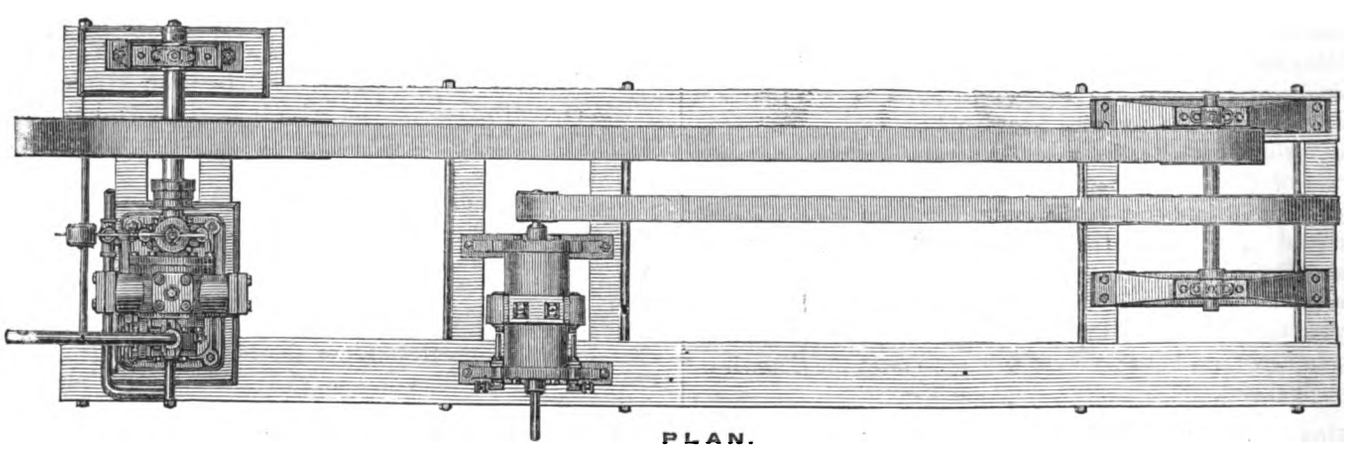
The quantity of water passed was 7,700 gallons. The pressure was assumed to be 660lb. to the square inch, owing to our machine being 80ft. above the main, where the pressure is said to be 700lb. This quantity of water should be capable of 58·138 horse-power-hours of work.

The total observed electrical horse-power was equal to 30·446 hours; therefore, the loss in friction, and inefficient incidence of thrust upon the crank of the engine, owing to the inelastic nature of the medium, would be about 48·642 per cent., and the efficiency 51·358 per cent. (I mean by inefficient incident of thrust that at the beginning and end of each stroke of the pistons the force is principally exerted on the bearings).

The total charge during the 6½ hours at 15 amperes amounts to 97·5 ampere-hours, and the output from the accumulators as measured by a sulphate of copper voltameter was 88·128 ampere-hours, the loss being 9·61 per cent. in volume, and the loss in pressure, or the difference between the potential of the dynamo charge of 194 volts and that of the accumulator discharge of 154·46 volts, is 20·45 per cent. The hydraulic machine has been in daily use for 14 months without interruption.



ELEVATION.



PLAN.

Hydraulic Motor and Gramme Machines.

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Summary of figures:—

		Horse-power.
Theoretical horse-power of water..		59·29
Electrical horse-power.....	30·4505	59·29
Loss	28·8395	
Efficiency	51·358%	
Electrical horse-power.....		30·4505
Current circulating internally.....	5·0765	30·4505
External or useful current	25·374	
External current		25·374
Return from accumulators	18·247	25 374
Loss	7·127	
Loss		7·127
Difference between dynamo and accumulator potential	5·187	7·127
Loss in accumulator from overcharge and internal leakage ...	1·940	

The horse-power of the electricity generated by the dynamo is estimated from the observed potential and volume of current, and was not measured, as was the discharge, from the accumulators. The figures given are not therefore precisely accurate, but are based on the mean readings of the measuring instruments, and it is also possible that the pressure at the motor while running is overestimated, because our connection with the main is through 120ft. of small pipe. Should this be found to be the case the necessary correction can easily be made.

P.S.—Since the above was written the mean water pressure has been ascertained to be 650lb. The efficiency of the motor is therefore 52·36 per cent. instead of 51·35 per cent.

SOME ENGLISH CENTRAL LIGHTING STATIONS.

V.—LEAMINGTON.

We do not propose on this occasion to enter upon the history of the electric light at Leamington, but merely to give a straightforward description of the plant laid down by Messrs. Chamberlain and Hookham for the Midland Electric Light and Power Company.

The engine-room, a building 90 feet square, stands on the banks of the Warwick Canal, at a point where plenty of space is available for future extensions. The plant at present in use consists of four Chamberlain and Hookham dynamos,* two Robey engines, and two steel boilers of the locomotive type, together with a high-speed engine and a pair of smaller dynamos used for charging accumulators for the day service. The large Robey engines, which are each capable of developing 200 horse-power, are of the horizontal type, compound and condensing, with cylinders 15in. and 26in. in diameter and 2ft. 4in. stroke. They are provided with the Proell cut-off gear, controlled by Richardson's electric governor. The two boilers are connected to a common steam pipe, and each is provided with an injector, while there is also a feed pump common to both.

Power is transmitted to the dynamos by means of a countershaft and cotton rope gearing, with grooved pulleys. The engines have 9ft. fly-wheels, with nine grooves, which drive on to 4ft. followers, on a 6in. main shaft. The dynamo pulleys have four grooves, and are driven from 6ft. pulleys on the main shaft. The cotton rope employed is made by Mr. Thomas Hart, of Blackburn, and is known as the Lambeth rope. The fibres being laid together without twist, it is claimed that there is no liability to stretch.

The dynamos are shunt wound, and the four large machines are each of 800 lights capacity. At present there are about 1,500 lamps wired, so that only two machines are required at once. The current is taken to a large switch-board of enamelled slate, on which are mounted a number of Drake and Gorham's ring contact switches, by which any required change in the coupling of dynamos and mains may be rapidly and safely effected.

In the day time current is supplied from a set of accumulators of the E.P.S. 31L "1888" type. This battery is divided into two parts, each containing 63 cells, with a maximum discharge of 70 amperes. These cells are charged from two 10-unit dynamos driven by a 30 horse-power Robey high-speed engine, and cotton rope gearing is again adopted. The discharging current passes through a pair of relays, by means of which a bell is set ringing as soon as the limit of 70 amperes is exceeded. This is taken as the signal for starting the main engines. In changing over from the batteries to the dynamos, the latter, when running at the proper speed, are first switched on in parallel before the batteries are switched off. The cells are charged at night while the lighting is being done from the large machines.

Under the advice of Dr. Hopkinson, the three-wire system of distribution was at first adopted, but experience soon led the company to discard this system. The difficulty of balancing the circuits may be said to vary inversely with the total number of lamps in use, whilst the saving effected is not a sufficient set off for the additional complication entailed. The Leamington station is, therefore, now worked on a simple parallel circuit with feeders, distributors, and service mains. There are two lines of feeders, one 900 yards and the other 460 yards in length, with sectional areas of 375 and 300 sq. mm. respectively, the cables being of the well-known Callender make. They are laid in brick trenches having a sectional area of 4 sq. ft., and lying 5ft. below the level of the road. The cables are supported in cleats of paraffined wood, which rest upon slate shelves clear of the bottom of the trench, so as to allow room for a drain way. The feeders terminate at two iron distributing boxes placed above ground in the streets, from which the whole of the distributing mains radiate. These mains are also carried in brick trenches, of somewhat smaller area, and the section of the copper varies from 120 to 60 sq. mm., according to the distance and number of the lamps supplied. The service mains are connected to the distributing mains by a soldered joint made in the trench, no junction boxes being employed.

The most important indoor illumination at present carried out by the company is that of the Town Hall, which comprises 360 lamps. This is a new and handsome building, in the centre of the town, and the electric fittings are of a very appropriate and tasteful character throughout. The assembly room, which has a floor space of 3,200 sq. ft., is lighted by 186 lamps, each of which is provided with a silvered reflector. This reflector is so formed that while no light is thrown vertically downwards, the number of rays reflected at any other angle to the horizontal increases as this angle diminishes. The result is very pleasing, and the illumination of this room must be pronounced a great artistic success. We may mention that this method of diffusion was designed by Mr. Hookham, and might often be used with advantage elsewhere. In the Pump Room there is an installation of 170 lights, and there is also a large installation at the house of the Mayor of Leamington, Mr. J. Fell. This is the furthest point at present reached, and is distant 1,860 yards from the central station. A good many of the leading tradesmen in the High-street have adopted the light; and in some of the shop windows, by the use of opaline shades, which screen the light itself from the observer, some very pretty effects have been produced. We heard nothing but expressions of satisfaction with regard to the indoor lighting; and, taking things as we found them on the occasion of our visit, we have no hesitation in pronouncing this portion of the Leamington installation a complete success.

As regards the street lighting, we have already had occasion to state our impression that it is of an inadequate character, and the majority of the inhabitants seem to be of the same opinion, which also they are not slow to express. It may, nevertheless, be doubted whether a stranger standing at the top of the High-street, and supposing it to be lit by gas, would find any fault with the lighting. As we have already said, the question is largely one of sentiment. The magic phrase "electric lighting" arouses expectations which nothing but a 1,200 candle-power arc light can fulfil; and from a business

* For description of this machine see *Electrician*, Feb. 11th, 1887.

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point of view this should be regarded as a conclusive reason for reserving low candle-power incandescents for indoor illumination, where alone they reign supreme.

The High-street, which is nearly a mile in length, is lit by 183 lamps of 16 candle-power (nom.). The lamp-posts are of handsome design, and the lamps are hung from short brackets projecting at right angles. These brackets extend alternately along the line of the street and over the footway, an arrangement which presents a somewhat ragged appearance when viewed from the middle of the street. At the crossings of the more important streets the lamp-post carries three brackets set at 120deg. from each other, and one of these posts is placed at each of the salient angles of the footpath; so that at a four-way crossing there are 12 lamps, and in these cases the effect is decidedly good. Eighty-three of the street lamps are on one circuit, and the remaining 100 on another. The first set are turned out at 11 p.m., and the remainder at hours varying from 1 a.m. to 6 a.m. The lamps are supposed to be lit at dusk. From our own experience, which seems also to be confirmed by the local newspapers, we think that in this and all similar cases the contractors would do well to be guided by the atmospheric conditions rather than by the almanac in determining the actual hour of lighting. The Town Council pay £2. 2s. per annum for each street lamp, and as this covers lamp renewals, it is certainly a very reasonable charge.

The distribution is effected at 110 volts, and, judging from the entries in the log-book, which are made each hour, it is very fairly uniform, the variations tending in general to be above rather than below the normal value. The regulation is effected in the first place by the Richards electric governor, which varies the speed of the engine from a minimum of 84 revolutions up to a maximum of 90 revolutions per minute. The final adjustment is made by means of a rheostat in the field-magnet circuit, which is varied in accordance with the indications of a Schuckert voltmeter specially adapted for the purpose, the fall of potential in the feeding main being compensated for by taking a turn of the feeder round the voltmeter at a certain distance from it. The effect of this is that the voltmeter indicates, not the difference of potential in the engine-room, but that at the distributing centre. We have already mentioned that there are two distributing boxes, each supplied by its own feeder, and the two dynamos in use are not coupled together at the station but work independently, one on each feeder, so that the whole of the regulating apparatus is duplicated. The load is, however, nearly equalised by means of a pair of connecting leads which are taken from one distributing box to the other. This system of regulation is certainly simple and effective, and requires no special skill on the part of the attendant. In practice it appears to work with perfect success.

The consumers are charged by meter, the instrument employed being one of Mr. Hookham's design. We shall describe and illustrate the arrangement in a later issue, when it will be seen to be of a particularly ingenious character. The tariff is as follows:—For a quarterly consumption not exceeding the equivalent of 12 units per lamp, 8d. per unit; for any further quantity exceeding the equivalent of 12 units per lamp but not exceeding the equivalent of 24 units per lamp, 6d. per unit; for any further quantity exceeding the equivalent of 24 units per lamp, 4d. per unit. This is equivalent to a charge per lamp-hour varying from ·54d. down to ·27d.

THE GLASGOW INTERNATIONAL EXHIBITION.

(FROM OUR CORRESPONDENT.)

Electric Welding and Riveting.

The application of electricity to the welding of metals has within the last few months been brought prominently before the public by the publication of the results of experiments on the subject by Prof. Elihu Thomson. Mr. Richard Miller, the agent for the Thomson-Houston system in Glasgow, has an interesting exhibit of this process in daily operation in the dynamo shed at the Glasgow Exhibition. As is to be expected in such a centre of engineering enterprise as Glasgow, this exhibit attracts a considerable amount of attention. The general principles of the process are now so well known to the readers of this journal that it seems only necessary to recapitulate the chief features of the system as shown in this exhibit. Suppose, for example, that two round rods of brass or iron are to be welded end to end. The ends to be joined are made slightly oblique or slightly convex, and the rods are then grasped respectively in the jaws of two powerful clamps fixed to a bench in such a way that the axes of the rods are in the same straight line. One of the clamps is fixed, while the other can be made to move parallel to the axis of the rod by means of a screw. The two clamps are insulated from each other, and are made to form the terminals of the low resistance circuit of a transformer having an adjustable ratio of transformation, the maximum ratio being about 500. The primary circuit of the transformer is supplied with current from an alternate-current dynamo, the potential at the terminals of which is about 220 volts. The primary coil of the transformer consists of six parts, all joined up in series, and a commutator is attached to the transformer, by means of which the current from the dynamo can be sent through all the coils in series or in parallel, or through $\frac{5}{6}$, $\frac{2}{3}$, $\frac{1}{2}$, $\frac{1}{3}$, or $\frac{1}{6}$ of the coils in series. The current for welding is further regulated by a set of spring resistances in series arranged as a shunt between the dynamo leads. By means of a switch the dynamo can be shunted by throwing in the whole or any part of these resistances, and the current in the primary coil of the transformer is correspondingly reduced.

These arrangements being premised, the operation of welding is comparatively simple. The movable clamp is screwed forward until the ends of rods just touch each other, and a small quantity of powdered borax placed on the junction. The current is then switched on to the primary coil of the transformer, and increased in strength until the metal at the junction becomes sufficiently hot for the two pieces to fuse together. The movable clamp is then screwed forward, so as to squeeze the two parts into perfect contact. The welded piece is then removed from the clamps and straightened, or otherwise hammered to the required shape, on an anvil while it is still hot. The part of the rod heated is quite short, most of the heat being generated at the junction, because of the high resistance of the contact in the first place, and the relatively high resistance of the hot part of the rod after the junction has become more complete. Should the weld prove on examination to be faulty, the specimen may be again put into the clamps and reheated. The bad weld will in most cases have sufficiently high resistance to localise the heating.

This method has obvious advantages for light work where electrical power is available. The appliances can be fixed to a bench in any part of the workshop, and the operation is clean, exact, and expeditious. Another great advantage is, that almost any kind of metal can be welded by this means.

The specimens most commonly used as illustrations of the application of the process are of cast iron, steel, malleable iron, brass, and copper, all of which weld perfectly. Some of the specimens were examined by the present writer personally, and with the exception of the cast iron they generally broke to one side or the other of the weld, showing that the weld was certainly as strong as the original metal. The cast iron was broken by holding one end in the hand and striking the other on an anvil. The fracture in the specimens tested took place at the weld, but not entirely across the original plane of division. The probability is that the specimens, which were taken at random from the box of newly-welded pieces in the Exhibition, had not been sufficiently heated. The current required to weld a rod of any given thickness depends, of course, on the metal of which the rods are composed, while for different thicknesses the current will vary approximately as the cross-section of the rod. The current required to quickly fuse the junction of a half-inch steel rod is about 450 amperes, but a somewhat smaller current suffices to maintain the welding heat after it has once been obtained.

A simple modification of the welding apparatus just described renders it applicable to the riveting of plates. The two plates

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with the rivets inserted are placed in the fixed clamp, which is so modified that it serves to hold up the head of the rivet. The movable clamp is fitted with a head for closing the rivet which is screwed into contact with the end of the rivet. The current is then switched on and adjusted until the rivet is white hot, when the clamp is screwed up so as to close the rivet and form a head. This application is ingenious, but it is evidently only suitable for work where the highest strength is not required, because the fact that the rivet cannot be hot quite through, and the force applied being comparatively small, the rivet is not likely to firmly fit the hole in the plate.

A much more effective method of applying electricity to riveting is shown in the machinery section by Mr. F. J. Rowan, C.E., Glasgow. This is an electro-magnetic riveting machine, and it is shown at work suspended on the side of a ship's bulkhead. Mr. Rowan's apparatus was fully illustrated and described in *The Electrician* of March 11th, 1887. The rivet is prepared in the ordinary way, and when placed in the hole the head is held up by a powerful electro-magnet, which holds on to the side of the plate by magnetic attraction. A similar electro-magnet is attached to the opposite side of the plate and this magnet carries a powerful spring-hammer placed between its poles.

The hammer is pulled back by means of a small electro-motor, working through reducing gear, which causes a cam to revolve and to compress the spring to which the riveting hammer is attached. When the highest point of the cam is reached the spring is suddenly released, and it causes the hammer to deliver a powerful blow on the rivet. This can be repeated at a rate of 150 blows per minute, and its force can be adjusted by changing the position of the fixed end of the spring. The holder-up and the hammer apparatus are each suspended on convenient frames, fixed to the side of the ship or other plating to be rivetted. These will be found illustrated and described in the article above referred to. The various parts can be brought very readily into position, and the work well and quickly done. Mr. Rowan also exhibits two of his electro-magnetic drilling machines. These are of similar construction to the riveter, the drill taking the place of the rivet-hammer, and the electro-motor being geared to the drill. The holding-up magnet is of course unnecessary when the drill is being used.

All these tools have a most serviceable and efficient appearance, and especially in ship work, where the application of hydraulic and steam riveters is difficult, they will doubtless prove eminently useful.

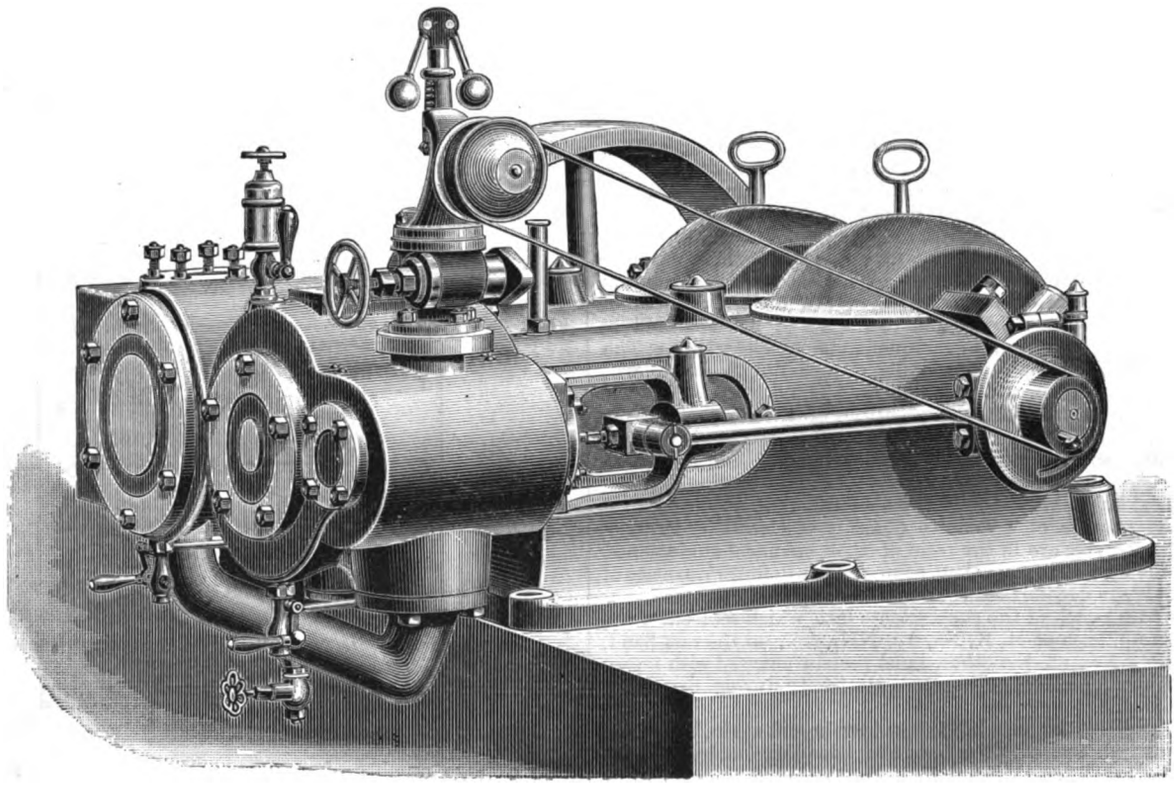
Messrs. Greenwood and Batley, Limited, of Leeds, also show an electro-magnetic drilling machine, similar in construction to one of those exhibited by Mr. Rowan. The drill, which is placed between the poles of a powerful electro-magnet, is driven, through bevel-wheel reducing gear, by a small electric motor, the feeding, as in the case of Mr. Rowan's machine, being done by hand.

High-Speed Compound Engine by Robey and Co.

Messrs. Robey and Co., the well-known engine makers, exhibit a small high-speed compound engine which has been specially designed for driving dynamos either direct or from the fly-wheel. This engine, which is represented in the accompanying illustration, runs at 500 revolutions per minute. The moving parts are all made of steel, the piston and rod being in one piece, and the number of pieces has been kept as few as possible. The crank is steel, and runs in very long bearings of gunmetal.

It will be noticed from the drawing that the whole of the working parts are enclosed within the base-plate, or hinged cones surrounding the crank, completely protecting it not only from dust and grit, but also preventing the splash of any oil. The working parts are lubricated from the inside, a licker fixed under the large end of the connecting rod taking up a portion of the oil at each revolution, and not only lubricating the crank pin but throwing it upon the connecting-rod, slipper, and piston-rod. There is thus continuous circulation of oil from the well underneath the crank through the piston-rod slide, and back again through a channel provided for it to the well.

In consequence of this arrangement the consumption of oil is practically *nil*, and the lubrication seems to be very perfect. The engine illustrated is designed for a working pressure of 150lb., and has a high-pressure cylinder 5¼in. diameter, low-pressure cylinder 9in. diameter, and is said to work economically up to 25 horse-power.



The Robey High-Speed Compound Engine.

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The valve of the high-pressure cylinder is of the piston type, and runs practically without friction. There is little or no vibration perceptible, and compared with the ordinary single-acting engines for high-speed there can be no question that this engine works with a very economical use of steam.

A REVIEW OF THE PRESENT CONDITION OF THE THEORY OF THE ELECTROLYSIS OF SOLUTIONS.*

BY F. KOHLRAUSCH.

1. *Grothuss's Hypothesis.*—The hypothesis propounded by Grothuss† shortly after the discovery of the electrolytic decomposition of water,‡ still forms the essential basis of all inquiries into the nature of electrolysis. While in metallic conductors the passage of the electric current takes place apparently without producing any permanent change in the molecules of the body, in electrolytes, on the other hand, the molecules themselves carry the electricity with them.

The chemical molecule becomes separated into its positive and negative components; for example, Na and Cl, Ag and NO_3, Cu and SO_4. These components are assumed to contain, one the positive and the other the negative electrification, and they therefore become themselves acted upon by the electrical forces, which cause them to move in opposite directions through the fluid, carrying their charges with them.

Strictly speaking, therefore, electrolytes must be considered to be non-conductors, the transference of electricity being effected by the actual movement of portions of matter, much in the same way as the transference of heat in liquids and gases by means of convection currents.

2. *Faraday's Law.*—The hypothesis was first expressed in a quantitative form by Faraday,§ whose law is essentially that if an electrolyte be decomposed by an electric current, the quantity of any constituent separated will be proportional to the quantity of electricity which has traversed the electrolyte, and will be independent of the chemical compound used.|| For example, if silver be thrown down from fused chloride or iodide, or from a solution of the nitrate, sulphate or acetate, or of the double cyanide of silver and potassium, equal amounts of silver will be separated in each case by the passage of equal quantities of electricity. The same law holds good for other metals, as potassium, copper, &c., and also for hydrogen, and it holds for the negative as well as for the positive constituents, the quantities of the former set free at the anode being simply the remainders when the positive constituents are separated from the original compound, and set free at the cathode.

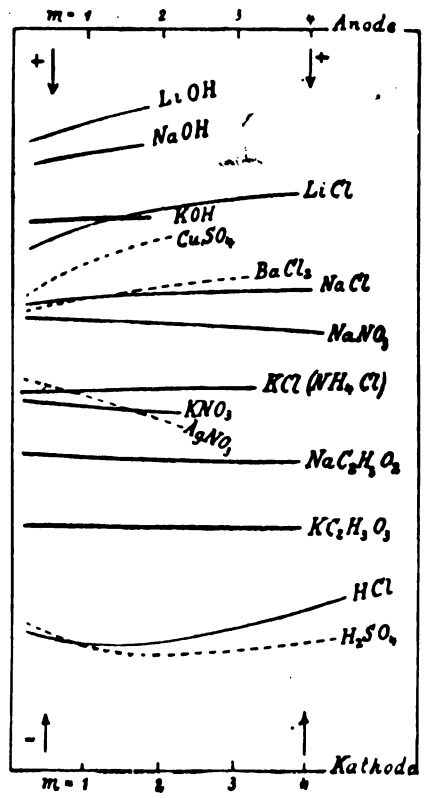
In chemical language, the quantities of different substances set free by the passage of a definite quantity of electricity through different electrolytes are in the ratio of their chemical equivalents, so that in the case of mono-valent compounds a definite quantity of electricity always decomposes the same number of molecules.

It follows that each of the constituents into which molecules are thus broken up, such as H, K, Na, Ag, NH_4, &c., on the one hand, or Cl, I, NO_3, &c., on the other, must remain charged with a constant quantity of positive or negative electricity during the whole of its electrolytic movements.

The truth of this law has been tested again and again,¶ and the more carefully all sources of error have been guarded against the more exactly has it been shown to hold, so that it appears to be an exact, and not merely an approximate law. This is the more remarkable, since the nature of the relation between the charge of a molecule of any substance set free at one of the electrodes and its chemical equivalent, on which the truth of the law depends, is not yet clearly understood. A solution of this question would be of the utmost importance both from an electrical and from a chemical point of view.

3. *Migration of the Ions.*—Twenty years after the statement of this law of definite electrolytic action a further question was opened up by Hittorf, a question which his great power of exact thought, combined with a most complete mastery of the resources of both physical and chemical science, enabled him to answer, and by so doing to make clear for the first time the essential mechanism of the electrolysis of solutions.* Faraday's law only deals with the final products which appear at the electrodes. Now, copper, for example, when deposited electrolytically from a solution of its sulphate, may actually pass through the solution to the cathode, or the other constituent, SO_4, of the sulphate of copper may be transferred in the opposite direction; or, again, both of these actions may go on simultaneously. We can no more obtain an answer to such a question in the case of an electrolytic decomposition from the knowledge of the products separated at the electrodes than we can determine from the flow of electricity in a metallic conductor whether positive electricity be moving in one direction, or negative in the other, or whether both be moving simultaneously in opposite directions. It is, however, possible to obtain an answer by means of a chemical analysis of the solution after the passage of the current. Hittorf's investigations led him to the conclusion that both of the oppositely-charged constituents of each molecule actually travel through the solution, but the distances traversed by them in a given time are not in general of equal length. For example, in a dilute solution of sulphate of copper, the negative constituent SO_4 travels with about double the velocity of the positive constituent Cu, and in the opposite direction. This ratio of 1 : 2 in the velocities of the two ions does not, however, obtain universally, but varies according to the nature of the electrolyte and the strength of the solution.

Fig 1



In a large number of cases these ratios have been represented graphically in such a manner that their nature may be seen at a glance (*see* Fig. 1).

4. *Molecular Concentration of Solutions.*—The strengths of the solutions from which this and the other diagrams were obtained were not made by weight, but according to the number m of electrolytic molecules contained in a given volume, the values of m being obtained by dividing the weight in grammes of a litre of the solution by the molecular weight of the electrolyte in the case of univalent molecules. In the case of divalent molecules the divisor will be half the molecular weight, *e.g.*, for H_2SO_4 the divisor will be 98/2 = 49, and so on.†

5. *Length of Path Traversed by the Ions.*—The results of Hittorf's researches for a large number of substances are given in Fig. 1.‡ The number of experiments which have been made is not large enough, especially considering the liability of the results to errors of observation, to enable the curves to be drawn with any certainty for all substances. I have endeavoured, with as little arbitrariness

* Paper read before the Electrotechnical Society of Berlin. Translated from the *Electrotechnische Zeitschrift*, Vol. VIII.

† Grothuss, Gehlen's *Journal*, Vol. V., 1803.

‡ Nicholson and Carlisle, Gilbert's *Annalen*, Vol. XVI., p. 340, 1800.

§ Faraday, "Experimental Researches," VII., 1834.

|| Some of the more complex compounds must be excluded from this statement.

¶ Faraday, Soret, Buff, Lord Rayleigh, Shaw and others.

* Hittorf, Poggendorff's *Annalen*, Vol. LXXXIX., p. 177, 1853; Vol. XCVIII., p. 1, 1856; Vol. CIII., p. 1, 1858; Vol. CVI., p. 337, 1859.

† F. Kohlrausch, Wiedemann's *Annalen*, Vol. VI., p. 145, 1879.

‡ Wiedemann's *Annalen*, Vol. XIII., p. 289, 1881.

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as possible, to eliminate any want of uniformity in the curves. The curves for KOH, NaOH, LiOH and LiCl were obtained from the results of Kuschel's experiments.* Let any two portions of the upper and lower horizontal boundaries of the diagram (Fig. 1) lying between the same vertical lines represent respectively the anode and the cathode, separated by a column of liquid of the same length as that of the diagram, and of a molecular concentration represented by the corresponding value of m; then the vertical distance of any point of the curve from the lower boundary represents the distance traversed by the negative constituent, or *anion*, and its distance from the upper boundary represents the distance traversed by the positive constituent, or *cation*. In other words, two molecules (anion and cation) starting simultaneously from the electrodes will meet on the curve.

We see that in solutions of KCl, NH_4Cl, KNO_3 and $AgNO_3$, the two ions travel with nearly equal velocities, and meet therefore near the middle, but in the case of $AgNO_3$, the velocity of the constituent NO_3 shows a decided decrease as the concentration increases. For NaCl the ratio of the velocities is about Na : Cl = 1 : 2, and for LiCl about Li : Cl = 3 : 7, and the inequality increases with the concentration. In the case of sodium acetate, and still more in that of potassium acetate, the metal travels more rapidly than the constituent $C_2H_3O_2$.

The inequality is still greater in the case of the hydrogen compounds or acids, the velocity of the hydrogen being some five times as great as that of the negative constituent. In the case of the alkaline hydrates, KOH, NaOH, and especialy LiOH, the velocity of the metal is much smaller than that of the other constituents. (We assume that these bodies break up into metal and OH.)

6. *Part Played by the Solvent.*—The results of these researches of Hittorf's point to the conclusion that the water of the solution plays no part in the decomposition. Earlier theories which looked upon water as a conductor were, on the other hand, frequently founded on the assumption that the water was really the electrolyte, and that the products of the decomposition which were liberated at the electrodes were in part due to secondary action, as, for example, that of the nascent hydrogen. In so far as a direct investigation of this question was possible, Hittorf has proved, at any rate in the case of the stronger solutions, that no appreciable part of the conductivity is due to water.† In point of fact, it is indisputable that the so-called conductivity of water is always due to the presence of impurities of which it is extremely difficult to remove every trace. It is possible by using very great care in its purification to obtain water, of which a column, one millimetre in length, will have a resistance equal to that of a copper conductor of equal section and of a length equal to that of the moon's orbit, so that pure water may be considered to be a non-conductor.‡

7. *Electrolysis Due to Mixture.*—This behaviour of water is only a special case of a general property of bodies. All fluids, with the exception, of course, of metallic conductors, are at ordinary temperatures essentially bad conductors. Alcohol, ether, and sulphide of carbon are well-known examples of this. But, according to the researches of Faraday, Hittorf, Gore, and Bleekrode, anhydrous acetic, chromic, hydrochloric, and fluoric acids have a very low conductivity. Even sulphuric acid (H_2SO_4) is a very bad conductor.

Electrolytes with a high conductivity are principally obtained by mixture (solution).§ The most highly conducting aqueous solutions of sulphurous acid have about 100 times the conductivity of the pure acid, those of acetic acid about 30,000 times, and similarly aqueous solutions of hydrochloric acid conduct many times better than the pure acid. It has been found, too, that the addition even of alcohol to water will increase its conductivity.‖

8. *Metallic Conduction.*—A further conclusion may here be drawn with a probability practically amounting to certainty. It has been supposed that electrolysis is merely a kind of secondary result of the passage of the electric current, the constituents of the fluid being assumed to be separated by the current by a sort of friction. This assumption of a "metallic" conductivity in electrolytes has often been made, but the advance in our knowledge of the subject has made it quite untenable.¶ This is in agreement with the general property of bodies that metallic conductors are never transparent. Electrolytic conductivity, on the other hand, is quite independent of transparency to light and radiant heat.**

9. *Conductivity, Ohm's Law.*—The inquiry into the behaviour of electrolytes may be extended and simplified, and also, on account of the difficulty of the chemical investigations, be made more exact, by previously making an accurate determination of the conductivity. The investigation of this question has shown, in the first place, paradoxical as it may seem, that the laws which govern the conduction of electricity in metals hold good also for the current in all the electrolytes which have been experimented on. Every decomposable body has, in the sense of Ohm's law, its own definite resistance, so that the conductivity of an electrolyte, like that of a metallic conductor, may be expressed by a definite number, by comparison with that of mercury, for example. The transference of electricity by the motion of the electrolytic molecules must therefore be subject to a resisting force proportional to the velocity, just as in the case of the motion of electricity in metallic conductors. Such small E.M.F.'s even as the millionth of a volt, acting through a thickness of a centimetre of fluid, are subject to Ohm's law, and no effects due to inertia have been observed, even with rapidly alternating currents or currents of short duration.*

(To be concluded.)

* Wiedemann's *Annalen*, Vol. XIII., p. 289, 1881.

† Hittorf, Poggendorff's *Annalen*, Vol. CIII., p. 36, 1858.

‡ F. Kohlrausch, Wiedemann's *Annalen*, Vol. XXIV., p. 48, 1885.

§ F. Kohlrausch, Poggendorff's *Annalen*, Vol. CLIX., p. 271, 1876.

‖ E. Pfeiffer, Wiedemann's *Annalen*, Vol. XXV., p. 232, 1885.

¶ Buff, Poggendorff, Hittorf, Von Helmholtz, and others.

** F. Kohlrausch, Wiedemann's *Annalen*, Vol. VI., p. 29, 1879; S. Bidwell, *Report* Brit. Assoc., 1886, p. 309.

THE EDISON IMPROVED PHONOGRAPH.

On Tuesday last Colonel and Mrs. Gouraud received a large party of visitors, principally representatives of the London press, for the purpose of inspecting an Edison phonograph of the latest type, which had just arrived from America. Everyone knows that the tinfoil of the instrument of 1878 has been replaced by a film composed of a composition of paraffin and wax laid upon a cardboard cylinder. We understand that the discovery of the suitability of films, consisting wholly or partly of wax, for receiving the records of phonograms was due to Mr. Chichester A. Bell, one of the inventors of the Tainter-Bell graphophone.

The substitution of wax for tinfoil totally alters the character of the record, which becomes a continuous wavy line instead of consisting of a series of separate indentations, and the improvement in the articulation is almost comparable with that which Graham Bell effected in the telephone by substituting an undulatory for an intermittent current. The wax cylinders have the still more important advantages that they can be removed and replaced on the mandrel of the same or another instrument, and that the sounds recorded may be repeated a very large number of times without any sensible diminution of distinctness. Colonel Gouraud illustrated this on Tuesday by placing in the instrument a cylinder containing the record of a cornet and pianoforte duet, which he informed us had already been through it more than a thousand times, and the reproduction was beautifully clear and distinct. He is now making arrangements for systematically testing the number of times the same record may be used without deterioration by means of an automatic electric apparatus, which will shift the cylinder back to its starting point as soon as it has passed through the instrument, and register the number of times the reproduction has been effected.

The instrument is driven by a small electric motor enclosed in a box forming the base of the instrument, and is energised by a single bichromate cell, and controlled by a small centrifugal governor. The motor, the details of which have not yet been made public, works noiselessly, and, as far as we could judge from the exhibition given on Tuesday, appears to be thoroughly satisfactory. The speed is adjustable, as it is desirable to run it at a much higher rate for the reproduction of music than for that of speech. The recording and reproducing styles and diaphragms are attached to a single rigid frame moving on an axis permanently attached to the instrument, and one can be substituted for the other in a moment. A knife blade is attached to the recorder, which shaves the surface of the film, and makes it truly cylindrical, and if it has been already used for a previous record it removes this as the new one is impressed upon it. The depth of the cut is adjustable, as records produced by very loud speaking or by loud musical notes are made deeper than those produced by more feeble sounds.

By fixing a sound trumpet to the reproducing mouthpiece, both speech and music can be rendered distinctly audible to a small audience, but the sounds are reproduced with much greater purity when tubes are used connecting the mouthpiece with both ears of the listener, and by attaching a branched tube to the mouthpiece and using several sets of tubes the sounds can be listened to by several persons simultaneously. During the afternoon Mrs. Shaw, commonly known as "La Belle Siffleuse," whistled into the instrument, and the tune was reproduced with exceptional clearness and loudness.

One of the cylinders had been spoken to by Mr. Edison, and the visitors were much interested in listening to his remarks, laughter and snatches of songs.

* Kohlrausch and Nippoldt, Poggendorff's *Annalen*, Vol. CXXXVIII., p. 370, 1869; Cohn, Wiedemann's *Annalen*, Vol. XXI., p. 667, 1884.

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SPECIAL NOTICE.

Owing to the increase in the number of pages of "The Electrician," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows :—

	3 months.	6 months.	12 months.
For Foreign Parts and Colonies :—	s. d.	s. d.	s. d.
Within Postal Union	6 6	... 12 6	... 24 0
„ Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	... 14 6	... 28 0
The rates for the United Kingdom remain as follows :—	5 0	... 10 0	... 19 6

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"The Electrician" offers exceptional advantages to Advertisers. **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

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Advertisements intended for the current issue must be handed in not later than 4 p.m. on Thursday.

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"The Electrician" Printing and Publishing Company (Limited) beg to inform Electricians and Electric Light Engineers that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.

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At the end of December in each year is issued The Electricians' Directory and Handbook. *The Directory was established in 1883, and has now attained considerable proportions. Every care is taken to make the names and addresses of all persons engaged in the Electrical Industries absolutely accurate. Useful Tables and Electrical Formulæ are given, together with popularly-written Biographical Notices of the leading Electricians, accompanied in many cases by Portraits.*

THE DIRECTORY FOR 1889 IS IN PREPARATION.

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Arrangements have been made by which "The Electrical World" of New York can be obtained from "The Electrician" Office, 1, Salisbury-court, Fleet-street, London, E.C.

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"The Electrician" can also be obtained from D. Van Nostrand, *23, Murray-street, and 27, Warren-street, New York.*

The Rate of Subscription for American Subscribers (payable in advance) is $6 per annum.

LOCAL AUTHORITIES AND ELECTRIC LIGHTING.

The passing of the Electric Lighting Amendment Act this Session has already resulted not only in the formation of several new companies with large aims for the supply of electricity within the metropolitan area, but in the revival of numerous demands for electric lighting in provincial towns where the original Act of 1882 had effectually extinguished such schemes. We hear rumours of fresh companies being started, of applications for licenses and provisional orders being projected, and, moreover, of local authorities being desirous of undertaking the business on their own account. The large experience which has been gained and the confidence inspired in the interval between 1882 and the present time certainly justifies this activity; and it does not surprise us that the attitude of local authorities, which was then extremely shy, or covertly hostile, is now almost uniformly favourable. The first question they will have to decide will be whether they shall permit the right of public lighting to pass out of their hands into those of private companies; and, on the other hand, one of the questions which existing or projected companies must consider is, whether they will approach the local authorities as undertakers—to quote the wording of the Act—or as contractors?

On these two points some misapprehension seems to prevail, although the wording of the Act is perfectly clear. Section II.

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provides that any local authorities who have obtained a license, provisional order, or special Act, for the supply of electricity may contract with any company or person for executing and maintaining the same. Probably in a number of cases the local authorities will prefer this course, retaining the powers of the Act, but delegating their execution to more competent hands. Electric lighting undertakers, we imagine, will, on their part, have no objection to this arrangement; many would prefer it, as being less speculative and freer from the objectionable restrictions to which undertakers working directly under the Act are subjected. It should be noted here, however, that the Board of Trade still possess large powers of regulation and interference not defined by the Act either of 1882 or 1888. Rules framed by the Board of Trade from time to time are, it is true, to be laid before Parliament; but when this formality has been complied with, no vote being required, the rules acquire all the force of an Act of Parliament. The Board of Trade, however, will be bound to call in the assistance of professional advisers directly or indirectly connected with the electric lighting industry, so that little fear need be entertained of vexatious or obstructive rules being sprung upon the undertakers or contractors after the business has been entered upon.

On one or two other points we may here usefully draw attention to the wording of the Act. Inquiries have reached us as to applications for licenses or provisional orders, merely for the purpose of covering the ground. No doubt a very great number of such applications were lodged on the passing of the first Act—applications, some of which were never intended to be pushed forward, or only in order to dispose of the concessions, if obtained, at a profit. As, however, none of these projects went any further than the first stage, the question of their validity or permanency never arose. No doubt the covering of a given area may in certain cases be convenient and even necessary; or, to put it differently, the acquisition of certain parts or the whole of such area by other hands may be highly advantageous to all the parties concerned. The Act provides for this, the Board of Trade having power to sanction the transfer or assignment of rights obtained under its provisions. But it should be noted that, without the Board's consent, the original holders cannot divest themselves either of their powers or their liabilities. There is nothing to prevent more than one application being made for the same area; and within one local authority's district licenses or provisional orders may certainly be granted to several different companies or firms—possibly to more than one even in the same area. The Act does not prohibit such competition, and Parliament would, no doubt, permit it if the occasion arose, and provided the local authority did not itself propose to undertake the duty.

Local authorities supplying their own electric light would not be exempt from the contingency just alluded to, and this consideration ought to weigh with them in determining whether to undertake the business or to let a private company come in. Be the area large or small the installation must be carried out and maintained under the supervision of a competent electrical engineer—a personage rarely met with in the precincts of the parish vestry. He can easily be found, however, by paying for him, and where the areas are small a combination of towns or parishes to defray the professional charges would probably meet the case. Where the authorities already supply the town with water, they could utilise the premises, the engine power, and the engineering talent on the spot. This has been largely done in America, and the economy effected is said to be very considerable. There are about 170 towns in the United States wholly or partly lighted by electricity, 25 of which already are undertaken exclusively by the respective municipalities, and with results that are highly satisfactory. From the data supplied by Mr. F. H. WHIPPLE, in his pamphlet on "Municipal Lighting," in America we gather that, although the price charged for the light differs greatly in different places, it is always much less than the price of gas, and is supplied by the local authorities at about half the price charged by any private company. The accounts from all these places speak enthusiastically of the electric light.

Of course our expectations in this country are not based on what has happened in America, where the conditions are peculiarly favourable to the electric light. We shall have to rely at present more on its intrinsic merits and the preference of those who are once induced to use it rather than on its superior cheapness. And this being the case, we may be quite indifferent as to whether the earlier installations are undertaken by local authorities or by private companies. The plant and the professional help will be required in either case; and on whichever principle the business is started, if properly gone about, its success is almost certain, and its example is sure to be followed. Not improbably the new County Councils may develop great spending capacity; and it is worth while to remember that under the Electric Lighting Act the local authorities have power to borrow money on terms which no private firm can command. They have, also, the right to oppose any independent application for a provisional order within their district, and would probably do so effectually; for the Board of Trade are ordered by the Act to give preference to the local authorities, and will doubtless interpret this clause very broadly in their interests. This year's Amendment Act betrays the same jealous regard for local authorities; the first clause making it quite clear that, without their consent, practically the Board of Trade cannot grant a provisional order. This being the case, electric lighting undertakers will do well to make friends of the local authorities and not attempt to do anything over their heads. The list appended of towns in the United Kingdom, excluding the metropolis, where public electric lighting has already been established by or at the invitation of the local authorities, or where the negotiations are in an advanced stage, may be studied with advantage in this relation.

Barnet.	Exeter.
Bath.	Glasgow.
Blackpool.	Hastings.
Bradford.	Ilfracombe.
Brighton.	Leamington.
Cheltenham.	Leeds.
Dewsbury.	Southampton.
Dublin.	Taunton.
Eastbourne.	Waterford.
Edinburgh.	Weston-super-Mare.

THE TESTING OF ELECTRICAL INSTRUMENTS AND APPARATUS IN THE JOHNS HOPKINS UNIVERSITY.

The following important notification has been issued by the Johns Hopkins University:—

In order to bring electrical measurements to a greater uniformity and accuracy, it has been decided to undertake at this University the comparison of electrical instruments and resistances, together with such tests as cannot be made without special or elaborate apparatus with which private individuals are not usually provided.

The rapid advance of electricity in this country—an advance which cannot but react favourably on physical research—and the necessary increase in the number of electrical instruments for measurements, make it important that means be provided for standardising these instruments, especially as their constants vary from time to time. There are many institutions also whose apparatus could be used for accurate experiments, provided the instruments could be compared with standards. Few laboratories contain the apparatus necessary for such comparisons.

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This laboratory offers unusual facilities for the standardising of electrical instruments as well as for general physical work. Having been built especially for physical research, under the direction of Prof. Rowland, it has been provided with every requirement that experience and ingenuity have devised. In that part of the laboratory in which electrical and magnetic experiments are conducted, no iron nor steel has been allowed to enter into the construction, brass being the metal used. Moreover, the building has been furnished with a series of vaults, in which the variation of temperature is imperceptible, and which are of especial value in the measurement of resistances. Motive power is obtained from an 18 horse-power steam engine located at one end of the building, and current from a set of dynamos of different makers in the same room. The battery room is furnished with fifty storage cells, as well as a large number of the ordinary Bunsen and Daniell cells. Special dynamos have been provided for testing work, one giving continuous currents up to 400 amperes, the other giving electromotive forces to 1,000 volts.

Electrical Instruments.

The following is a description of those standard electrical instruments which will be used in the tests :—

Dynamometers.—The larger dynamometer is a very massive and sensitive instrument, made by Prof. Rowland for his recent Government work on the "Unit of Resistance." It differs in general plan only from the British Association instrument. The suspended coil is single, but the fixed coils, of which there are two sets, are double as in the Helmholtz arrangement. One set of coils is wound with heavy wire for the measurement of large currents, and one set with smaller wire. The coils of each set are at a distance apart equal to their radii respectively. This instrument will measure accurately currents ranging from 4 amperes to 10 amperes.

The smaller dynamometer is almost exactly like the British Association instrument, of which an excellent illustration, as well as the theory of the apparatus, is given in Maxwell, Vol. II., p. 337. With this dynamometer currents from a fraction of a milliampere to 4 amperes can be measured.

The constants of these instruments have been obtained by careful measurements and by comparisons with standard coils. On the former, particularly, the work has been done with the greatest possible care, and it is perhaps the most accurate current measuring instrument in existence.

Electrometers.—Of these there are two, and similar instruments have been so often described in electrical text-books that only a few words are necessary here. They are both of the Thomson form, and known respectively as the Thomson quadrant electrometer and the Thomson (or absolute) suspended-disc electrometer. The latter, however, was made from special designs, and a few important modifications of the original apparatus (Maxwell, Vol. I., p. 304) have been introduced. With this instrument electromotive forces from 1,000 volts upward can be determined, and the electrometer has been employed in several important researches.

Wheatstone's Bridge.—For resistance measurements Fleming's modified form of Wheatstone's Bridge will be used. In this apparatus the two fixed and equal arms are connected by a platinum-silver wire bent into a circle and provided with a scale alongside. The ratio of the arms is changed by making contact at different points along the wire. When the fixed coils are each one ohm, a change of one whole scale division gives a change of 1 part in 10,000 in the ratio, and by using a suitable galvanometer a change of 1 part in 100,000 can be detected.

Resistances.—The standards of resistance have been accurately determined by Lorenz's method in absolute measure, and by a modification of Kirchoff's method. They have also been several times compared with the British Association Standards at the Cavendish Laboratory. For measurements of current a fixed resistance has been prepared. This consists of three strips of German silver 4½in. broad by ·036in. thick, the ends of which are hard soldered into massive copper blocks. The whole is immersed in a tank of refined petroleum. To the copper blocks wires are permanently soldered, and to these the galvanometer leads can be fastened. When in use the oil is stirred, and its temperature noted from time to time.

Galvanometers.—The laboratory is provided with a number of galvanometers for various uses, some of which have been constructed for special work.

Thermometers.—There are several thermometers in the laboratory whose range is from 0 deg. to 100 deg., which have been directly compared with the air thermometer, and others for which indirect comparisons have been made. Tables have been constructed for all of these, and their indications are correct to within ·003°C.

Methods of Measurement.

Current.—For measuring currents up to ten amperes the electrodynamometers will be used, one or the other. For currents from 10 amperes to 400 amperes the "fixed resistance" method is used, the apparatus being calibrated before each measurement by comparison with the large dynamometer. This method has been used for measuring heavy currents at the Munich, Vienna, and Philadelphia Expositions ; a full description of the method of using it in the Philadelphia Exposition—where it was much improved—will be found in the *Journal* of the Franklin Institute, October, 1885. Briefly it consists in comparing the difference of potential at the terminals of a fixed resistance when a known current and the current to be measured are passing respectively. To the copper blocks in the fixed resistance before described are joined the terminals of a galvanometer, in whose circuit is a resistance box. A known current measured by the large dynamometer is first sent through the "fixed resistance," and the resistance box adjusted until a convenient deflection of the galvanometer is obtained. Then the current to be measured is sent through the fixed resistance, and the box is again adjusted until the deflection is nearly the same as at first. We have then, neglecting temperature corrections,

$$C = C_0 \frac{R}{R_0} \cdot \frac{d}{d_0},$$

where C_0 is the current corresponding to resistance R_0 and deflection d_0. In the actual observations of course the temperature of the different parts of the circuit are noted and corrected for. The only possible errors in this method outside of errors of observation, which are negligible, are in the current used for calibration, in the resistance box and in the temperature of the fixed resistance. The first of these measured by the dynamometer is correct to within one part in 2,000 ; the resistance box with the facilities at hand can be determined to one part in 5,000 ; and the temperature of the strip is known very accurately, there being no perceptible heating even with the heaviest current used ; moreover the temperature is certainly known to a few tenths of a degree, and one degree would cause an error of only one part in 3,000.

This method of measuring current possesses advantages over any tangent galvanometer, however accurately the measurements of the latter are known, since the constant of a galvanometer involves a determination of H, the horizontal component of the earth's magnetic force, a quantity more difficult of accurate measurement than is an ordinary current. In calculating current measuring instruments, they will be put in series with the fixed resistance and simultaneous readings taken with different current strengths ; and for smaller currents—below 8 or 10 amperes—they will be joined in series with one or the other of the dynamometers and measurements made directly.

Potential.—For potentials between four volts and 1,000 volts the instruments will be compared with a galvanometer which has been calibrated by connecting the ends of its circuit to the terminals of a fixed and known resistance, through which is flowing a known current. The resistance used for this purpose is of bare German silver wire immersed in oil, and its value known to 1 part in 10,000 ; the current is measured by one of the dynamometers. In the galvanometer circuit is a high resistance box, whose coils have been compared previously. If it is desired after calibration to measure a higher potential than was used, the resistance of the circuit is increased ; for a lower potential it is decreased. If E_0 is the difference of potential used for calibration, R_0 the resistance of galvanometer and leads, and d_0 the deflection, then the potential corresponding to any other deflection d and resistance R is, if we neglect temperature corrections :—

$$E = E_0 \frac{R\,d}{R_0\,d_0}.$$

For electromotive forces less than three or four volts a quadrant electrometer standardised by a Clark cell—of which there are a number in the laboratory—is used, and comparisons made directly with it. For instruments measuring very high potentials of several thousands of volts—electrostatic voltmeters, &c.—the absolute attracted-disc electrometer before described will be used, the necessary electromotive force being furnished by a modified Holtz machine.

Resistance.—Measurements of resistance will be made in the vault beneath the laboratory, whose temperature is practically constant. Boxes to be compared are placed in the vault at least 24 hours before any measurements are made, and standard resistances are immersed in water for at least an equal time, in order to allow all parts of the apparatus to acquire exactly the temperature of the vault. The Fleming bridge, described under the head "Instruments," will be used for comparing the resistance boxes. This apparatus is the one which was recently employed in the determination of the ohm made at the University.

In giving the values of resistances, results will be expressed in terms of Legal or British Association units, as desired, together with the value in *true* ohms, as determined from the most accurate measurements that have been made.

A special bridge has been constructed to measure small resistances by an arrangement of Sir William Thomson's method, known as the method of auxiliary conductors.

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Capacity.—For the purpose of determining the capacity of the condensers ordinarily used in measurement, J. J. Thomson's modification of Maxwell's method (*Phil. Mag.*, August, 1884) will be used or they will be compared *directly* with a standard condenser. For small capacities comparisons will be made with an accurately known air condenser in the possession of the laboratory.

Efficiency of Dynamos.—The efficiency of dynamos ranging from one to twelve horse-power will be obtained from measurements of power by a Tatham transmission dynamometer, and of current and potential by the methods described above under their respective headings. The dynamometer is similar in principle to the larger one used at the Philadelphia Electrical Exhibition, which was accurately checked by a determination of the mechanical equivalent of heat. The value deduced from its records was 772·8 foot lbs. Fah., a value agreeing very closely with the most recent determinations. In all cases the dynamo will be run at its normal output until the effects of heating have become constant, both as regards the results of mechanical friction, and the rise of temperature due to the current. It will be possible not only to determine the efficiency with full load, but also with varying loads if desired.

Efficiency of Motors.—Tests of the efficiency of motors from 10 horse-power to 2 horse-power will be conducted in exactly the same manner as in the case of dynamos, and the same precautions to insure accuracy will be observed. The efficiency of motors below 1 horse-power will be determined by calorimetric methods by measuring the losses when running. For this purpose the motor will be enclosed in an air-tight box surrounded by a water-jacket, through which water runs in a constant stream. From the heating of the water when the motor is running the efficiency can be immediately calculated. The result gives the commercial efficiency, since all losses due to heating are measured.

PRICES.

Current Meters (according to range)	$5 00 to $7 50
Voltmeters ,, ,, ...	5 00 to 7 50
Resistance Boxes ,, ,, ...	5 00 to 25 00
Standard Resistance Coils.....	5 00
Condensers	5 00
Curve of Magnetisation	10 00
Constants of Batteries, Insulators, Efficiency of Dynamos, Motors, Special Work, Calculations, &c., Alternating Current Apparatus,	According to Nature of Test.

ON THE USE OF BISMUTH AS A SIMPLE MEANS OF MEASURING THE MAGNETIC FIELD.*

BY DRS. LENARD AND HOWARD.

When metallic bismuth is placed in a magnetic field it is found to possess many remarkable properties which are not found in any other metals, or, at any rate, not in nearly such a marked degree. One of these peculiarities, which was discovered by Righi, is the increase of electrical resistance which it undergoes. Leduc has made use of this property for the purpose of measuring the strength of magnetic fields, and his method, from its accuracy and simplicity, appears to be an extremely valuable one for technical measurements. We have recently made several experiments of this character, a description of which may be interesting. The metal we used was in form of wire, and wound in a non-inductive spiral. When warm, bismuth can be squirted into wire just like lead. When newly made, especially if still warm, the wire can be fairly easily wound without breaking, though it becomes very brittle with age. For insulation we use two or three coats of thick collodion, which very quickly dries, and forms a thin but perfectly insulating and very strong covering. To wind the spiral two pins were fixed in the middle of a thick plate of lead, which was kept at a temperature of 70° C.; the middle of the wire was looped over one pin, and then the whole length wound up into a flat spiral, and consolidated by a few coats of some quick drying mucilage. Two strong copper electrodes were soldered on with Rose's metal, and finally the spiral was protected between two plates of mica. A convenient size is a spiral of 2 cm. diameter by 2 mm. thick, formed of one metre of wire; this will measure about 10 ohms—a convenient resistance for bridge measurements. On a field of 17,000 C.-G.-S. units per sq. cm. the resistance of our spiral increases nearly twofold; this is a greater increase of resistance than has ever been noticed before, and is due probably to the molecular structure of the squirted bismuth, and partly to the fact that the insulating film is of very low thermal conductivity.

For as Ettingshausen and Nernst have shown when an electric current is sent through bismuth at right angles to the lines of force passing it, a difference of temperature is set up in the bismuth, and thereby a thermal back E.M.F. is set up, which in the bridge measurement appears, of course, as an increase of resistance. If by any means the spiral is kept at an even temperature, this spurious part of the increased resistance is avoided.

The method is of course not an absolute one and can only be made use of by first observing the increase of resistance due to magnetic fields of known strength and curving, the results a_s in Fig. 1.

The ordinates are the various values of $\frac{R_2 - R_1}{R_1}$ when R_1 = ordinary resistance, and R_2 resistance under action of the field. The abscissæ being taken in absolute C.-G.-S. units; the curve G is for a wire measured by a galvanometer, and T the same measured by telephone. This greater resistance, when measured by telephone, is quite independent of the nature of the current, whether intermittent-direct or alternating.

For comparison the curves E E and L L are given. The first pair are those obtained by Ettingshausen and Nernst, from two cast plates of specially pure bismuth; the second are the extreme curves obtained by Leduc with electrolytically deposited metal. Care must be taken that the bismuth employed is free from tin, as even a few tenths per cent. diminishes the effect very considerably. For exact measurement each spiral should be separately calibrated, for which, however, only two readings are necessary, as Leduc's equation for increase of resistance of plates is also true for spirals.

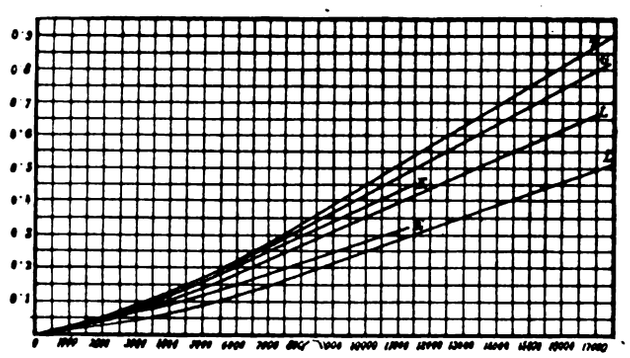

FIG. 1.

We also tried whether the spirals altered their constant with time, but no alteration was apparent in nine months. The mean temperature coefficient between 0° and 36°C. was 0·52 per cent., an impure sample tried having a coefficient of 0·21 per cent. This bears out Leduc's experiments that the temperature coefficient is positive with compressed bismuth. On the other hand, Ettingshausen and Nernst have shown that bismuth, when solidifying free from pressure, decreased in resistance with rise of temperature. In measuring dynamos care must, of course, be taken to prevent any rise of temperature in the spiral due to the dynamo itself being hot. In this case the measurement must be made very quickly, and it is as well to protect the spiral by a sheet of tin foil, for Righi has shown that at high temperatures bismuth loses these peculiar properties, as well as other magnetic ones. It is important that the plane of the spiral should be as nearly as possible at right angles to the lines of force. Within small limits the effect is not much decreased, but is diminished to half when the plane of the spiral is parallel to the lines.

* Abstracted from *Elek. Tech. Zeits.*, No. 14, July, 1888.

AMERICAN MODEL SPECIFICATIONS.*

CENTRAL STATION ARC LIGHTING.

HIGH-SPEED STEAM PLANT.

Engines.—Twelve engines of 125 horse-power each, engines to be of high speed, automatic cut-off, with hammered wrought-iron or cast-steel shafts. Each engine to be provided with throttle valve, two band wheels turned true and balanced, oiling devices of the most approved type, consisting of side feed lubricator, sight feed oil cups with stands, needle valves and wipers, full set of wrenches, foundation rods, anchor plates, &c., to cover complete engine ready to receive steam and exhaust pipes. Each engine to have a heavy cast-iron self-containing sub-base or coping stone. Said engines must develop the given horse-power under an initial pressure of eighty pounds to the square inch.

Boilers.—Twelve tubular boilers, each seventy-two inches in diameter, containing sixty-four four-inch tubes, sixteen feet long,

* From "Municipal Lighting," by F. H. Whipple, Detroit.

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with shell extension of not less than twelve inches. Each boiler to be provided with two manholes, one located on top of shell at rear end, the other in front of heads below the tubes, said manholes to be not less than ten inches by sixteen inches. The material for shell to be best quality homogeneous flange steel, sixty thousand tensile strength per square inch of section, and not less than three-eighths of an inch in thickness. Material for heads to be of same material and of same tensile strength, and of not less than nine-sixteenths of an inch in thickness.

Nozzles.—Each boiler to be provided with two nozzles riveted to shell, and of proper size for steam pipe and safety valve connections, and of not less than six inches in diameter.

Bracing.—Heads to be thoroughly stayed to shells by long overlapping braces. Each stay-rod to be made of best Swedish iron of not less than one inch in diameter, and attached with solid crowfoot and strap head properly riveted to heads and shell plates.

Seams.—Seams to be tight fitting, and rivet holes punched to line true one with the other, and no drifting allowed to force holes in line. Holes out of truth to be reamed with sharp-edged cutting tool and rivet fitted to hole and driven straight and true. All joints to be planed or chipped and caulked. All longitudinal seams to be double riveted.

Testing.—Each boiler to be tested to one hundred and fifty pounds per square inch hydrostatic pressure.

Boiler Fixtures.—Each boiler to be furnished with a full line of fixtures complete, including full fire fronts, liners, grates, and bearing bars, return draft arch, ash doors and frames, wall binding rods and back stays, cast-iron wall brackets for supporting boiler, with wall plates and expansion rollers, all necessary gauges, steam and water stop valves, blow off check and safety valves, and firing tools. Each boiler to be set in separate arch and to be entirely independent of others.

Pumps.—Two duplex steam lift and force pumps, each capable of supplying twelve boilers of a capacity of one hundred and fifty horse-power each.

Injectors.—Two injectors as auxiliaries to steam pumps for feeding boilers, each capable of delivering 7,500 gallons of water per hour at a steam pressure of eighty pounds.

Heaters.—Two brass tube feed water heaters, each capable of supplying a boiler capacity of eight hundred horse-power.

Furnaces.—Twelve furnaces (state whether with or without automatic feeders and stokers), placed under boilers in batteries of six each, connecting with a brick chimney eight and one-half feet inside diameter and not less than one hundred and forty feet high. Said furnaces to be erected by the bidder, with the chimney.

Grates.—Grates to be either rocking or stationary (state which), and not to have less than fifty per cent. air space, with openings of not more than one-half inch.

Steam Piping.—From boilers to engines one main line of steam pipe, with straight-way stop valve, pipe to be of sufficient diameter to supply twelve engines, each of 125 horse-power, with branch pipes of sufficient diameter for each engine, in each of which there is to be straight-way stop valves. In leading pipes from boilers to main line there is to be straight-way stop valve placed near connection of said pipes with boilers.

Exhaust Pipes.—The exhaust pipes of each engine to be run to a main exhaust pipe leading to heaters, and this main pipe to be of sufficient diameter to allow of free exhaust from eight hundred horse-power. Straight-way valves shall be placed in each branch exhaust pipe leading to the main. From each heater there is to be an exhaust pipe leading to top of building of not less than sixteen inches diameter.

Water Pipes.—Steam and water pipes between main steam lines and pump and injectors, and all water lines between waterworks connection to conform to tabulated sizes required for pump as heretofore specified.

Protection.—All steam exhaust and water pipes to be thoroughly protected with sectional pipe covering.

Duty.—The bidder to estimate on preparing all foundations and masonry and to deliver, erect and connect all engines, boilers, heaters, pumps, &c., and turn the steam plant complete over to the purchaser ready for duty.

Estimates to be in detail, stating name and kind of each article and price, and guarantee amount of fuel per horse-power delivered.

CORLISS STEAM PLANT.

Engines.—Three compound condensing Corliss engines, each capable of developing six hundred horse-power, with a boiler pressure of ninety pounds. The material and workmanship to be first class in every respect. Bidder to state diameter and stroke of cylinders, diameter and length of engine shafts, diameter and length of main bearings, diameter, face and weight of fly-wheels. Each engine to be provided with a full set of graduating oilers, sight-feed cylinder oiler, and set of hand oilers with tray. The oilers to be so arranged that they may be refilled while the engine is in operation.

Air Pumps and Condensers.—Three air pumps and condensers of the spray or jet type, each to be connected to one of the above engines and to be of proper capacity for the engine. Bidder to state diameter and stroke of air pump, diameter of suction and overflow pipes, and state whether the air pump is driven by belt, connecting rod, or independent steam cylinder.

Boilers.—The boilers (state kind) to be of sufficient capacity to furnish the steam required to run the above engines up to 1,800 horse-power, each boiler to be as follows: Sixty inches diameter, sixteen feet long, containing forty-four tubes, four inches in diameter; shell of boiler eleven thirty-seconds of an inch thick; heads one-half inch thick; dome thirty inches in diameter by forty-four inches high, double riveted to shell; shell of dome five-sixteenths of an inch thick; head of dome seven-sixteenths inch thick; all to be homogenous steel, 60,000 pounds tensile strength. Longitudinal seams of boiler and dome to be double riveted. Two cast-iron brackets, riveted to each side of boiler. Boiler to have one manhole on top of shell and one manhole in front head under the tubes. One full front with anchor bolts, five feet grate bars, bearing bars, liners, ash door and frame, back plate for arch, binder bars and rods. One set of boiler fixtures, including three inch pop safety valve, two inch blow-off cock, one and one-half inch feed valve, one and one-half inch check valve, steam gauge, glass-water gauge and gauge cocks. Suitable breeching of No. 12 iron to connect all the boilers to brick stack.

Steam Pumps.—Two steam pumps, each large enough to feed the boilers required to run two of the above engines.

Piping.—All necessary pipes and valves inside of boiler and engine house to connect above engines, condensers, boilers and pumps. The steam pipe from all the boilers to be connected to one header. From this header one supply pipe to run each engine. The exhaust pipes to be so arranged that the engines can be used non-condensing when necessary.

Shafting, &c.—(State whether one or two) line shaft of suitable diameter and length to drive forty dynamos, each of thirty arc light capacity. A suitable number of ball and socket pillow block bearings to support above shaft. Three main driving pulleys, one to be driven by each engine, these to be arranged with hollow sleeves and jaw clutches. Forty friction clutch pulleys, each of proper size to drive one dynamo, each clutch to be provided with a lever for throwing clutch in and out.

Belting.—(State whether one or two) belt from each engine fly-wheel to the corresponding driving wheel on line shaft to be best short lap, oak-tanned double leather belting. Forty dynamo belts, one from each of the friction clutch pulleys to its corresponding dynamo, to be best double light leather dynamo belting.

Masonry.—The engines, condensers and feed pumps to be provided with suitable foundations of brick or rubble stone, with cut stone cap stones. The shafting to be supported on piers built of brick with iron cap plates. The boilers to have substantial brick settings. All the inner surfaces of the walls exposed to the flame to be lined with first-class fire-brick.

Tests.—The bidder to guarantee the number of pounds of water evaporated per hour per indicated horse-power required for each engine when developing six hundred horse-power, and also to guarantee the evaporation of the boilers, using (state kind of) coal.

ELECTRIC PLANT.

Dynamos.—Forty dynamos of thirty arc lights each, to be mounted on adjustable insulated bases, with belt tightening apparatus. Each dynamo to be provided with approved lightning arresters, automatic regulator, to fully govern and control the current, and regulate the same in proportion to the number of lamps in operation, from one lamp to the maximum capacity of machine, a test of twenty-four hours to be guaranteed. Each dynamo shall be provided with approved ampere-meters, and the terminals shall be taken to suitable switch-boards, so arranged as to enable the operator to manipulate the dynamos and circuits at will, with the least possible opening of circuit. Bidder to state lowest guaranteed horse-power required in each arc and to drive each machine. Lamp magnets and dynamo armatures must be guaranteed against burning out from short-circuiting of the current for two years. Dynamos shall admit of being coupled together to operate any multiple of their capacity.

Lamps.—One thousand double carbon, standard 2,000 candle-power arc lamps, each lamp to have automatic cut-out, and hand switch, with lifting and sustaining magnets of sufficient strength to enable the use of carbons one-half inch in diameter if desired; said lamps shall be thoroughly insulated and protected from the weather by hoods or other devices; bidder to state the nature of such devices. Bidder must state the number of amperes of dynamo running under normal condition, also the voltage per lamp.

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Line Wire.—(State number) miles of No. 4, 5, or 6 B. and S. Gauge copper line wire, water, weather, and fire proof insulation, said wire to be subject to test of twelve hours under water, after which it must show (state) resistance, and shall be tested from reel supplied for work. Said wire shall not be less than 98 per cent. pure copper. Every joint to be soldered and wrapped with tape.

Poles.—Four thousand forty-five foot cedar poles, not less than six inches in diameter at the tip. Said poles shall be set six feet in the ground and covered with preservative, and the part above ground trimmed and painted with two coats of paint.

Cross Arms.—Six thousand four-pin cross arms, four and one-half by five and one-half inches by four feet in length, free from knots and cracks, and painted with two coats of paint.

Insulators.—Twenty-four thousand deep groove electric light insulators.

Pins.—Twenty-four thousand one and one-half inch standard locust or oak pins, painted with two coats of paint, also end protectors for arm of one-inch strap iron, one-quarter inch thick, to prevent end wire dropping into street in crossing.

Belting.—Belting to be leather and endless.

If the lights are to be placed upon poles, insert the following :—

Poles.—One thousand thirty-feet iron (or wood) ornamental poles with steps.

Or, if over street intersections, insert this :—

Intersections.—One thousand mast arms, arches, or other devices (state which), capable of holding the lamps forty feet high at street intersections.

If towers are desired, insert this :*

Towers.—One hundred standard one hundred and fifty foot electric light towers, description to be stated, with supports for six lights each ; one hundred standard one hundred and fifty foot electric light towers, with supports for four lights each.

Plant Complete.—The bidder to bid on furnishing the above plant complete in every particular, furnish all labour, including superintendence, and construct and build the circuits, &c., and turn over to the city ready for duty. Bids to be in detail, stating name and kind of each article and price.

Maintenance.—Bidder to accompany bid with a schedule showing the number and approximate salary of labour required and other cost of maintaining the complete plant per year, each item to be carried out in detail. The cost of steam and electrical plants to be kept separate where bidder is estimating on entire specifications.

Where the wires are to be placed underground, the specifications should provide that :

The cables shall have a carrying capacity equal to No. 4, 5, or 6 B. and S. gauge wire, bidder to give price on each. Said wire shall be thoroughly insulated and character stated. The cables shall have an insulation resistance of not less than ten megohms per mile when laid in the ground. The contractor must estimate on digging all trenches, furnishing all appliances, stating their nature, removing and repairing paving, and laying cables ready for use, guaranteeing them for at least two years.

ISOLATED INCANDESCENT PLANT.

Dynamos.—One dynamo capable of generating current for 250 incandescent lamps of sixteen candle-power each. The dynamos to set upon insulated bases and provided with belt tighteners and to be capable of generating the current as stated, for a period of at least twelve hours' continuous running daily, without excessive or abnormal heating or sparking at the commutator brushes, or unduly heating the journals. Ths dynamos will be practically automatic, and capable of permitting any number of lights to be turned on or off at will without affecting the others in use.

Lamps.—Two hundred and fifty lamps of sixteen candle-power. Bidder to state price of lamps for renewals.

Sockets.—Two hundred and fifty sockets for lamps.

Electrical Appliances.—Necessary rheostats for setting the candle-power of the lamps ; same to be of sufficient capacity to control the E.M.F. of dynamos without unduly heating. The rheostats to be connected with dynamos with good insulated copper wire ; necessary balancing rheostats for enabling dynamos to be operated in parallel (multiple arc) ; necessary potential indicators to put in the lamp circuit and remain continually in such circuit, to indicate clearly at all times electrical pressure at which lamps are being operated ; necessary ampere-meters to be also put into the circuit to correctly indicate the number of lamps in operation, and to denote any changes in the number of lamps burning ; necessary ground detectors to show instantly the location of any ground on the circuit ; necessary switches and switch-boards. All to be erected and properly connected and made ready to be attached to the power provided for.

* It should be borne in mind that if towers are used the number of lights necessary will not be so large as by the pole or intersection systems.

Wiring.—Furnish a complete system from the dynamo to the main switch or switch-board (as the case may be), and from the main switch (or switch-board) to the point of distribution, the mains to have sufficient conductivity to operate 250 lamps of sixteen candle-power. The wiring to be calculated and put up so that the loss in electrical pressure shall not exceed 5 per cent. between the dynamos and the lamps when the full number of lamps are burning. The mains to be of the best quality of copper, 98 per cent. conductivity, and of the best insulation. Mains to be put up in good and substantial manner, and have double-pole safety devices inserted where leaving the main switch (or switch-board).

Branch Wiring.—All branches from mains will be attached thereto by means of good soldered joints, and such joints will be thoroughly protected by insulating with some standard compound. Double-pole safety devices will be inserted at convenient points near the attachment to mains. The branch wires to be of best quality copper. The branches to be so calculated and put up that not to exceed 5 per cent. shall be lost in overcoming the resistance from the mains. The entire loss of current in mains and branches will not exceed 5 per cent.

Lamp Attachments.—Furnish suitable ceiling rosettes and affix same to the ceiling where lamps are to be suspended, and suspend the lamps from such rosettes by means of insulated flexible copper cord, and properly attach lamps thereto at such height from the floor as will be required, or attach lamps to such fixtures as may be provided by the purchaser.

Labour.—Furnish all necessary labour to fully erect the plant complete.

Miscellaneous.—The bidder will guarantee the plant to work properly and that the lamps will burn steady and not blacken.

Maintenance.—Bidder to accompany estimate with a schedule showing the number and approximate salary of labour required to run this plant ; also the cost of maintaining this plant per year, each item to be carried out in detail.

REVIEWS.

Principles of Dynamo-Electric Machinery, and Practical Directions for Designing and Constructing Dynamos. By CARL HERING. (New York : W. J. Johnson. London : 1, Salisbury-court, Fleet-street, E.C.)

The subject matter of this volume has for the most part appeared as a serial in the *Electrician and Electrical Engineer* of New York, and, therefore, must be taken as being fairly well known, even on this side of the Atlantic, where our contemporary has a considerable circulation. Serial articles in a technical journal are, however, not in a very convenient or accessible form for reference, and, without doubt, Mr. Hering and his publishers acted wisely in issuing these articles in book-form.

The dynamo has inspired many pens, and has already an extensive literature of its own. but we can only call to mind two works the positions of which on our shelves are known to us. One is Prof. Thompson's substantial volume, the other Mr. Kapp's smaller work on a separate department of the subject. Mr. Hering's book is intended for the workshop rather than the study, and probably contains in a well-digested form the practical rules followed in American factories, and will be found interesting and suggestive by all those who are commencing their dynamo education.

The author explains in his preface that he aims at securing readers amongst builders and attendants of dynamos, amateurs and students, and not amongst experts, physicists or theorists ; and taking it at this valuation there is very little cause to complain of the manner in which his readers' wants have been provided for. The book contains a very great deal of solid practical general information, and a careful perusal of it will do far more than that of any of the "introductory" treatises to prepare an amateur or a student for approaching the more advanced publications. It is only when the author ascends from the "how" to the "why" that he occasionally becomes a little disappointing. Thus, on p. 3 we must object to the statement that "a difference of electrical pressure cannot exist at two points of a conductor without generating a current between these two points." What is meant is, of course, that a difference of electrical pressure cannot exist between two points of a closed circuit without generating a current in that circuit. This is, however, evidently the author's meaning, as appears from a succeeding passage (p. 17).

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We feel that we can heartily recommend the book to those for whom it was intended, but must express our regret that the author has not gone further, and carried his readers into the more recent theories and laws of construction, based principally upon a better understanding of the magnetic circuit and its resistance.

He alludes to recent work, certainly, but only to say that "until such theories have been thoroughly tested by repeated and varied applications in practice, and are reduced to such a form that they may be readily applied, the constructor of dynamos is recommended to use the well-tried but less direct methods." This regret is the keener as we feel that this task of making recent work easily intelligible to all is one for which the author is very well qualified; and with the large amount of practical constructive detail at his command the work of trial and proof of the methods should not be difficult.

We notice (p. 55) a statement, to which we call the attention of constructors, that the thin layer of blue oxide on iron sheets used for armatures should be removed by pickling, as it retards magnetisation and demagnetisation, and an experiment is described in support of this view. We always considered thin oxide as an advantage rather than a source of loss, on account of its insulating properties. The fact that it is the magnetic oxide (Fe_3O_4) may cause a slight loss, but it never occurred to us that its amount could be appreciable, and we shall be glad of further information on the subject from those who have experience.

THE HOLOPHOTOMETER, WITH STAND.

We described in our last issue the principle upon which this instrument is based, and the method of its use. We now illustrate the practical form of the holophotometer as made by the Woodhouse and Rawson Company. It will be seen that the instrument is mounted upon a stand, which moves freely on three castors, E, and after being placed in position is fixed by means of three screw-pins, D, which also serve for levelling purposes.

The solid casting (into which the support of the instrument slides) is capable of considerable vertical movement, so as to suit any height of photometer disc. The fly nuts A serve to clamp it firmly at the required height.

The whole body rotates about a centre pin moving in the casting; and the exact position of the arm at right angles to the upright is ensured by the pin B, which drops into a conical slot in the casting.

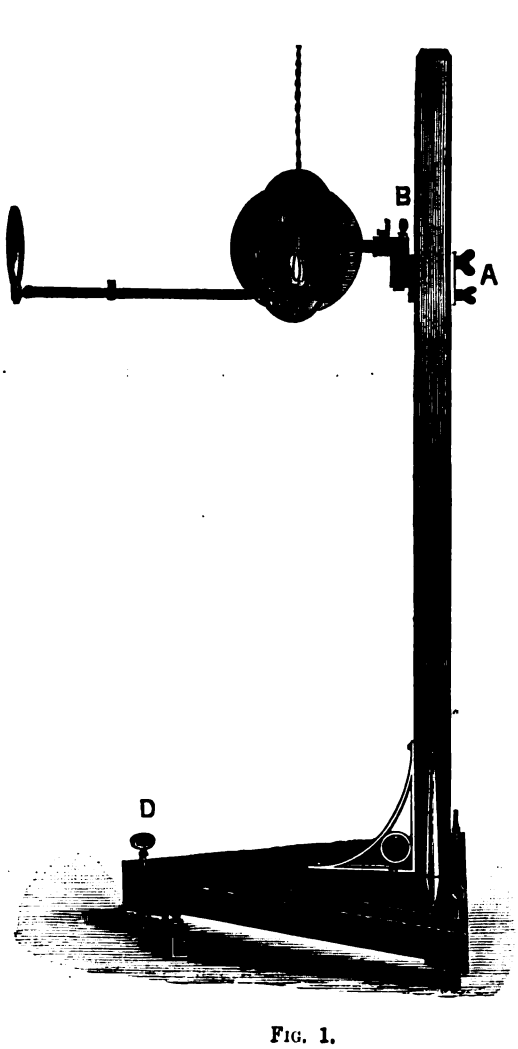

Fig. 1.

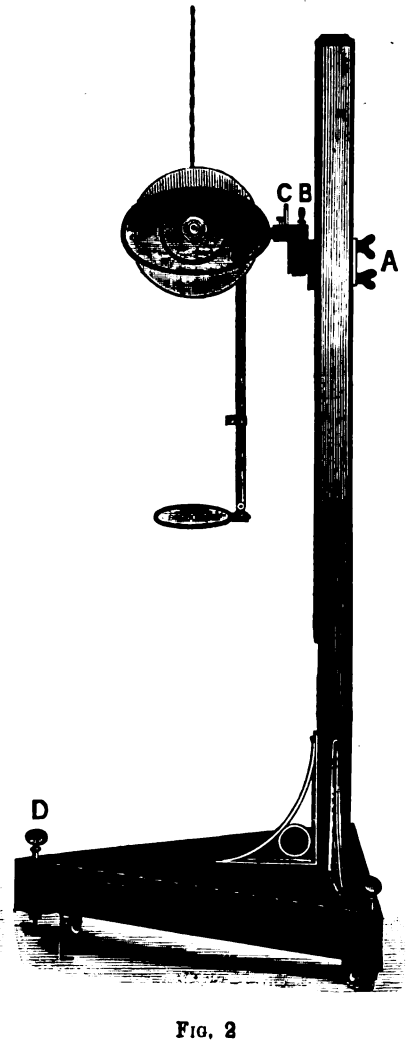

Fig. 2

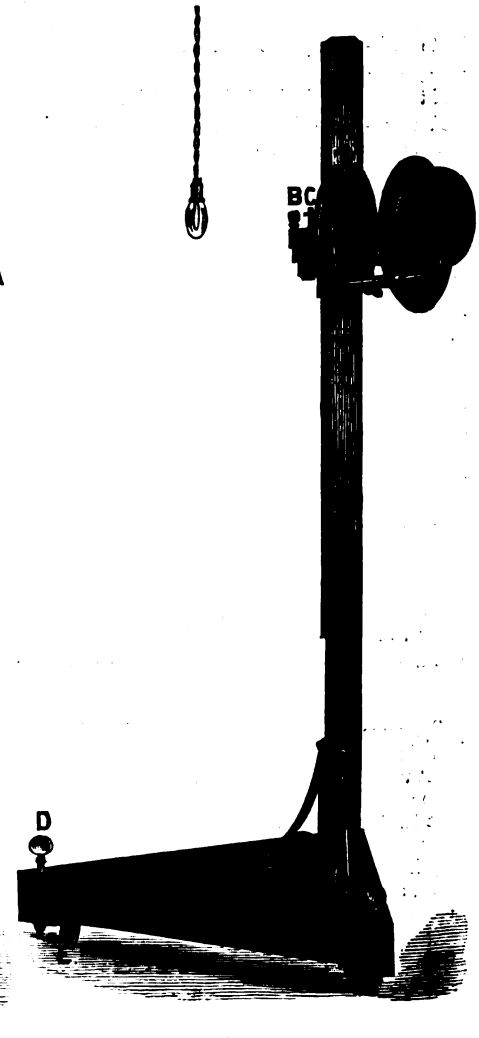

Fig. 3.

Rotation of the arm is prevented by the pin C and the adjacent set screw.

Fig. 1 shows the instrument as seen from the photometer disc, the rotating arm being in a horizontal position, and consequently the image in the mirror is a horizontal image of the incandescent lamp suspended behind.

Fig. 2 shows the arm vertical, and the image that of the lamp as seen from below.

Fig. 3 shows how the whole instrument is turned about B, so as to enable the direct horizontal light of the lamp to be measured in estimating the absorption of the mirrors.

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LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER IX.—*Magnetic Fields.*

(Continued from page 445.)

123. *Graduation of Tangent Scale.* — It has already been shown (para. 98) that in a figure such as Fig. 90 distances measured from A along the line A B are proportional to the tangents of the angles which those distances subtend. For example, two equal angles are drawn at C (Fig. 90); the tangent of the first angle is proportional to A D and that of the two together to A E. It is evident that when the force by which a magnetic needle is deflected (from a zero position

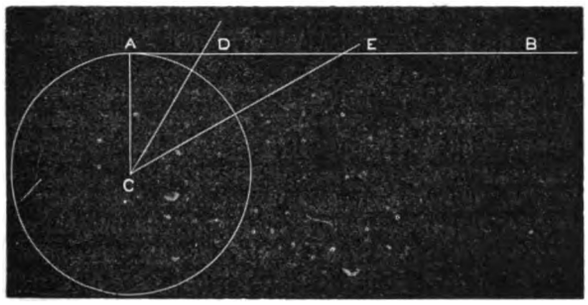

FIG. 90.

at A C) is proportional to the tangent of the angle of deflection, that it requires *more than* twice the force to move the needle through twice the angle, for A E is more than double A D. The object, then, of dividing out a scale in tangent divisions is to make the divisions proportional to the force moving the needle. This principle is shown in Fig. 91, where the distance A E is divided into two equal parts at the point F. Now, on drawing F C the scale is divided into divisions proportional to the force exerted on the needle; that is, the force which would move the needle from the direction A C to that of C E would be just double that required to move it from A C to C F, the needle turning, of course, about the centre C. The method is therefore to mark out a number of equal divi-

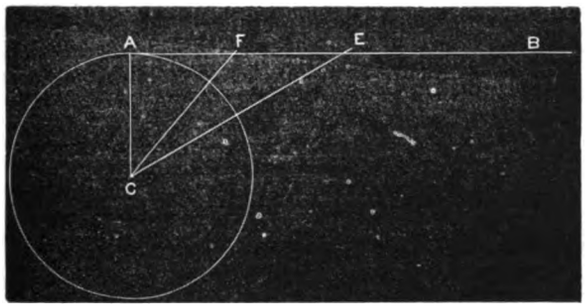

FIG. 91.

sions on the line A B, starting say from A, and then to draw lines from these divisions to the centre C, dividing the circular scale into divisions proportional to the tangents of the respective angles, and therefore proportional to the forces exerted on the magnetic needle. It only remains to decide as to the size of each division on A B. In the case of tangent galvanometers, the tangent scales of which are generally divided out up to 60°, the line C E is drawn, making an angle of 60° with the vertical A C. The horizontal distance A E is then marked out into 100 equal divisions, and the circular scale is graduated by drawing lines from these equal divisions towards C. This process is shown in Fig. 92, where it will be seen that the divisions become very crowded near 100, and it is useless to carry them beyond 60°, therefore it is usual to divide the scale on the opposite side of the circle in degrees of arc up to 90° on each side, by which means angles of deflection higher than 60° may be read off on the degree scale, and the tangents found by reference to tables. Now it should be understood that the numbers marked out are not the *actual* tangents of the angles, they are simply *proportional* to the tangents, for in the comparison of currents by the tangent galvanometer the actual or natural tangents are not required. With the instrument at present before us, however, we shall require for some measurements the natural tangents of the angles moved through by the needle, and therefore the scale is graduated in a different manner. The angle of 45° is selected as the standard (Fig. 93), and the distance which it cuts out on A B is divided into 100 equal parts, the scale being graduated by lines drawn towards

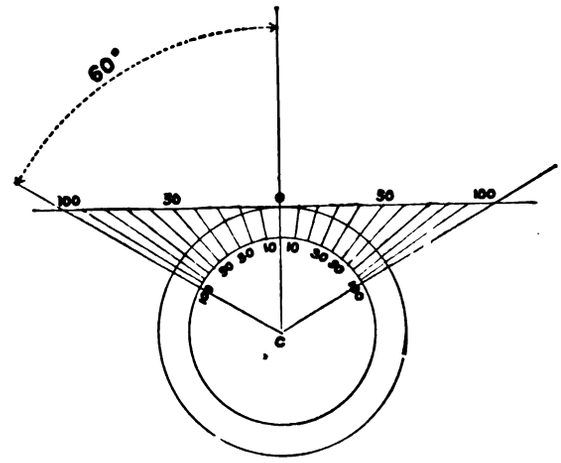

FIG. 92.

the centre as before, and the same numbers marked on the circular scale as exist on the divided line A B. Now, since the tangent of 45° is unity the natural tangent for this or any other angle is found by dividing the scale-reading by 100 —that is, moving the decimal point two places to the left. Suppose we had a deflection of 85 divisions; the natural tangent of this angle is ·85 and the angle itself need not be

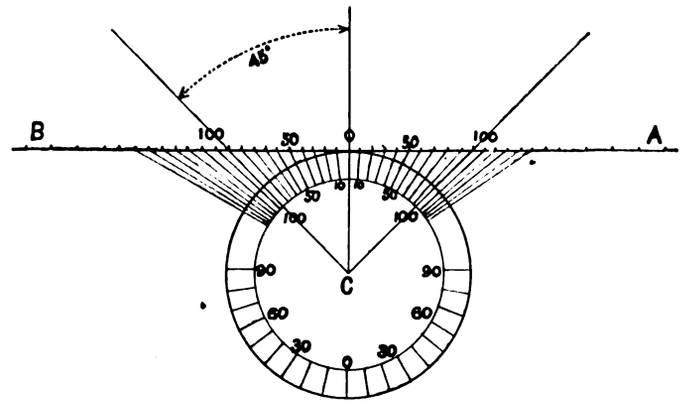

FIG. 93.

known. The line A B is marked out on both sides up to about 60° or 70°, the length of each division being the same all along. A straight rule is then placed in line between each division in succession and the centre, and the corresponding scale lines drawn at the edge of the scale circle for each position. The lines may be drawn from each single division near zero, but as the divisions become closer together they may be drawn from every second or fifth division, the intermediate divisions being judged by the observer when taking readings. The other side of the circle should then be marked out in degrees, up to 90° on each side.

124. *Adjustment of Magnetometer.* — To complete the magnetometer and set it up for use the wooden baseboard should have two fine lines *m m* and *n n* (Fig. 94) cut or

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marked on it accurately at right angles to each other and passing through the centre; a circle should also be described on the board a trifle larger in diameter than the outside diameter of the scale, to act as a guide in placing the scale symmetrically with the centre. The scale is cut out ring shape and placed in position with its zero marks in line with the line *m m* on the baseboard. It is better to let the scale lie loose on the board, as once placed there is nothing to move it, and sticking it down causes bulging. Inside the scale there should be a ring of mirror glass as shown in the figure; this is for the purpose of reading accurately the position of the pointer, the reflection of which is seen in the mirror. At the centre of the baseboard there should be fixed a little brass point standing vertically, only to the height of about $\frac{1}{8}$ inch above the level of the board; this will be found very convenient for levelling the instrument, during which operation

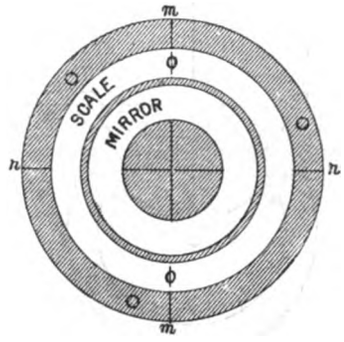

FIG. 94.

the eye may be kept on a level with the surface of the board, and the levelling screws turned till the centre of the suspended needle is seen to hang immediately above the centre brass point, viewed from all sides. The previous directions having been carried out for the removing of torsion from the fibre, the baseboard is placed with the line *m m* as nearly as possible in the magnetic meridian, and the inverted funnel carrying the suspended needle and pointer is then placed on the board, the rim of the same being placed symmetrically with the scale. The height of the needle can now be adjusted by raising or lowering, not turning, the wire suspension head; the stirrup should then just clear the brass centre point. It will most likely be found that the pointer is very near zero, but not quite. To bring it to zero, the baseboard of the instrument must be turned round, little by little, till the pointer is at zero. This adjustment is somewhat tedious, because the needle must be allowed to come to rest between each adjustment, and the slightest movement of the board often sets the needle swinging considerably, and alters the levelling.

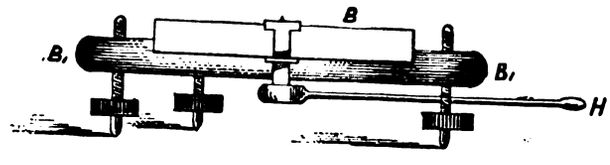

FIG. 95.

This inconvenience may be dispensed with in the following way: Mount the ordinary circular baseboard B (Fig. 95) on a second and larger board, B^1, countersunk to receive it. Attach the levelling screws to the lower board, and let the glass shade carrying the suspended needle rest on this. Through the centre of the upper baseboard fix a brass spindle, so as to enable the board to be turned by means of the level handle H. This lever should not be rigidly fixed to the spindle unless made short enough to work inside the levelling screws. It may be made like a spanner and fit on to a nut head at the lower end of the spindle, and can then be removed when once the instrument is adjusted. The scale and mirror are fixed to the upper board, so that these may be turned till the zero point is exactly under the pointer, while the needle itself and the levelling of the instrument are not disturbed. The brass spindle might also carry the centre point, as shown. Without this elaboration, however, once the adjustment is made it will never require repeating if the instrument is not moved. No magnets or pieces of iron must be anywhere near the instrument during this adjustment.

(To be continued.)

THE TURBO-ELECTRIC GENERATOR.

During the recent summer meeting of the Institution of Mechanical Engineers, which has just been held in Belfast, a discussion arose on the well-known turbo-electric generator made by Messrs. Clarke, Chapman, Parsons and Co., of Newcastle-on-Tyne.

Mr. STURGEON, Birmingham, wished to know whether Mr. Parsons had tried compressed air in his motor. They were wanting a motor in Birmingham suitable for driving dynamos by compressed air for electric lighting purposes. For private electric lighting he thought the best method was to convey the power to the user, and let him make use of it on the spot by some such apparatus as the one described. They should remember that an electric lighting company, supplying the light from a central station, had only the night hours during which to earn its profits, while during the whole of the day it had still to keep up its staff and its plant for the sake of a thousand hours during the year wherein it could turn them to profitable account, and they should consider that by taking power from a general company there were a number of other purposes to which it could be applied, so that they might have something like 3,000 working hours in the day time in addition to the 1,000 night hours every year. In Paris they had already applied compressed air very extensively to electric lighting purposes.

Mr. DAVEY reminded them of Mr. Aspinall's suggestion that the ancients were very prone to copy their ideas. It had occurred to him that a man named Hero, who flourished a century or two before the Christian era, had been copying Mr. Parsons; but he thought they had before them the first successful real rotary steam engine. They had had numerous so-called rotary steam engines, but they had been only reciprocating engines with the reciprocating parts nearly concealed. The Hero engine was a re-action steam engine, and this was an engine following on the lines of the first steam engine. He would like to know to what extent Mr. Parsons had reduced leakage; also whether he had considered the question of adapting the principle to engines of slower speeds. The speed appeared to be too high for general purposes at present. An obvious way of getting out of the difficulty would be by making the machine larger in diameter, more in the form of a fly-wheel. He wished to know whether Mr. Parsons had thought of applying a condenser to his engine, and, if so, what increase in economy might be expected. He suggested the possibility of applying a centrifugal air-pump to the shaft. In the matter of results, if the efficiency of the dynamo was 95 per cent., and assuming 80 per cent. efficiency for the generator alone, they had a total mechanical efficiency represented by 26½lb. of steam per indicated horse-power per hour. That was a very good result for an ordinary engine. Of course, first-class triple expansion and other engines had a consumption occasionally below 16lb., but such a return could not be expected in a new engine of this description.

At the suggestion of Sir Jas. Douglass, the PRESIDENT proposed that the discussion should be adjourned.

The proposition was carried.

The PRESIDENT then offered the opportunity of continuing the discussion to any Dublin man who could not be present in London at its continuation.

The Rev. GERALD MOLLOY, D.D., said he had used this engine to produce incandescent lights very successfully. With regard to the use of compressed air, it struck him that there would be no advantage gained by its use. It would involve the use of steam to compress the air at first, and then the use of the compsessed air to do exactly what the steam was capable of doing directly itself. The commercial efficiency of the dynamo was quoted at 95 per cent. If by commercial efficiency was meant the ratio of the electrical horse-power to the mechanical horse-power, it would be seen from the Paper that this dynamo had the highest efficiency of any dynamo yet produced. The Edison-Hopkinson dynamo, which had been most carefully tested, gave only an efficiency of from 85 to 90 per cent.

Mr. PARSONS, in replying, said that they had not yet tried compressed air. Theoretically they should get a much better duty than with steam, because the speed of outflow would more nearly agree with the speed of the blades. One difficulty that would come in would be that the air would require to be heated to 180deg. or

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200deg., because in expanding it would cool down. The leakage was the principal cause of loss at present, but no doubt they would be able to reduce that. It occurred between the blades and the sides. The clearance space had been reduced to ·015. There was, however, 15 to 20 per cent. leakage of the whole quantity of steam used. There was no reason why the engine should not be used as a condensing engine. The very high efficiency was due to the high speed. The magnetising current was only about 1 per cent., so that they could afford to have a loss in other places. The largest loss was due to the energy required to magnetise and demagnetise the iron core of the armature, and that was a large loss, and must be got over. The core was composed of thin iron plates about $\frac{1}{100}$in. thick. Mr. Davey was quite right. The efficiency of the dynamo was 95 per cent., and of the engine 80 per cent., and the consumption of steam would be, therefore, 26½lb. per indicated horse-power per hour. The comparative efficiency of the engine is just over 50 per cent.

Mr. DAVEY asked how did Mr. Parsons get the 18lb. Was it by taking the efficiency of the motor at 50 per cent.?

Mr. PARSONS said the theoretical consumption of a perfect engine would be equivalent to 18lb. per indicated horse-power per hour with an initial pressure of 90lb.

The discussion was then adjourned until the London meeting.

THE LEAMINGTON TOWN COUNCIL AND THE ELECTRIC LIGHT.

At the last monthly meeting of the Leamington Town Council the following letter was read on the question of the electric lighting of the town, respecting which there has been so much public discussion both in the Council and in the press:—

"Midland Electric Light and Power Company (Limited),
Leamington, July 31, 1888.

"To the Town Clerk, Leamington.

"Dear Sir: We beg to acknowledge receipt of your favour of the 10th inst., informing us that our letter of the 21st ult. was considered by the Council, and that they have given permission for the erection of four arc lights, by way of an experiment (provided no charge be made on the Corporation), on some spot to be agreed upon, at a height not exceeding fifty feet, but that the Council object to the lights being placed on the Town Hall tower, as they considered the access undesirable, and the height (100 feet) far too great, and believe that a position facing the Parade would be more suitable. The essence of our offer was that the arcs should be placed on the tower, and therefore in a position not absolutely facing the Parade, should be at least 100ft. high, and though lent and fixed by us free of charge, should be connected to the present mains, and the current, therefore, paid for by the Corporation. We may take it, then, that the Council have given us permission to do as nearly as possible the exact opposite of what we offered to do. We do not call in question the wisdom of the Council in wishing to try the effects of four arc lamps of 2,000 candle-power each, placed not more than 50ft. high, and facing the Parade, which at its narrowest point is only 50ft. wide. We only say that we do not wish to try this particular effect a second time at our own expense. We have already at our own expense and on our own property tried the effects of arcs between 30ft. and 50ft. high for street lighting. There is no mistake about the light. Used as we have shown it in Wise-street, it would take the place of ten street lamps. If the Council have not given attention to this particular illustration of the power of electricity as an illuminant, they can see it any night from 9 till 11. But this is an illustration of street-lighting by arcs. What we last offered to do was to give the town an opportunity of seeing street lighting by incandescent lamps in combination with arc lighting of open spaces. The two are quite different problems. We think it extraordinary that so substantial and extensive a building as the Town Hall tower should only be available for the purpose of housing a clock, and we cannot understand how the man who attends to the arcs can do more damage to it than he who attends to the clock; but we accept the decision of the Council, and now withdraw our offer, and we take the opportunity to withdraw also, at all events for the present, our former offer made some three months ago, to bear half the cost of removing the arms that now suspend the 16 candle-power lamps from the posts and to exchange them for upright lanterns and 32 candle-power lamps. Our reasons are these: We find that our motives are not appreciated. We are supposed to be madly desirous for a continuance at any cost of our present contract for lighting the Parade, whereas, as a matter of business, we don't care about lighting the Parade at all. As far as the Parade is concerned, our chief desire was to assist the more public spirited members of the Council in bringing Leamington abreast of the times. The system of lighting recommended by us, we admit, discussed in full conclave and adopted unanimously, does not appear when in practice to please the Council; this is a matter of taste and not of electrical engineering. Still we were willing to assist the Council in any change they desired, but every offer we make is used by our opponents as the excuse for some attack on our reputation, and some fresh outpourings of local spite and local prejudice. When we have been personally present we have had no reason to complain of the result of the discussion, but behind our backs the matter is different. These statements are made to our disadvantage that are unsupported by any evidence that would be received in a court of justice, and that are untrue in fact; and no effort is made to distinguish between legitimate criticism of matters of taste and opinion, such as the method of distributing the light and the appliances by which it is distributed, and for which matters the Council are now alone responsible. That other matters for which only we are responsible—the candle-power of the lamps—we ask (and surely it is not an unreasonable request) as a condition precedent of any fresh offer on our part that the candle-power of our lamps should be regularly tested and published at the same time and in the same way as candle-power of the gas lamps is tested and published. As we noticed that the last one-sided discussion on the electric light which appeared in the papers was unaccompanied by our letter which gave rise to it, we shall feel obliged if on the present occasion you will hand this letter to the public press after it has been communicated to the Council.—Yours truly (for the Midland Electric Light and Power Company, Limited), Arthur Chamberlain."

The MAYOR said he thought it was a pity Mr. Chamberlain had not a wise man at his elbow when he sat down to write that letter.

Mr. CROWTHER DAVIES proposed that the letter be referred to the Watch Committee. The letter was such that, as a matter of taste, it was to be regretted that it had been written.

The motion was carried.

Mr. CROWTHER DAVIES had a motion on the agenda paper that notice be given the Electric Light and Power Company to terminate the present contract in twelve months' time, but when the time came for moving the same he asked permission to withdraw it. In doing this he explained that it was his desire to leave no means untried by way of arriving at a satisfactory settlement with Mr. Chamberlain. The desire of those with whom he was acting, and it was a feeling he shared, was that the electric lighting company should not feel that any hasty steps had been taken by the Council to put an end to the contract, but, on the contrary, that every means had been used to bring about a satisfactory settlement. It was undoubtedly a most unfortunate letter they had heard read—unfortunate for the writer rather than the recipient. He had formed a most unjust and unworthy conception of the Council as a whole, as well as of some of its individual members. The resolution he asked to withdraw was one he could carry, but as it was to be withdrawn, he hoped Mr. Chamberlain would come to the conclusion that it would be well to treat the Council as reasonable, just, and honourable men. There was no desire to throw cold water upon his company, but to secure an arrangement which would be just to the ratepayers and fair to the Company.

Mr. BRIGHT said he thought Mr. Davies had acted most generously in withdrawing the motion. As one who advocated the introduction of the electric light, he was not satisfied with it, but thought the defect was due, not to the light itself, but to the lanterns used. The letter sent by Mr. Chamberlain was extremely unwise.

Mr. DAVIES said he did not retract anything he had said about the light. What he had said he stuck to, and could prove it if necessary. If the light was not made satisfactory he should revive the subject at some future time.

Leave to withdraw the motion was then given, and the subject referred to the General Purposes Committee, a meeting of which is to be convened at an early date.

BOOKS, &c., RECEIVED.

"The Glasgow District Telephone Directory, 1888-89." (Glasgow.)

"Traité Elémentaire de L'Accumulateur Voltaïque." By EMILE REYNIER. (Paris: Baudy et Cie.)

"Telegrafia Militar." By EL COMANDANTE D. RAFAEL PERALTA, Capitan de Ingenieros. (Madrid.)

"Distributory Electrical Power Plants: Daft System." (New York: Jos. B. Stillwell and Co.)

"Municipal Lighting." By FRED. H. WHIPPLE. (Detroit, Mich.)

"The School of Mines Quarterly." Vol. IX., No. 4. (New York.)

"Syllabus of Day Classes of the Mason Science College, Birmingham. Session 1888-89."

"The *Journal* of the Franklin Institute." Vol. CXXVI. No. 752. (Philadelphia.)

"Price List of Electric Light Cables and Wires." W. T. Henley's Telegraph Works Company, (Limited). (1888.)

Luxemburg.—The central lighting station at Luxemburg, the concession of which has been granted to M. Hastert, is now under construction, and the firm of Siemens and Halske of Berlin are engaged in laying the main cables. The conditions imposed upon intending consumers appear somewhat vexatious. Nothing less than a yearly contract will be entertained. Incandescent lamps will be supplied by the company at five francs apiece; no others are to be used. All the internal fittings must be put up by the company. The current will be supplied by meter from dusk till midnight at the rate of 10 centimes per ampere-hour.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *August 4th*, 1888.

New York electricians have been very much amused, edified, and disgusted during the past week by an exhibition which Mr. Harold P. Brown has given at Columbia College of experiments on dogs, to show what are the limits of safety to animal life with varying pressures of direct and alternating currents. It will be remembered that Mr. Brown has lately appeared before the public as the advocate of "closed coil" machines for arc lighting, and of low-tension continuous currents for incandescent lighting. But a great many of his assertions were contradicted by various authorities whom I cited in my letter last week, and it seemed as though Mr. Brown had been "downed." Such was not the case, however, as he came up smiling, with a proposition to disprove by means of dogs certain of the statements made against him and his theories. Invitations were issued for the performance, and there was a very large attendance last Monday, when the tests were made. Mr. Brown had provided himself with an assortment of dogs, an Edison municipal machine of 1,200 volts continuous current, a Siemens alternating machine whose E.M.F. could be varied from 100 to 1,000 volts, and an arrangement for producing pulsatory effects with a continuous current. Before proceeding to make his demonstration Mr. Brown read a paper, in which he stated that with a continuous current, no provision being made to eliminate the extra current, dogs had been killed at 800 volts. With the extra current shunted a dog had stood 1,420 volts before being killed. With the alternating current, however, at 288 alternations per second, and an E.M.F. of 160 volts, the dog had been taken off in 15 seconds. An unfortunate cur was here introduced to the audience and subjected to the torture. It was first treated to an application of the continuous current at 300 volts. His resistance was determined as 15,000 ohms. As the experiments progressed he became at once a wiser and a madder dog, and so resented the treatment that in a short time he had released himself from muzzling straps and other gear, and stood free, glaring at his tormentors. At this juncture several of the spectators discovered that they had important business to attend to down town, and took their hats, but after the poor beast had once more been secured they reluctantly consented to stay a while and see the thing through. The potential of the testing current was run up to 1,000 volts, but the dog still stood it, although his resistance had fallen as low as 2,100 ohms. Mr. Brown was ready to go on raising the E.M.F. as high as possible, and when he had reached his limit he intended to vary the programme by giving the dog the alternating current, "to make him feel better," as he said. Some one suggested, however, that it would be more humane to dispatch the dog, whereupon Mr. Brown gave it a current of 330 volts alternating, which killed it at once. Resort was then to have been made to the cage for more dogs, but on the protests of some of the persons present, an officer of the Society for the Prevention of Cruelty to Animals interposed his authority, and the experiments were at an end. I do not mean it to be inferred that there was any intentional cruelty in what took place, nor that the results sought to be reached as to the effects of various currents fell short of the very first importance, but it does seem as if the wrong course was followed. Thus, it must be evident to everybody that the dog which served for the experiments must have been worn out by the continuous current long before the alternating was applied to him. The fall in his resistance shows this. Moreover, although I have not seen attention called to the point, it seems evident that the connections between the dog and the machine must have been much closer and much more intimate than would be the case with regard to accidental shock, which, after all, is the main point. As a rule, the man who gets a shock gets it from a casual, slight, and momentary contact, but in this instance everybody could see that a very large portion of the dog was in contact with the conductors. Hence each side of the controversy must draw its conclusions from imperfect data, unless the experiments should happen to be renewed.

If this sort of thing goes on, with the accidental killing of men and the experimental killing of dogs, the public will soon become as familiar with the idea that electricity is death as with the old superstition that it is life. It is interesting to note that from Philadelphia is reported the fact that electric light men are never troubled with rheumatism, and that people who are tortured with pains in their joints hang around the dynamos eager to subject themselves to the influence of the magnetic field, just as consumptives are said to hang around slaughter houses to drink the blood of freshly-killed bullocks.

Mr. M. D. Law, the very efficient superintendent of the Brush Company in Philadelphia, is quoted, however, as the authority for the statement that men engaged around dynamos are decidedly free from rheumatic and neuralgic troubles, and that continuance in the work is calculated to improve the health of men who had been subject to such ailments. Mr. Law gives his own experience, and mentions that although when he first entered the electric light business some years ago he was afflicted with acute rheumatism, in less than eighteen months he was a cured man. Another item of interest in this connection, bearing the other way, is to the effect that there may be some delay in carrying out executions by electricity in this State. The authorities do not seem to be as well satisfied as they might be regarding the advisability and practicability of the infliction of death sentences by electrical methods, and it seems possible that some time may elapse before the legislation on the subject is carried into effect.

We are beginning to have some very large isolated incandescent plants in this country. One of the largest and finest of these is that installed by the United States Company in the Equitable Insurance building in this city, where the fittings of the dynamo and engine rooms are of the most sumptuous order. This plant has been considered the largest of the kind extant; but it now bids fair to be eclipsed by an Edison installation for the new Auditorium building at Chicago. This plant will start, it is said, with no fewer than 8,600 lights. One of the special features of the installation is that the lights will be used to illuminate so large a hall, and the results obtained during the recent Republican Convention in the building promise a brilliant triumph. The lights in the Equitable building are not used in this way to illuminate large spaces, but are distributed over several floors and light up hundreds of distinct offices. If there is anything at all equal to these plants in Europe we have not heard of them, though it would seem that some of the magnificent halls and cathedrals of the Old World would afford even better opportunities for electrical display.

Last week I wrote you in regard to the statements which Mr. Whitney, of Boston, had expressed in regard to the desirability of the electric motor for street railway purposes. His language has attracted considerable attention here; but his action is even more likely to do so, for he has given evidence of the faith that is in him by ordering of the Sprague Company for Boston's suburbs an initial equipment for an overhead service of twelve miles of track and twenty cars. The cars will be specially roomy and comfortable, and everything about the road will be as ornate as possible. It will be running as soon as the work can possibly be done. Another large city to put in the Sprague system is Cleveland, for which place an equipment of eight miles of track and sixteen cars has been ordered. In fact, the motor business generally is in excellent shape. Despite the summer dulness, all the minor companies are busy, and seem to experience difficulty in filling their orders promptly. In Baltimore, the local Brush Company, of which Mr. Frank Morrison is the able president, is now running three large dynamo machines on motor circuits exclusively, and is operating from them about 200 of the Baxter motors, in the construction of which Mr. Morrison is actively interested. So great is the promise of the increase of electric lighting in con-

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nection with electric power in Baltimore that the Brush Company there is already getting ready to build a new station. This again, like a few other things we have in America, is to be the largest in the world, and is to have a capacity of nearly 5,000 horse-power.

A great deal of interest is taken here in the reports which reach us in regard to the carrying out of the Pacific Cable plan for connecting Canada and Australia and the far East. We have just seen the completion of another ocean telegraph service in the cables laid and now put in operation between this country and Venezuela and other South American countries bordering on the Caribbean Sea. An interesting episode also has been the arrival in this city of Dr. Allen, secretary of the Corean Legation to the United States. Corea has been very much of a hermit among the nations, and little is known of the island, although we know so much of neighbouring Japan. One of the objects of Dr. Allen's visit has been to arrange, if possible, for some means of direct telegraphic communication between Corea and San Francisco. American officers are now reorganising the Corean army, and Californian miners will soon be developing the Corean goldfields, which are said to be extremely rich, and hence, with a greater trade between the two countries, the need of a cable is already felt.

At this time of the year, most of our associations, no matter of what nature, contrive to have a convention, and electrical bodies are no exception to the rule. Next week the Edison Association, which meets every six months, will hold its summer convention at Nantasket Beach, near Boston, when a large attendance is expected of the representatives of the parent and local companies. The week after the Telegraphic Old Timers and the Military Telegraphers meet in Chicago. At the end of the month the National Electric Light Association holds its convention in this city, and it will be followed a few days later by the annual meeting of the National Telephone Exchange Association. Pretty soon, I suppose, your electrical contemporaries here will be staggering along under a load of electrical oratory. All these conventions do but little harm and a great deal of good. They develop many interesting points, and they tend to secure uniformity of practice and of operation which, perhaps, would otherwise be unattainable. The electric light man who lives in Hoboken, for example, is apt to believe that he has the best way of doing things until he finds that his friend, operating perhaps the same system at Kalamazoo, has a great deal better method, and as soon as he learns of the difference he makes the change and gets his plant on a far more economical and profitable basis. This is the practical side of the convention, to say nothing of the pleasant opportunities afforded for renewing friendships and enlarging one's circle of acquaintances.

I had closed this letter, but I open it to add that another series of experiments on dogs was made yesterday by Mr. Brown at Columbia College, with the assistance of several well-known professional men, doctors, electricians, and others. The net result was far more satisfactory, if it may be stated that way, than was the case with the first trial. The attendant circumstances were by no means as repulsive; on the contrary, the experiments were all made in a neat and clean way, each demonstration being sharp and effective. The dogs were not subjected this time to any tests of the continuous current, but exclusively with the alternating, which proved fatal at E.M.F.'s of 272, 340, and 234 volts respectively, in this way corroborating the results which, it was said, had already been reached. The object of the experiments has obviously been to prevent the admission of alternating currents into this city. I do not think they will have this result, but they will certainly cause the authorities to be exacting as to the conditions under which they allow such currents to be distributed and used.

The idea of obtaining a practical facsimile telegraph has not by any means been given up, and the latest attempt in this direction on our side of the water is that of Prof. Elisha Gray, with whom your readers will be well acquainted as the leading telephone claimant and as the inventor of the harmonic multiple telegraph system. In the "telautograph," as Prof. Gray calls his new system, quite novel methods are employed, which consist in transmuting the movements of a transmitting pen into current pulsations, varying in number with the linear extent of movement, and their speed of succession with the rapidity of that movement, and in then transmuting these pulsations into like movements of the receiving pen. The system consists essentially of a transmitter and a receiver. In the transmitter the pen is connected by two cords at right angles to each other, and two devices which interrupt the current over two main lines in conformity with the movement of the pen. These currents thrown into pulsations are received on a receiving instrument, which consists of two pairs of magnets, which act upon two rods also placed at right angles to each other, and the movements of which rods are effected by the currents sent over the lines, and made to correspond exactly with the movements of the transmitting pen. Hence, any character traced by the latter is reproduced at the other end. I cannot here enter into the details of the apparatus, which, though quite simple, would require too much space, and moreover, the practical machine has not been brought out yet, only the patents having been issued. The laboratory tests are reported to be quite successful.

CORRESPONDENCE.

LIGHTNING DISCHARGES, &c.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The gap between the electrical phenomena of common practice and those concerned in the transmission of light and heat, a gap that it once seemed almost impossible to get over, is being gradually filled up, both from the theoretical and the experimental side; both from above, by the observation of dark heat and in other ways; and from below, by electrical means, as condenser discharges, vacuum tube experiments, &c. Dr. Lodge's recent work on lightning discharges, especially the experiments described in his second lecture, deserves the most careful attention, as a substantial addition to our knowledge of the subject, and also because it is, so far as I know, the first serious attempt to treat the subject electro-magnetically.

The fluids are played out; they are fast evaporating into nothingness. The whole field of electrostatics must be studied from the electro-magnetic point of view to obtain an adequately comprehensive notion of the facts of the case; and it is here that Dr. Lodge's experiments are also useful.

Independently of this, I should not be surprised to find that a *new fact* is contained in some of the experiments. Now a new fact is a serious matter, and its existence can only be granted upon the most conclusive evidence, of varied nature. There is already some independent evidence, viz., in Kundt's recent Paper on the speed of light in metals. But it is scarcely sufficient.

There is the plainest possible evidence that with waves of telephonic frequency the magnetic force and the flux induction are proportionate, and that their ratio is a large number in iron. I have observed, and I read that Ayrton and Perry have also observed, decrease of the inductivity with increased frequency of alternation. But, at least with me, it went only a little way, and I had not the opportunity to extend the experiments.

Now a conducting wire at the first moment of receiving a wave (in the dielectric, of course) performs the important function of guiding it and preventing its dissipation in space; and besides that, the nature of the conductor partly determines what impedance the wave suffers, causing a reflection back, with heaping up behind, so to speak, of the electric disturbance. But at first the conduction current is purely superficial. It is clear then that at the *very front* of a wave, where conduction is just commencing on the surface, the conductor cannot be treated as if it had the same properties (conductivity, inductivity, permittivity) as if it were a *bulk* of material, for

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only a thin layer of molecules is concerned. We therefore do not know what the true boundary condition is when pushed to the extreme. And yet it may be that this unknown condition may serve to sometimes determine a choice of paths.

Thus, iron may behave, superficially, as if it were non-magnetic. (This does not mean that the inductivity of the iron wire is unity.) In Kundt's experiments, electromagnetically interpreted, the inductivity of iron is nowhere; the conductivity, too, must, in other cases as well, be less than the steady value. This corroborates Maxwell's remarks concerning gold leaf. Of course the application of electro-magnetic principles to the passage of light through material substances is at present in a very tentative state; so that too much importance should not be attached to the speculations one may be led to make in these matters.

[If a conductor could be treated as homogeneous right up to its surface, the initial resistance of unit of surface I calculate to be $4\pi\mu v$, where μ is the inductivity and v the speed of transmission in the conductor. But neither μ nor v can be considered to be known in the case of iron.]

Another matter I wish to direct attention to is this. Dr. Lodge has described some experiments relating to the reflection of waves sent along a circuit. It will also be in the knowledge of some readers that Sections XL. to XLVI. of my "Electro-magnetic Induction and its Propagationn," *Electrician*, June to September, 1887 (and a straggler, XLVII., December 31, 1887), deal with the subject of the transmission of waves along wires, their reflection, absorption, &c., by a new method.

Now I find that there is an idea prevalent that it is only possible for very advanced mathematicians to understand this subject. It is true that when it is comprehensively considered it is by no means easy. But I desire to call attention to the fact (as I did in one or more of the articles referred to) that all the main features of the transmission, reflection, absorption, &c., of waves can be worked out (as done there by me) by elementary algebra.

I was informed substantially that no one read my articles. Possibly some few may do so now, with Dr. Lodge's experiments in practical illustration of some of the matters considered.

My next communication, I may add (written in September, 1887), is on the important subject of the measure of the inductance of circuits, and its true effects, in amplification of preceding matter. It has also special reference to some experimental observations. It has also some valuable annotations by an eminent authority.—Yours, &c.,

OLIVER HEAVISIDE.

P.S.—In connection with lightning discharges, I may remark that it is usual and seems very natural to assume, that the discharge is initiated at the place of the visible spark—the crack, so to speak. But my recent investigations lead me to conclude that this is by no means necessary, and that the strongest dielectric can be disrupted by a suitable convergence of a wave to a centre *or an axis*, starting with any steady field.

For instance, if in a cylindical portion of a dielectric the displacement be uniform, and parallel to the axis, and it be allowed to discharge, the convergence of the resulting wave to the axis causes the electric force to mount up infinitely there, momentarily; hence disruption.

But I do not pretend to give a complete theory of the thundercloud. It is only a detail.

P.P.S.—In Dr. Fleming's recent articles on the theory of alternating currents, I observe that he calls the component Ln of the impedance $(R^2+L^2n^2)^{\frac{1}{2}}$ the "inductive resistance."

I should myself have scarcely thought that it deserved a name, for of course we must draw the line somewhere. But the fact that Dr. Fleming has given it a name is evidence that he found it convenient to do so. Taking it, then, for granted that it should have a special name, I can only object to the one chosen that it creates two kinds of resistance. I desire to recognise but one—*the* resistance. I might, for instance, call Ln the hindrance. Thus, in the case of a coil, R is the *electric* resistance, Ln the *magnetic* hindrance, and their resultant the impedance. But in any case it would not be a term for popular use.

August 13, 1888.

THE DELANY AND WHEATSTONE-STROH CABLE KEYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Delany's letter in your last week's issue I think your descriptions and illustrations of the Wheatstone-Stroh apparatus in the previous number answer nearly all his questions.

I was not aware of the existence of a patent, or would have refreshed my memory from the specification; but the apparatus shown in your illustrations is that which was tried as I stated, and my description of it is substantially accurate.

The fly shown can be made to determine the duration of the contact independently of the manipulation of the operator, and when once adjusted to suit a particular cable will remain invariable.

I do not think it is correct to say that this method of signalling by currents of equal duration in opposite directions has been abandoned for an inferior system, because in the Wheatstone automatic, which is still in use, the signals are of this character.

Mr. Delany points out that the key is not "similar" to his arrangement. I did not mean by the use of this expression that the mechanical details were alike in the two instruments, but that the Wheatstone-Stroh key was, like Delany's, a hand-worked key, which produced the same results by signals transmitted in the same manner.—Yours, &c.,

F. HIGGINS.

17, Cornhill, E.C., August 13th, 1888.

UNIPOLAR INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have looked up the account on page 203 of *The Electrician*, June 22nd, of Messrs. Exner and Czermak's experiments to which Mr. Tunzelmann refers me for a demonstration of his theory, and find their apparatus described in part by a comparison with that designed by Fessel, which it resembles, and which is described on page 171, June 15th.

I note on this page that when Fessel's magnet and its jacket were rotated together, and either of the end centres was connected through a fixed wire and rubbing contacts with the middle of the jacket, a stronger current was observed than when the magnet rotated alone, and either of its end centres was similarly connected through a fixed wire and sliding contacts with the middle of the magnet. I should have expected the very reverse of this, seeing that a few of the lines would return within the jacket, without in the former case cutting either it or the wire. This neither helps the "stationary" nor the revolving theory, but it cannot be reasonably claimed for any of the experiments that they were exact quantitative determinations, the E.M.F. being so very low in relation to the difference between the resistances when the different sliding contacts were used. Probably also the fact was overlooked that a very tangible thermo-electric current is produced in the absolute surfaces of the rubbing contacts, which would account for all the difference observed according as the middle contact rubbed against the copper jacket or the steel magnet.

In Messrs. Exner and Czermak's experiments we have a cylindrical electro-magnet, one-half encased in a metallic jacket, the other half occupied by the exciting coil. The two ends of this jacket were connected "through a silver voltameter placed inside the jacket," the voltameter and connections rotating as one with the jacket, or remaining stationary with it as determined. Here I may point out the incontestable fact that the one condition necessary in all cases of current induction is, not that the number of lines within the circuit shall vary, but that at any given moment the E.M.F.'s induced in any circuit by the lines of force traversing the several parts of the conductor which composes it shall *not* balance. This necessarily involves the use of sliding contacts, or their equivalent, in all cases in which the *position* of the circuit is fixed in an invariable field; as in Forbes's dynamo, for instance. The rule may be stated thus:—If any circuit be chosen in any conductor, situate in an invariable revolving field, and the whole of the material constituting such circuit be fixed, no current

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can be induced in that circuit, because it is simply impossible to find any two points in it the lines passing between which do not cut that portion of the conductor on one side of the points chosen (say, at entering the circuit) exactly as fast as they cut the remaining portion of the circuit (say, at leaving), so as to produce two balanced E.M.F.'s. But if some portion of the material in the path of the current (*i.e.*, the circuit, which is fixed in position) moves relatively to the rest, either in the same or in the opposite direction to that in which the lines are supposed to be revolving, it will cut the lines faster or slower than if it were stationary, and a current one way or the other results accordingly, because now two points may be found in the current's path (this seems the proper definition of a circuit) between which on either hand an unequal number of lines cuts the conductor, so that the E.M.F.'s no longer balance.

To say that in such cases "the circuit continually increases in area," or "the number of lines passing through the circuit continually increases," is most incongruous language. These considerations, I think, answer the points raised in the last two paragraphs of Mr. Tunzelmann's letter in your last impression.

If now we take the two ends of the jacket in Exner and Czermak's apparatus we inevitably find that the sum of the lines traversing the voltameter and connections when the field revolves exactly equals the sum of those which traverse the jacket in the same direction; the induced E.M.F.'s would therefore equilibriate, and I fail to account on any theory for the effects noted by these observers. For, even allowing that the lines in their experiments did traverse their circuit when the magnet rotated, the small quantities of + and – electricities which would be developed could not perceptibly polarise the voltameter. Much, however, might depend upon the conductivity of the implement, and upon the agility exercised in the act of disconnecting the terminals of the voltameter while the apparatus was working; and, perhaps, also upon the anxiety of the experimenters for tangible results.

With regard to the observations put forward by Mr. Tunzelmann, on pages 232 and 233, in support of the revolving theory, it is, of course, granted that no tangible alteration takes place in a magnet's field when it is simply rotated; but there is connected with every magnet a certain seat of "coercitive" power, fixed, no doubt, in the case of a permanent magnet, so that the rays, so to put it (Figs. 14 and 15 on the above pages illustrate my meaning), of this coercitive force act constantly in the same *radial* direction and with the same power relatively to the magnet, so that it is not unnatural to suppose that when a magnet revolves the form characteristic of its field may be preserved by new lines being thrown out and others retracted radially like the pseudopodia of a rhizopod, as may be required, just as well as if it were actual vortex rings which rotated. To make clearer my meaning, suppose a bar of some substance impervious to magnetism to be placed parallel to the axis of a magnet, it casts a shadow on that side remote from the magnet, comparatively free from lines of force, and if the bar were close to the magnet the only way in which the magnetic energy could pass the obstruction during the magnet's rotation would be by radial retraction and collapse of lines on the front side of the obstruction and the shooting out of lines on the further side. This, however, is rotation in much the same sense as that intended by Mr. Tunzelmann, in the interpretation he gives in the above pages, but he holds that an electro-magnet with stationary exciting coil holds its lines fast, so that they rotate only when the iron rotates. Surely in this case the coercitive force has its seat in the current circulating in the exciting coil, which neither rotates one way nor the other; and what reason can there be for supposing that the iron core through which the lines pass possess a special power of driving round or holding fast the line than a core of nickel, of copper, or of wood? In this connection there is a difficulty which Mr. Tunzelmann hardly disposes of in the second paragraph of his letter, page 450. I will put it in a different form. A fixed exciting coil occupies the space between two concentric iron cylinders of the same length; this coil magnetises the core, it also magnetises the outer cylinder; we may suppose them to be magnetised to saturation. If, therefore, either of these rotates, so do the lines of force, and in the same direction; but the same lines are common to both cylinders, and supposing the cylinders to rotate in contrary directions, it is necessary to suppose that so many lines as traverse the two must be at the same time revolving in both directions. This actual rotation of the same thing in two directions at once admits of no physical interpretation, although it might do very well for ordinary purposes to regard the lines as virtually rotating both ways simultaneously, so as to neutralise each other; but that is a different matter.

From the very nature of the case all the experimental evidence advanced in favour of one or other theory appears equally as compatible with one as another, and probably a more accurate physical conception of the nature of magnetic energy than that of vortex motions may be required to establish the truth. Confining attention to the conventional lines of force, my own way of regarding them is as if they were of the nature of (1) closed curves of force; (2) always possessing the same amount of energy in a given length; (3) entirely free from all restraint with regard to revolution about the magnetic axis; (4) expanding or shrinking in length, as the distribution of force may require in the various parts of its revolution about the magnetic axis; (5) traversing conductors, in which current cannot be set up to resist their passage with as much ease as if they were dielectrics; (6) preferring to move round the magnet's axis rather than traverse, or be traversed, by any conductor which may advance relatively to them, and in which they would induce current, excepting when hemmed in, so to speak, or so approached as to be compelled to undergo such a degree of deformation, or displacement from their normal figure, that their elastic effort to resume the form and position of least magnetic resistance supplies the reaction necessary to force them to traverse such conductors.—Yours, &c.,

R. SNOWDON.

Staveley Ironworks, Chesterfield, August 12th, 1888.

THE BEAUMONT EPICYCONOIDAL AND EPICYCLICAL GEAR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am greatly obliged to Mr. Beaumont for drawing my attention to the modified form of his epicyconoidal gear, and for the figures illustrating it; the mechanical conditions here are very different to those in the form I commented upon.

In the gearing now under consideration, the velocity ratio between the wheels C and A, B being supposed fixed, will be the same as though C geared direct with A, D making no difference so far as velocities are concerned beyond changing the direction of the transmitted motion, so that A and C turn in opposite directions instead of in the same direction, as they would do if they geared (internally) directly with each other. Considered as a means of transmitting power, however, the introduction of the idle wheel D just about doubles the loss from friction that would occur if the wheels C and A geared directly together, inasmuch as there is the loss due to C working with D, as well as that due to D working with A, and in each case the pressure is the same (omitting the difference due to the loss by friction in transmission to A through D), as it would be if C and A only were working together.

I believe the loss due to friction in the other parts of the mechanism would be, or should be, small; in the first place, because these parts are only brought into action when it is necessary to reduce the normal velocity, and in the second place because there are no great pressures between these parts, and their velocities are comparatively small. It may be that the loss due to the introduction of the idle wheel D would be a more serious matter; but if the apparatus were well designed, and well made, it should not absorb much more power than would be taken up if a second motion shaft were used, and the perfect control which this mechanism gives over the transmitted velocity is worth something, even when it has to be paid for in foot-pounds of work.

I am pleased to hear that this gearing is used for transmitting large powers, and regret that I have not had the opportunity of seeing it in use; the form of it now under considera-

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tion is well adapted for transmitting such powers. I, however, am concerned with the transmission of power upon a tramcar, and the source of power I feel most interest in is a storage battery. In this storage battery there is a very definite, and a very limited amount of power accumulated, and it may be that after the tramcar is sent out in the morning with its normal store of power that it will get an extra lot of hard work to do; encounter a snow storm, perhaps, or some other of the many ills that tramway life is heir to, and have all this accumulated power used up before it can get home again. Under these circumstances, one or two cog wheels, with a substantial amount of pressure between teeth having quite the usual amount of slip between them, may make a great deal of difference. Where the power is so limited it does not do to throw much of it away. Again, it must be remembered that this mechanism has to be stowed away under the floor of a tramcar, in a situation of difficult access, and exposed to much dust and dirt; hence the necessity for looking out for possible difficulties in the lubrication. Car-drivers, who are paid at the market rate of wages for the number of hours they "put in," will not look to these little matters until they are convinced that for some reason or another it is necessary that they should do so. If the machinery does not get what is necessary from the oil-can it will immediately make increased demands on the source of power, and a bit later on it will cause trouble in the repairing shops.

These are some of the reasons why on, or rather under, a tram-car, it is so necessary to economise mechanism, and why I thought the gearing discussed in my last letter was not suitable for the purposes for which it was proposed. The modified form shown in your last number is much better, but for these same reasons I still think it too elaborate; still no one will be better pleased than I shall be to hear that it has been tried on a tramcar, and has, for a reasonable period, successfully withstood the racket it will get in regular service.—Yours, &c.,

Birmingham, Aug. 14th, 1888. T. ARNALL.

THE UNITED TELEPHONE COMPANY v. THE NEW PUBLIC TELEPHONE SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention was only yesterday called to the letter from Mr. Hawes in your issue of April 27th. It will presently be apparent how sorry I must be not to have seen it earlier. The task I proposed to myself in writing the series of articles has involved much experiment and calculation, but I hope to conclude them very shortly. Meanwhile I have much pleasure in analysing Mr. Hawes's criticisms on my multiple-switch system. I think I am justified in saying at the outset that in dealing with Mr. Hawes's criticisms I am dealing with the ablest and most critical expert in the employ of the United Telephone Company.

My answer, I fear, will be rather lengthy, but on the essential points it will be thorough, and the subject is getting more important every year; indeed, the United Telephone Company have in London a greater task to perform than is imposed upon any other company in the world, but what is apparently lost sight of is that there are compensating advantages in the case of London which make some other companies covet the neglected opportunity. The remarks of Mr. Hawes are so courteous that I trust there will be nothing in my reply to prevent him saying whether he is answered or not.

The first objection I have to meet is that my general scheme of one large central exchange on the multiple system and forty small exchanges is "a distinctly retrograde step," and contrary to the view dictated by practical experience in both London and New York. My answer is that mathematical laws and New York experts are all in my favour. More than a month before Mr. Hawes wrote, the "American Notes" in your journal contained the information that the large new exchange on the multiple system in New York was to be supplemented by a number of auxiliary exchanges, the latter being found necessary. The reasons why this must ever be so, in order that the multiple system may effect the main object I am fully prepared to enter into when occasion offers. The objections to my method of insulating outdoor wires must also remain unanswered till then, as neither objection has any necessary connection with the merits or demerits of my multiple switch.

Mr. Hawes admits that my multiple switch-board "looks well on paper," and then goes on to show that his own criticisms fall to the ground when transferred from paper to practical experiment. He says six feet in width is the greatest width that can be allowed for each section, and that two hundred subscribers are as many as could be properly attended to on one section. Well, I adopt the latter figure, and instead of six feet in width I provide for 5,500 in the space of five feet square. The 26 sections necessary to work that number would thus require 130 feet of "wire" (which it would be more accurate to call chain). Now, as Mr. Hawes makes out that 90-feet lengths might stretch 1½ inch, which would be fatal to the system, it naturally follows that 130-feet lengths would be out of the hunt altogether. But let us see. Mr. Hawes says that before any man should undertake the duty of keeping such a system in order his first duty would be to insure his life.

I propose to act differently. Any multiple switch-board must cost a great deal of money—which to a capitalist counts first—and I propose that the first duty of a maker or buyer of a multiple switch-board shall be to ensure *its* life.

I was a mechanic before an electrician. Mr. Hawes is an electrician, above the average, but not yet a mechanic, otherwise he would have known that a composite chain, made of steel, to the size and shape shown in the drawings in *The Electrician* of April 13, and measuring 130 feet, could not be stretched *even one eighth of an inch* by the direct pull of the strongest man in the service of the United Telephone Company. I would ensure the life of these chains by testing every one with a strain ten times greater than ordinary rough usage would put upon them. This would be a wider margin of safety than civil engineers allow in cases where many lives are at stake. Nearly all the objections hang upon this imaginary weakness.

With regard to the criticism referring to Fig. 12, if there were any ground for the stricture, then the steering gear at the stern of every ship and the chronometer in every captain's cabin are jeopardising the lives of thousands daily.

I may, however, admit that Fig. 12 *does not obviously* show what it, in fact, provides for, viz., that there is contact between X and Z during a half-inch of movement of the insulator plug W.

In spite of all care and tests, suppose one of the chains should happen to break, what then? Not a stoppage of nearly the whole telephone system of London for six weeks, such as an extraordinary snowstorm causes, but the stoppage of that individual line for *one hour*. I admit the facility of repair is not obvious, but it was fully provided for before I put the scheme on paper. To describe the process to anyone but an experienced mechanic would require drawings and much letterpress space, but the necessary appliances for taking out a broken chain and putting in a new one will enable the repair to be done in an hour, and will cost only a few shillings for a permanent outfit for a 5,000-line exchange. Mr. Hawes or Mr. Morgan may have the explanation whenever they may think it worth while.

The assumed difficulty of leading the wires to the plug-holes is not reconcilable with Mr. Hawes's familiar acquaintance with large groups of wires. I am quite sure that it *is* "one of the principal difficulties of the present form of multiple boards," but I should have thought Mr. Hawes had long ago seen the needlessness of the self-inflicted difficulty. It is quite true that my drawings show no provision for obviating the difficulty, but it will be found that the general construction of the front board provides for a simple and safe method; but I fancy it would be unreasonable to encumber the question with details of such a kind as could be interesting only to a few experts in public telephony.

Looking at my scheme generally, and in detail, it will be found that every separate part can be made accurately without any more expense than common toy work costs, because if the thing is wanted at all, there will be required for one exchange only no less than 125,000 of each of the pieces on

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boards P and Q, and 5,000 of each of the pieces on board V. The outlay and skill called for is not, therefore, to produce so many pieces with skilled accuracy, but to produce a set of machine tools that cannot fail to turn out every part with speed as well as accuracy.

I am afraid to encroach on your space by further remarks, but shall be glad to return to the subject if Mr. Hawes is satisfied on the points already enlarged upon. I am quite prepared for the trouble of defending my scheme against all comers, for the same reason as Mr. Hawes has taken the trouble to attack it, viz., because the future success of public telephony will be controlled by the best multiple-switch system.

In New York, December 31st last, £60,000 was expended on an incompleted multiple switch-board for 6,000 subscribers; perhaps Mr. Hawes can ascertain what further outlay was necessary to complete it. And will he then say that my system would cost more? If he does, I will produce some of the best manufacturers in the country who will contract to do it for very much less with far greater efficiency.

Hitherto, New York has been years in advance of London in telephony and electric lighting, and since Mr. Hawes quotes New York unsuccessfully on one point, I will conclude by quoting a New York precedent on another, viz., the space occupied by large multiple switch-boards. In connection with the quotation above referred to, it was stated that the switch-board then nearing completion was for 6,000 subscribers and measured 300ft. long, whereas my board for 5,500 will measure only 130ft. long.—Yours, &c.,

WALKER MOSELEY.

DETERMINING PERCENTAGE OF COPPER IN A CYANIDE SOLUTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Could the editor or any reader of the paper inform me of any ready method of determining chemically the percentage of copper, also of cyanide of potassium, in a liquor in use for the electro deposition of copper on iron by the cyanide process?—Yours, &c.,

D. CORRIE.

Polmont Station, Stirlingshire.

THE INSTITUTE OF MEDICAL ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As you and many of your readers have expressed considerable interest in this institute, the directors would feel obliged if you will allow me an opportunity of making known in your columns the reason why the opening of our London establishment has been so long delayed.

In the end of March last the directors proceeded to the appointment of medical officers, and, after consultation with the medical "Visitors," selected two distinguished London physicians, well known in scientific circles for the great attention they have long given to the medical applications of electricity.

These gentlemen, however, happen to be, one a Fellow and the other a Member of the Royal College of Physicians, and, though they were personally willing, unexpected difficulties of a purely professional character have been encountered in connection with their acceptance of the posts offered to them. The directors hoped at one time that a memorandum on the subject, which was signed by ten of the leading men in the electrical profession, all being members of the Council of the Society of Telegraph-Engineers and Electricians, and six of them being also Fellows of the Royal Society, would have aided in removing the difficulties, but I regret to say that they are still unsurmounted.

I need hardly assure your readers that this unfortunate *contretemps* will in no way alter the character and tone of the Institute; but that, being more than ever convinced of the need for such an undertaking, and of the good that may come from it, the directors will proceed with a medical officer who is not a member of the Royal College of Physicians.

These premises are now being fitted up rapidly with all the necessary apparatus, and the directors hope that they will be ready to receive patients early in September. They think it expedient, however, to defer the formal opening until October, when they hope to gather their friends around them.—Yours, &c., H. NEWMAN LAWRENCE, Managing Director.

The Institute of Medical Electricity (Limited),
24A, Regent-street, London, S.W., August 11th, 1888.

PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

10,941. I. A. TIMMIS. London. Improvements in the arrangements for the lighting of railway trains by electricity. July 28, 1888.

10,945. W. H. AKESTER and G. HOPKINS. London. An improved cut-out for electric circuits. July 28, 1888.

10,952. L. S. M. PIKE and H. T. BARNETT. London. Improvements in dynamo-electric machines. July 28, 1888.

10,954. E. H. GEIST. London. Improvements in or connected with dynamo-electric machines. July 28, 1888.

10,956. C. SMITH. London. An electrical lighting apparatus for medical and surgical purposes (R. Blaensdorff, Nachfolder, Frankfort-on-Maine). July 28, 1888.

10,982. T. PEASE. Birkenhead. Improvements in electric battery cells and combinations of same for electric lighting, power, signalling purposes, firing torpedoes, &c. July 30, 1888.

11,019. W. MOSELEY. London. Improvements in electric bells. July 30, 1888.

11,055. W. P. THOMPSON. Liverpool. Improvements in or relating to apparatus for regulating the brilliancy at which lamps included in secondary circuits of induction coils or electric converters may be caused to burn (G. Westinghouse, jun., United States). July 31, 1888.

11,082. P. A. NEWTON. London. An improved mode of an apparatus for transmitting electrically autographic messages, signs and markings (E. Gray, United States). July 31, 1888.

11,092 G. M. CAPELL and J. S. RAWORTH. London. An improved combination of a steam engine, having a vibratory and partly circular motion, with a dynamo-electric machine. July 31, 1888.

11,100. J. KINCAID. London. Improvements in permanent way for vehicles propelled by electricity. July 31, 1888.

11,106. H. H. LAKE. London. Improvements in electrical signalling apparatus (E. Davis and E. B. Welch, United States). July 31, 1888.

11,174. T. PARKER, of the firm of Elwell-Parker (Limited). Manchester. Improvements in and connected with the method of and apparatus for electrically lighting railway trains. August 2, 1888.

11,182. F. S. HARWOOD and H. G. CHEESMAN. Doncaster. Motive power for driving electric and other machinery. August 2, 1888.

11,184. F. TEAGUE and F. E. TEAGUE. London. Improvements relating to electric arc lamps. August 2, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

August 4, 1888.

10,663. A. J. BOULT. London. Improvements in or relating to electrical type writers and printing telegraphs (J. F. McLaughlin, United States). August 2, 1887.

10,785. J. G. LORRAIN. London. Improvements in clocks and apparatus for winding the same by electricity. August 5, 1887.

10,836. C. A. MCEVOY. London. Improvements in electrical firing mechanism for ordnance. August 6, 1887.

12,880. W. J. REYNOLDS. London. Improved method of producing solid metal sheets by electro-deposition, suitable for compass cards, stencils, and open-worked flat or curved articles for decorative and other uses. September 22, 1887.

13,709. R. S. BOZON. London. India-rubber compensators for telegraph signal and other wires. October 10, 1887.

4,659. F. T. SCHMIDT. Bradford. Improvements in apparatus for making and breaking electrical circuits in connection with call or alarm boxes, and recording the same automatically on dials. March 27, 1888.

7,848. W. P. THOMPSON. Liverpool. Improvements in or relating to indicators for alternating electric currents (G. Westinghouse, jun., United States). May 29, 1888.

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7,849. W. P. THOMPSON. Liverpool. Improvements in or relating to apparatus for detecting and locating faults in alternate-current electric circuits (G. Westinghouse, jun., United States). May 29, 1888.

7,998. F. HOLMAN. London. Improvements in and relating to shades and reflectors for incandescent electric lamps. May 31, 1888.

9,206. C. LÜTCKIE and P. GEORGE. London. Improvements in galvanic elements or batteries. June 23, 1888.

9,660. A. J. BOULT. London. Improvements in electric motors and dynamo machines (O. Lugo, United States). July 3, 1888.

9,661. A. J. BOULT. London. Improvements in telephone transmitters (J. Emmner, jun., United States). July 3, 1888.

PATENTS SEALED.

August 3, 1888.

5,648. J. H. HOLMES. Newcastle-on-Tyne. Improvements in apparatus for making and breaking electric circuits. April 18, 1887.

9,017. W. CROSS. London. An improved method of heating ores and other substances by an electric current, for effecting metallurgical, chemical, and other operations, and furnaces or apparatus therefor. June 24, 1887.

10,240. L. HANSON. Halifax. Improvements in field-magnets. July 22, 1887.

10,454. J. T. GENT and H. G. ELLERY. Leicester. Improvements in and relating to electrical signalling apparatus for domestic and other purposes. July 27, 1887.

5,362. J. H. HOLMES. Newcastle-on-Tyne. Improvements in arc lamps. April 11, 1888.

5,713. J. K. HALLOCK and G. C. BLICKENSDERFER. United States. Improvements in electric elevators. April 17, 1888.

5,913. A. W. HEAVISIDE. Newcastle-on-Tyne. Improvements in electric telegraph, telephone and electric light insulators. April 20, 1888.

COMPANIES' MEETINGS.

Bell's Asbestos Company (Limited).

The first ordinary general meeting of this Company was held on Wednesday at the Cannon street Hotel, Mr. John Bell in the chair.

Mr. R. LAUDER McLAREN (the secretary) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, it gives my colleagues and myself great pleasure to meet you at this the first ordinary general meeting of our company. You are aware that this is the meeting convened in conformity with the statute, and that no accounts are to be presented; in fact, the only business we have to transact to-day is the appointment of the auditors, as to which I shall presently propose a resolution. It seems, however, fitting that on this occasion I should give you some idea as to how we stand in regard to the fulfilment of the programme set forth in the prospectus on the faith of which you invested your money in this Company. It is very satisfactory to me to state that the applications for capital from the public were so liberal that the shares applied for amounted to several times over the number we had to allot, and we finally allotted the shares to 300 applicants. As soon as the minimum amount stipulated by the Stock Exchange had entered our coffers, we made an application for a special settlement in the shares and a quotation in the Official List. That matter is going through its ordinary course, and will in due time be settled according to the decision of the Stock Exchange. The titles to our properties over in Canada were investigated by your solicitors, and found to be in perfect order, and it seemed good to the Directors, instead of waiting until November next—over which period we had to pay for the properties—to pay for them in full at once. We have done so, and the properties are now completely vested in your Company as security for the debentures which we have issued. We have had one or two motives for doing this so rapidly. In the first place, we saved some interest, which is not unimportant; but the real reason was that we might at once complete the security of the debenture holders, and take the operations in Canada into our own hands. Those operations are of some considerable importance. They are now being conducted by our staff under our direction. I am glad to say that, like the rest of our business, an expansion has taken place in the demand for the crude material. As a rule, the manufacturers take the produce from the mines in Canada towards the end of the year; the summer is the period for working, and about October or November the produce is delivered to the manufacturers, and this led me to inform my brother directors we should have to advance a considerable amount of capital for working the mine during the summer, but it would come back with a handsome increase in November; that up to that time it would be all outgoing and no incoming. It is a very interesting fact that this year that has all changed. The indications are that the stocks taken into hand by the manufacturers last year are completely exhausted, because, instead of waiting till October to take delivery, they have begun during May and June to take considerable quantities, and instead of having to advance several thousands of pounds of capital, the funds necessary for the working have been provided by the sales on the spot, and in addition to that we have received a cash remittance of considerably more than is necessary to pay the redemption of the debentures in January next. The new company has made such a bargain in respect to the purchase of these properties that—I say it advisedly—no other company will ever be able to make such a bargain again. You have a third of the total supply of asbestos in the world, and you have the whole of the best asbestos, known for years past as Bell's Selected, which is only used, and can only be used, in the manufactures of this country. We have long been the first manufacturers—everybody has admitted that; we are now the first as producers of the raw material, and so our circle is completed, and we hold a position from which no one can shake us. This is of the utmost importance, not only with regard to our revenue, but with regard to the security of our debentures. We have to provide, as you know, about £5,000 for the interest and sinking fund of the debentures every year. At the present moment the revenue from our properties in Canada is more than double that amount, and the trade is expanding day by day. I look forward to the time when this fibre which we possess—which is unique, and unlike any other in the world, unconsumable and incorruptible—will extend to a variety of purposes unknown now, and whatever may be the good or evil fortune of our ordinary trading manufactures we are rapidly approaching a time when the produce of the mines will constitute a constant and splendid dividend on the capital of the company. So much for your property on the other side of the Atlantic and its bearing on the debentures.

Now let us look at home, and I will say a few words upon what you do with this produce when you get it over here and what you get for doing it. Let me show you first of all a sample of the stuff as it comes out of your quarries in Canada. This is as it comes out of the quarry [exhibiting sample]. The beauty of our invention is this, that we are not trading on an invention which is valuable to-day and which is superseded to-morrow. We are not dependent on any one establishment or railway, and—I say it with all respect—we are not even dependent on Governments. We possess a broader and a stronger basis than that. We have 13,000 customers in the general public on our books, who trade with us regularly, and whatever might happen to shake the patronage of one great establishment, it would scarcely touch our dividend-paying power. That rests on the fact that we make stuff which is useful to every steam user, and to every man who has to deal with electricity. That is a trade, gentlemen, which is certain to expand, and from which I take it we can never easily be shaken. In following the programme, as set forth in the prospectus, I should tell you that we have faithfully carried out all that we told you we would carry out. I have told you we have paid for the properties; you can infer from my remarks we have taken over the business. The solicitor has carried through all the formalities, and you are now in absolute possession of the business of the Company, and it is being carried on by your Directors in the way I have described. Going a little into details, there is one clause in the prospectus:—"The plant and machinery have been written down annually, and are to be taken over by the Company at the value at which they stood in the books on the 31st December, subject, however, to this value being ascertained to be fair and reasonable by competent valuers to be appointed by the company and vendors. The vendors stood on one side, and the Company appointed their own valuer. The result of the severe writing down on the part of the vendors during years past of the machinery and their effectual upkeep was that the independent valuers valued it at 60 per cent. more than it was in the books; therefore, in a word, you get the machinery and plant at 60 per cent. below the value. You will recollect that the business was bought as from January 1 last, so that a very few weeks after the constitution of the Company we found ourselves at the termination of the first half year of working, and it became due to you to have an investigation and to see what had been the result of that working. The stock was strictly taken, both at the head establishment and at all our depots, under the supervision of public accountants. A very strict investigation was made, because we wanted to begin as we intend to go on. We shall render our accounts annually, and I may tell you that the profits of the half year, not taking into account anything received from Canada at all, because all that comes into the second half-year, is considerably over £10,000. We have no bad debts, but we have allowed a handsome sum in case they should arise afterwards. The net profit handsomely exceeds £10,000, and we therefore thought, seeing that this is the lean half-year, that we might prudently give you an interim dividend of 7s. 6d. a share, which absorbs £7,500. We look forward to rendering to you a satisfactory statement at the end of the year. It is not my habit to prophesy—I will not do anything of the kind; but I may say that we are trading vigorously and prosperously, and I see no reason for any temerity about meeting you as early as possible after the close of the year. Now, gentlemen, we have entered into relations with you. Our main object was to obtain capital to purchase properties in Canada, and we, who are vendors, have sold our interest, not to run away, but shall remain most largely interested in the working of this undertaking. The resolution that I have to propose to you is:—

"*That Messrs. Cooper Brothers and Co., of George-street, Mansion House, London, be appointed the auditors of the Company till the next general meeting of the shareholders, and that their remuneration be fixed at 50 guineas.*"

It is quite unnecessary for me to add anything in support of that resolution, and therefore I leave it to some shareholder to second it.

Mr. HART seconded the resolution, which was carried unanimously and without discussion.

The CHAIRMAN said that he should be happy to answer any question that any shareholder might wish to ask.

Mr. HART proposed a vote of thanks to the Chairman and Directors for the careful and able manner in which they had looked after the affairs of the Company.

Mr. SPENCE seconded the motion, which was carried unanimously.

Mr. LIGHTFOOT, in acknowledging the compliment, said that the position of the Company was greatly due to the exertions of the Chairman.

The proceedings then terminated.

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NEW COMPANIES REGISTERED.

THE ELECTRICAL ACCUMULATOR ASSOCIATION (LIMITED).—Registered by Parker, Garrett and Parker, St. Nicholas Rectory, Cornhill, E.C., with a capital of £10,000, in shares of £10 each. Object, to purchase and acquire and work and use the letters patent for the United Kingdom, No. 8,379 of 1886, granted to Anthony Reckenzaum, entitled "Improvements in Secondary Batteries or Electrical Accumulators," or any interest therein; to manufacture and provide, sell, deal in, or let for hire, or grant licenses for the use of any instruments, machinery, or apparatus for accumulating, storing, regulating, or measuring the supply of electricity or electrical currents in force. The first subscribers are:—

	Shares.
A. Reckenzaum, 7, Albert-terrace, Clapham	1
J. Stephen, 1, Cuba-street, Millwall, E.	1
W. Adams, Hithersett Lodge, Putney, S.W.	1
J. R. Anderson, Stretton House, Putney	1
R. Grant, Farnleigh, Westgate-on-Sea	1
A. Smith, 1, Cuba street, Millwall, E.	1
G. Binswanger	1

The company is registered without Articles of Association.

THE LINEFF ELECTRIC TRACTION AND LIGHTING SYNDICATE (LIMITED).—Registered by Shaen, Roscoe, Massey and Co., 8, Bedford-row, W.C. Capital £10,000, divided into 10,000 shares of £1 each. Object, to acquire, introduce, work, develop and manage certain new inventions for operating tramways or railways by means of electricity, for which letters patent have been granted, one of which bears date June 10, 1887, and is numbered 8,380, and the other of which bears date October 4, 1887, and is numbered 13,447, and all the benefits, privileges, and advantages of, or to be derived from, the said inventions and letters patent, and to take out and acquire letters patent for the said inventions in any colony or foreign country; to light roads, thoroughfares, houses, shops, or public buildings. The first subscribers are:—

	Shares.
R. Applegarth, 11, Queen Victoria-street, E.C.	1
A. G. Lineff, 88, High-street, Chiswick	1
E. H. Bayley, 42, Newington-causeway, S.W.	1
R. G. Applegarth, 11, Queen Victoria-street, E.C.	1
A. E. Stone, 11, Queen Victoria-street, E.C.	1
E. G. Church, 120, Pollock-road, New Kent-road	1
J. S. Reay, 90, Ladbroke-grove, W.	1

There shall not be more than five directors, and the first shall be E. H. Bayley, J. S. Reay, A. G. Lineff and R. Applegarth. Each director shall hold at least 250 shares in the company. The remuneration to the directors shall be fixed by the company in general meeting.

LAURENCE, PARIS AND SCOTT (LIMITED).—Registered by F. G. Monkland, 78, Gracechurch-street, E.C., with a capital of £30,000 in shares of £10 each. Object, to adopt and carry into effect an agreement dated June 24th, 1883, and made between E. A. Paris and W. H. Scott of the first part, R. Laurence of the second part, and G. Cruikshank, as trustee of the company, of the third part; to acquire and carry on the business of E. A. Paris and W. H. Scott, electrical engineers. The first subscribers are:—

	Shares.
E. A. Paris, King-street, Norwich	1
A. J. Laurence, 13, Copthall-court, E.C.	1
W. H. Scott, King-street, Norwich	1
R. Halewood, Cairon Works, Norwich	1
T. W. G. Taylor, Norwich	1
P. E. Laurence, 13, Copthall-court, E.C.	1
L. Laurence, Clapham Park	1

The number of directors shall not be less than three nor more than eight, and the first shall be R. Laurence, E. A. Paris, and W. H. Scott. The qualification of a director shall be the holding in his own right of at least 100 shares in the capital of the company. The remuneration of the first directors shall be the sum of £250 per annum each, and 25 per cent. of all net profits after 5 per cent. per annum dividends have been paid.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 10th, 1888, amounted to £4,944.

GREAT NORTHERN TELEGRAPH COMPANY.—This company announces that their route to the Far East, Japan, China, Hong Kong, Manila, &c., is working well.

THE LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY.—This company notifies that the half-yearly coupons, which fall due on Sept. 1, 1888, of its £100,000 Six per Cent. Debentures, will be paid by Messrs. Glyn, Mills, Currie and Co., of 67, Lombard-street, E.C., on and after that date; and also that coupons must be left with the bankers three clear days for examination.

THE MADRID TELEPHONE COMPANY (SOCIETE TELEPHONES DE MADRID).—This company has recently held its general meeting, at which the first balance-sheet was presented, covering a period of sixteen months. The profits shown amounted to 115,490 pesetas, out of which it was proposed to distribute a dividend of 26 pesetas 66cs. per share (250 pesetas paid) for the sixteen months. It has been decided to increase the nominal capital from 1,200,000 pesetas to 1,800,000 pesetas by the issue of an additional 1,200 shares of 500 pesetas each, upon which 250 pesetas are to be called up. The paid-up capital will thus be increased from 600,000 to 900,000 pesetas, say, from £24.000 to £36,000, with a reserve liability of a similar amount. Considering the expenses incidental to the first operations of a new company, the results are considered very satisfactory. The growth of the company's business, as judged by the number of subscribers, has been as follows:—At the initiation, 683; 31st December, 1885, 821; 31st December, 1887, 1,287; date of general meeting, 1,321.

MAXIM-WESTON ELECTRIC COMPANY.—We are informed that Mr. Samuel J. Boyce (of Messrs. Boyce and Ramsay, chartered accountants), has been appointed secretary of this company in place of Mr. J. Wright. All communications should in future be addressed to Mr. Boyce, and all accounts due to the company should also be paid to him.

THE SOCIETE GENERALE DES TELEPHONES OF FRANCE.—At the general meeting recently held a dividend was declared of 25fr. per fully paid-up share, and of 18fr. 75c. per share with 315fr. paid. This is equal to 5 per cent. per annum, the shares being 500fr. shares. Some particulars of the operations of this company were given in Vol. XIX., No. 10, p. 195 of *The Electrician*, and Vol. XX., No. 496, p. 25.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 10th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £4,141.

WESTERN COUNTIES AND SOUTH WALES TELEPHONE COMPANY.—The warrants for the interim preference dividend for the half year to 30th June, at the rate of 6 per cent. per annum have been posted.

PATENT

SILICIUM BRONZE AND SILICIUM COPPER WIRE.

The best for overhead Telephone and Telegraph Lines,

AND ALL ELECTRICAL PURPOSES.

Hard Drawn High Conductivity Copper Wire.

ROLLED AND DRAWN

PHOSPHOR BRONZE.

PHOSPHOR BRONZE

BEARINGS, BUSHES,

AND OTHER PARTS OF

ELECTRICAL MACHINERY.

SOLE PROPRIETORS of the British, Indian and Colonial Patents,

THE PHOSPHOR BRONZE COMPANY (Limited),

87, Sumner Street, Southwark, London, S.E.

WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, August 15, 1888	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending August 15, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	40½ 41¼	3 6 3	Jan., Apr., July, Oct.	41	40⅞
2,614,820	Stock	10/0	Do. Preferred	67⅞ 68⅜	4 0 4	,, ,,	68½	67⅞
2,614,820	Stock	nil.	Do. Deferred	13⅛ 14	...	February	13⅜	13⅛
130,000	£10	3/0	Brazilian Submarine	12⅞ 13⅛	5 6 8	Mar., June, Oct., Dec.	13	12⅞
16,000	10	9,0	Cuba Submarine xd	13½ 13⅝	6 3 8	February and August	13⅝	...
6 000	10	10/0	Do. Preference xd	18⅝ 19⅛	5 2 6	,, ,,	18⅝	...
12,931	5	4%'87	Direct Spanish (£4 paid)	3⅜ 4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference	9⅛ 10⅛	4 15 3	April and October	...	...
60,710	20	2/0	Direct United States	9⅛ 9⅜	4 5 3	Jan., Apr., July, Oct.	9 5/16	...
330,000	10	4,0	Eastern	12½ 12⅝	4 16 0	,, ,,	12⅝	12½
70,000	10	3/0	Do. 6 per Cent. Preference	14⅝ 15½	3 19 0	,, ,,	15½	14⅝
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	108½	107½
250,000	10	2/6	Eastern Extension	12⅞ 13⅛	4 19 0	Jan., Apr., July, Oct.	13 1/16	12⅝
22,050	10	8/3	German Union Telegraph and Trust	9 9⅜	7 7 4	January and March	...	...
179,177	10	3,0	Globe Telegraph and Trust xd	6⅜ 6⅞	5 1 10	Jan., Apr., July, Oct.	6 9/16	6 1/16
178,992	10	3/0	Do. 6 per Cent. Preference xd	13⅜ 14⅛	4 4 11	,, ,,	14½	13⅜
150,000	10	7½%'87	Great Northern	13⅝ 14½	5 5 3	Jan., July, and April	14⅜	13⅝
17,000	25	37/6	Indo-European	36 38	6 11 9	April and October	...	...
33,348	10	3/0	London Platino Brazilian	6 6½	...	May and November	...	...
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	...	...
338,225	Stock	13½%	Submarine xd	135 145	10 0 0	February & August	...	...
30,000	10	6/0	West Coast of America	6½ 7	7 3 0	January and July	...	...
150,000	Stock	8%	Do. Debentures	110 115	6 19 2	June and December	...	...
88,321	10	nil.	West India and Panama	1⅛ 1⅜	...	...	1 5/16	1 1/16
34,563	10	10/0	Do. 1st Preference	11⅝ 12⅛	...	April and October	12⅛	11⅝
45,181	15	9/0	Western Brazilian	11⅞ 12⅛	5 5 3	March & September	12	11⅞
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	102 104	5 15 5	March & September	...	...
			TELEPHONES.					
224,850	14/0	£5 7s. '87	Consolidated Telephone and Maintenance	1 1/16 1 1/8	5 10 0	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	15/16 1	...	...	1 1/16	1
80,000	5	10/0	United	13¼ 13⅜	5 9 1	June and December	13⅜	13⅛
50,000	5	2/6	United River Plate	5⅛ 5⅜	...	April and October	5⅜	5⅛
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3 3⅛	...	...	3⅛	...
23,692	5	nil.	Do. (fully paid)	4⅛ 4⅜	...	February & August	4⅜	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅛ 2⅜	...	...	2⅜	...
312,000	½	5% '86	Maxim-Weston	1/16 1/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39 40	5 19 9	March and July	39½	39
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works xd	17 18	5 14 3	February & August	...	...

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 536.—Vol. XXI. FRIDAY, AUGUST 24, 1888. Price 4d.

NOTES.

Electrical science has no reason whatever to complain of the degree of recognition which is accorded it by the British Association. In addition to the numerous Papers which are read by its devotees in Section A and Section G, it has of recent years almost invariably occupied a prominent place in one or more of the Presidential Addresses and in the evening lectures. This year, indeed, it lays claim to at least three of these special events. Nevertheless, we venture to suggest that the time will soon arrive for the General Committee to take into consideration the advisability of forming a new section,—Section H—for electricity. The present arrangement, whereby electrical topics are discussed in two separate sections, meeting sometimes in widely different quarters of the town, has certain very obvious disadvantages. Apart from the admitted difficulty of being in two places at the same time, an electrician who is anxious to hear a particular Paper in either section sometimes wastes much time, and has to listen to things which he is quite incapable of comprehending. It is true that the Secretaries, with their invariable tact, endeavour to mitigate this difficulty by placing the electrical Papers as far as possible together, though this is not always feasible. But there are other considerations of at least equal weight which may be urged in favour of the proposal. At present both A and G sections have quite as much business as they can possibly get through, and discussions of the highest interest and importance are often hurried over for lack of time. That the electrical profession would gain by the increased importance conferred upon it in the Parliament of Science we are well assured; and although the expenses of the Association would no doubt be augmented, it may be taken for granted, on the other hand, that the roll of members would be considerably increased from the ranks of those interested in electricity. We trust that the Committee will before long see their way to give this suggestion such consideration as it may deserve.

The details of the Telautograph which are now to hand prove it to be one of the most elaborately ingenious pieces of electro-mechanism which has ever been devised. The receiving instrument dots its i's and crosses its t's, writes on stationary paper of any size, and begins a fresh line when necessary, as if it were held by some invisible hand. We cannot but admire the immense ingenuity and skill which Mr. Elisha Gray has brought to bear, yet we could wish that this ingenuity had been expended upon some problem of more immediate practical importance, and from which the inventor himself might have gathered a more commensurate return. As it is, we fear that even in the limited sphere of writing telegraphs the delicacy and complexity of the Telautograph will go far to outweigh its advantages in other respects.

In the case of an alternating-current motor, such as the Rechniewski, with a Gramme commutator, the machine is of course self-starting, though not self-regulating *per se*. It is, however, worth while to inquire what will happen if, the motor being at rest, the current is switched on at a time when the brushes happen to rest on two adjacent commutator bars. It is obvious that these two coils, being short-circuited, will have a tremendous current generated by induction from the core, quite sufficient in a very brief time to burn them out; in fact, the remaining coils act as the primary, and these two as secondary coils of a transformer. On the other hand, it seems most probable that the armature will begin to move before there is time for any mischief to be done—more especially as the effect of the two coils, being out of circuit at the moment, will diminish the impedance of the armature.

The coincidence of duplicate cables giving way simultaneously at two different points widely apart is singular, to say the least of it; and we are not surprised to hear that the latest incident of this kind gave rise to some alarm in the Australian Colonies, where it afforded a pretext for calling out the naval and artillery reserves to meet the contingency of war having broken out. Had the colonists been aware that the interruption of their own cables was speedily followed by that of the cables between Aden and Bombay, their apprehensions would have been intensified. If anything could compensate the proprietors for the loss they sustain in the damage to these cables, it would be the lesson it ought to teach us that reliance cannot be placed on their integrity in time of war, and that to multiply them, as some people would have us do, not for the requirements of commerce, but merely with the idea of giving the enemy a little more trouble in destroying them, would be a senseless piece of extravagance.

In a recent number of the *Electrotechnische Zeitschrift*, Drs. Lenard and Howard announced to the world that they had succeeded in preparing bismuth wire which, when placed in a magnetic field of 17,000 C.-G.-S. units, has its resistance in-

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creased two-fold. In the current number of the same journal we find a note as follows:—"A CORRECTION. . . . . The sentence stating that in a field of 17,000 C.-G.-S. units the resistance of the bismuth wire is about doubled should be omitted as not expressing the truth." There is a charming *naïveté* about this way of putting it which leaves us quite in the dark as to the amount of correction which this statement requires. Since we not only printed an abstract of the Paper in our last issue, but also called attention in our editorial columns to the extreme value of the discovery, we now feel entitled to ask Drs. LENARD and HOWARD what increase of resistance their bismuth really does undergo in a field of 17,000 units.

AT a time when the question of street lighting by electricity is once more occupying the attention of the local authorities in various parts of the country, the experience of the Eastbourne Electric Light Company should afford a wholesome lesson to those who may be tempted to undertake this class of work at a tariff based on the cost of gas lighting. The Eastbourne Town Council has been paying £25 per annum for each of their 16 10-ampere lamps on the Parade, and the company now confesses that the contract has resulted in a serious loss. They are prepared to continue the supply at the rate of £35 per annum, although whether they will find it necessary to decline the offer of £30 made by the Corporation we have yet to learn. Of course the price at which arc lighting can be made remunerative depends largely upon local circumstances; and whether £25 would necessarily be too low in all cases is open to question. Nevertheless we trust that this episode—of which further details may be found on a later page—will meet with the consideration which it deserves. No one can be more anxious than we are ourselves to witness a permanent extension of street lighting by electricity in this country, but as a commercial speculation no extension can be permanent which is unable to pay its way.

WE are sorry that the Pilsen-Joel Company has been unable to find a purchaser as a going concern. Mr. GWYNNE'S offer of £6,000 seemed to us a fair and reasonable one; but the shareholders have taken a different view, and the Company now goes into voluntary liquidation. It is to be hoped, however, that means will still be found to carry on the working of the two small central stations owned by the company.

IN a recent issue of the *Electrical World* of New York, there is an interesting Paper by Mr. DAVID BROOKS on the size of telephone conductors. The conclusions arrived at are thus summarised in the editorial columns of the same paper:—

"Mr. BROOKS, contrary to received opinions as dictated by the experience of recent years, thinks that the resistance of the wires may, within quite large limits, be practically neglected, and that the electro-static capacity should be kept down by decreasing the size of the wire. This brings us to the consideration of the fact that there must be a mean between the resistance and the electro-static capacity of the wires at which the best effects are obtainable."

There is thus a strong resemblance between Mr. DAVID BROOKS'S ideas and those set forth by Mr. PREECE in his Papers on "Copper Wire" and "On the Coefficients of Self-Induction in Telegraph Wires," read before the British Association last year (see *Electrician*, September 9th and 16th, 1887). Doubtless it was an oversight which led Mr. BROOKS to omit a reference to these Papers. It will be remembered that at the time Mr. PREECE'S theoretical views met with some adverse criticism; and additional interest is imparted to the present position of the controversy from the fact that whereas the *Electrical World* speaks of the theorem as being contrary to American experience, yet the experience of the English Post Office is, we understand, entirely in its favour.

THE experiments of Mr. HAROLD BROWN on the electrical execution of dogs are absorbing a great deal of public attention in the United States; and some of the papers devote several columns to post-mortem examinations which have been held with due solemnities. Our New York correspondent has already furnished as many details of the experiments as our readers will probably care to have. There appears to be no room for doubt that an alternating current is, or may be, fatal (to a dog) at a lower voltage than a continuous current. As a general rule the animals succumbed under about 230 volts—in one case as low as 160. But we cannot help thinking that Mr. BROWN has either proved too little or too much to justify the conclusion which he is endeavouring to support. Does any one believe that under any ordinary conditions 160 volts alternating can administer a fatal shock to a human being? Mr. BROWN'S opponents asserted again and again that they had received shocks of 1,000 volts alternating with little or no injury; and these cases could, we know, be paralleled in this country. Mr. BROWN replies that these gentlemen are mistaken, that the voltage could not possibly have been as high as they suppose. To still further prove his case, he relates several ghastly tales of injury and death from alternating currents, and although in the majority of cases the results were not of a fatal character, yet we cannot avoid the impression that the number of mishaps from high-tension currents in America, both alternating and continuous, has been greater than we have been led to suppose. Considering the terrible condition in which their overhead wires are acknowledged to be, there would be little room for surprise at almost any number of fatalities to the linemen in some of the larger cities.

ON the whole, we are inclined to think that Mr. HAROLD BROWN'S researches have so far led to the establishment of two results, one of which is chiefly interesting to physiologists, namely, that an electric shock which is harmless to a man may prove fatal to a dog; and the second is of interest to all practical men, namely, that it is a foolhardy thing to run any risk whatever with high-tension currents. Finally, we are driven back to our old conclusion that the question is far more complex than appears on the surface—that the issue depends upon the condition of the skin and of the general temperament of the subject, upon the part of the body receiving the shock, and upon many other things besides the voltage of the current; and the practical application is—**Caution!**

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Hansthohn.—The Hansthohn (Denmark) lighthouse will shortly be furnished with the electric light. The plant will be supplied by M. de Meritens.

Colliery Lighting.—The Consett Iron Company has decided to light the workings of its Westwood Colliery by electricity, and the contract for the work has been entrusted to Messrs. Clarke, Chapman, Parsons and Co., electrical engineers, Gateshead.

Johore.—His Highness the Sultan of Johore, G.C.M.G., K.C.S.I., has commissioned Dato James Meldrum, Edinburgh, to visit the Glasgow Exhibition and report on the subject of electric lighting. The Sultan intends to light the town of Johore with electricity.

The New Garrick Theatre.—The new Garrick Theatre, now in course of construction in Charing Cross-road, will be opened in January. Mr. W. S. Gilbert has had it built upon the most approved of modern principles, and auditorium and stage will be electrically lighted.

The Palais-Royal Central Station.—The excavations for the central lighting station at the Palais-Royal have led to the discovery of a large sheet of water at some feet from the surface. The plans have therefore been completely altered, and the idea of an underground building has been abandoned. The work is, however, being rapidly pushed forward.

Preservation of Telegraph Poles.—Telegraph poles are preserved in Norway by making an auger hole about two feet from the ground, in which four or five ounces of sulphate of copper are placed, and plugged in. The salt is gradually absorbed by the wood, until its whole outer surface turns a greenish hue. It is said to be a perfect preservative.

The Lighting of the Lyric Theatre.—A daily paper contains the following:—"It is said that the new Lyric Theatre in Shaftesbury-avenue is to be the best-lighted house in London. M. Emile Sechehaye, who 'controls the electric installation' at the Vienna Opera House, has come over here especially to personally superintend the illuminating department."

Bath.—In view of the decision of the Town Council to adopt electric lighting in one part of the city the Bath Gas Company, with the consent of the Council, has decided to fix improved lamps in Milsom-street, in order to show what gas can do. The experiment will continue for a period not exceeding six months, and the extra cost will be borne by the company.

The Bath Meeting of the British Association.—The Telephone. — By the courtesy of the directors of the Western Counties and South Wales Telephone Company the whole of the section rooms will be telephonically connected with the reception room, and, through the Telephone Exchange, with all important places in the neighbourhood, free of any expense to the local executive committee or members and associates for the meeting.

Doncaster.—We learn that Messrs. Hammond and Co. have received an extensive order from the Great Northern Railway Company to light their waggon repairing shops and offices at Doncaster. The plant to be supplied consists of three horizontal steam engines and three dynamo machines, and the lighting will be effected by means of 70 arc and 200 incandescent lamps. Storage batteries will be provided to supply the incandescent light at the offices, as the machinery will not be constantly running.

An Improvement in Relays.—In horseshoe magnet relays there is always a small amount of residual magnetism when the current ceases, and to overcome this the spring on the tongue has to be stronger than would otherwise be needed, this in turn necessitating a stronger current to actuate the relay. Messrs. Siemens and Halske are now making delicate relays with a small steel short-circuiting piece across the poles, which is said to greatly reduce the effect of residual magnetism, and allow much greater sensitiveness to be obtained.

Telegraphic Extensions in the North.—The Post Office authorities have just sanctioned several important telegraphic extensions in the north. An additional wire has just been laid between Aberdeen and Peterhead. A re-arrangement of the system in the Banff, Buckie and Macduff districts is in course of construction. Old Meldrum and Methlick are also to be connected with Aberdeen; but the most important extensions are those direct from Aberdeen to Newcastle and Kirkwall. In future all the Orkney work will circulate direct to Aberdeen, when it can be distributed to the various centres in the south.

Cologne.—We have just received the programme of the sixty-first meeting of the Deutsche Naturforscher und Aerzte at Cologne which we mentioned some weeks back. From it we gather that the proceedings will be very much on the lines of our own British Association meetings, with a strongly predominating medical tendency. Beginning on Monday evening, September 17th, with a reception, the rest of the week will be occupied with meetings of the various sections from 8 a.m. (*sic*) till 5 p.m., and festive gatherings at night. All foreign scientific men are warmly invited to attend the meeting, of which full particulars may be obtained from Prof. Dr. Bardenheuer, Koeln, Berlich, 20.

Ilfracombe.—A special meeting of the Ilfracombe Local Board was held last week to decide how the Victoria Promenade shall be lit. A letter was read from the gas company offering to fix pattern lamps with Doulton ware shafts free of charge to the Local Board if gas was accepted as the illuminating power. If not, and the company had to remove the lamps, they would require five guineas to assist in defraying the expenses.—Mr. Russell advocated that the chairman get the place lit by oil lamps temporarily until the Board had decided respecting the electric light.—This was seconded by Mr. Thomas, but it was eventually decided that the offer of the gas company be accepted.

Theatre Lighting at Liverpool.—Messrs. A. H. Fletcher and Co., of Liverpool, are carrying out an installation at the Grand Theatre in that city. The whole building will be lighted by incandescent lamps of varying power, from 1,000 candle-power to 16 candle-power, all at 100 volts. The lime light will be replaced by an electric light projector made by Messrs. J. G. Statter, who will also supply the dynamos. The stage, footlights, and scenery are all lighted, and arrangements are made for reducing the brilliancy of any or all of the lights (three different degrees for those on the stage). The installation will be temporarily worked by a 50 horse-power Otto gas engine in the basement. The auditorium and refreshment rooms will be ventilated by fans driven by electromotors.

Electrical Firedamp Indicator.—A M. Molas has devised an automatic electrical firedamp indicator, for the purpose of warning both the men in the mine and the engineers at pit's mouth. It is merely a system of electrical contacts actuated by the upward pressure of the escaping gases. When these contacts are made, bells are rung and indicators lowered at the surface, and warning lamps are lit in the mine itself. By this means both the engineers in charge at the surface and the miners at work are instantly informed of the presence and

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locality of dangerous gases. Moreover, by the extinction of the lamps and the stopping of the bells immediate notice is given of the disappearance of the danger. M. Molas maintains that in mines thus fitted special safety lamps can be dispensed with.

Benardos' Electric Welding Process.—A full description of this process was given in *The Electrician* of 25th November, 1887, and among its many applications that of boiler repairing was mentioned. A striking example of its utility in this respect occurred recently at Struck's factory in St. Petersburg, where the boiler became leaky and the factory had come to a standstill till repairs were made. A neighbouring engineering firm undertook to effect the work at a cost of 1,400 roubles within three weeks. Hearing of this, Messrs. Benardos and Olszewsky volunteered to repair the boiler in a much shorter space of time. The boiler was duly transported to them, and was repaired in *one hour*. Having been finally tested, it was reinstated in its place three hours later, and the next morning the factory resumed work.

The Sparking Distance of Alternating Currents.—E. G. Acheson (*Electrical World*, July 7, 1888) has made some measurements on the sparking distance in air of alternate currents. He finds that it varies with the capacity of the circuit and with the *cube of the E.M.F.* It is expressed by

$$d = \frac{E^3 K}{a},$$

d being the sparking distance in inches, E and K being in B. A. units and a a constant = 135. Two thousand volts, with 0·0032 microfarad in circuit, sparked about 0·2in., and 1,000 volts about 0·02in. These results are very different from those obtained by Warren de la Rue with his great battery, who found that with direct currents 1,200 volts sparked across 0·012in. and 2,400 volts across 0·021in., but the capacity present is not given.

Telegraphs and Telephones in Mexico.—The *Economista Mexicano* of July 28th, quoting from the half-yearly statistical bulletin of the Mexican Government, gives the following summary of the extent of the telegraphs and telephone wires in the Republic:—

	Kilometres.
Federal telegraphs	17,925
Provincial „	6,887
Private „	4,098
Railway „	6,244
Cable Company	2,926
Federal telephones	43
Provincial „	1,621
Private companies' telephones.....	2,887
Railway companies' „	471
Total.....	43,102

Artillery Practice against Electric Light Projectors.—A correspondent of *The Times*, writing from Okehampton, says:—"Some interesting experiments have been made here lately in firing at night against the reflector of an electric light. On the first night the range was ascertained, or thought to to be ascertained, to be 1,680 yards, and 16 rounds of shrapnel were fired, with the result that only one bullet pierced the reflector. The following day the range was found to be 1,580 yards, but the following night the observation gave again 1,680 yards. That night, accepting the daylight observation of 1,580 yards as correct, 16 shrapnel shells were fired, with the result that six bullets pierced the reflector, which, however, was practically not the least damaged. The Artillery officers are unable to explain the fixed difference be- the day and night observations of the distance. Had a shell struck the reflector before bursting complete destruction would, of course, have ensued." The engine and dynamo for these experiments were placed underground.

Tinning by Simple Immersion.—Argentine is a name given to tin precipitated by galvanic action from its solution. This material is usually obtained by immersing plates of zinc in a solution of tin containing 6 grammes (about 90 grains) of the metal to the litre (0·88 quart). In this way the tin scrap can be utilised. To apply the argentine according to M. P. Marino's process, a bath is prepared from argentine and acid tartrate of potash rendered soluble by boric acid. Pyrophosphate of soda, chloride of ammonium, or caustic soda may be substituted for the acid tartrate. The bath being prepared, the objects to be coated are plunged therein, first having been suitably pickled and scoured, and they may be subjected to the action of an electric current. But a simple immersion is enough. The bath must be brought to ebullition, and objects of copper or brass, or such as are coated therewith, may be immersed in it.

Photographs of Lightning Flashes.—In the last number of the *Comptes Rendus* M. Ch. Moussette has a short note on the precautions which it is necessary to take when photographing lightning flashes. According to the author, most of the peculiarities noticed in photographs of this description arise from accidental vibrations caused by the wind, the thunder, or the shaking of the earth. In order to prove this, M. Moussette made a white on black drawing of flashes inclined at different angles. This drawing was photographed in two ways: firstly, with the camera carefully secured from vibration; secondly, with the camera slightly jerked at the moment of photographing. In the first case the flashes came out fine and clearly defined; in the second case the flashes presented the appearance of striated ribbons, except where the lines of the drawing were parallel to the direction of motion of the camera.

The Tudor Accumulator.—It will be remembered that in our issue of 15th June we gave an abstract of a very favourable report by Prof. Kohlrausch on the above cell. Since then we see from the *Zeits. für Electrotechnik*, Vienna, the learned professor has tried the effect of a full charge in the wrong direction. The cell appears to have stood this rather severe ordeal in a very satisfactory manner, none of the oxides dropping off, and the liquid remaining perfectly clear the whole time. At the end of the second hour's charge the E.M.F. of the cell had dropped to zero; after the 3rd hour it was −1·7, then −2·34, −2·20, and −2·15. After the 4th, 5th, and 6th hours, and after 10 hours −2·12. It then received 105 ampere-hours in the right direction (the normal charge being 50 ampere-hours); after which it gave only 15 per cent. less return than the normal. It was then recharged with 75 ampere-hours, or 25 ampere-hours excess, and all effect of the reversal was found to have disappeared.

Mica.—As referring to a substance now so much used for electrical purposes, the following description of an American mica quarry may be of interest:—One of the best American quarries is some two miles from Rumney, on the Boston Montreal line. It lies rather high up, and consists of two gullies some 35ft. deep, with sides of almost pure mica bedded between feldspar and quartz. The mineral occurs in veins from 1ft. to 5ft. thick, and is got by blasting in pieces from 20lb. to 40lb. each. These are then broken up and removed to the works, where they are split up, shaped to wooden templates by shears, and packed in 1lb. bundles. The finer material is split by female labour in another workshop. The

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mica is sent out wholesale in 100lb. boxes, of an average value of $500. The works show as curiosities a sheet of mica 2ft. by 1½ft., perfectly transparent, and also a six-sided crystal of nearly pure beryl, weighing 80lb. The scrap mica and cuttings are ground up to powder with oil, and used as a lubricant.

Statistics of Injury by Lightning.—In his work on "The Thunderstorm" ("De la Foudre: de ses Formes et de ses Effets") M. Sestier has collected the following statistics relating to this subject:—"Only a minority of lightning accidents are fatal; in 601 cases there were only 250 deaths. Fatal accidents are more frequent in men than in women; of 307 men struck by lightning, 165 were killed, while of 137 women only 51 perished. In the vast majority of cases (340 out of 354) death was instantaneous. The danger is greatest in buildings and places (churches, schools, &c.) where crowds of people are gathered together. The part most often struck is the head, then the chest and limbs. In cases in which the head is struck, the mortality is double what it is when only the trunk or limbs are injured. Among the results of lightning-stroke are the following, according to the authority quoted above:—Loss of consciousness, lasting a few minutes to seven days; paralysis, lasting from half an-hour to four months; deafness, lasting from a few seconds to several months; blindness, lasting from three days to seven months; lastly, a state of apparent death lasting from a few minutes to six hours after the accident."

Edison and Swan v. Shippey Brothers.—We are requested to insert the following, for which, however, we accept no responsibility:—"Mr. Arthur Shippey has paid the taxed costs of the Chancery proceedings incurred in this matter, and therefore, according to law, in the cross action brought by Shippey Brothers against the Edison and Swan Company for intimidation of their customers from using the Shippey lamps (upon which action at the trial, it may be remembered, Mr. Justice Mathew directed a non-suit pending the appeal) legally this places Mr. Shippey in his former position to commence a fresh suit, taking into account the recent decision of Mr. Justice Kay, and the recent awards granted in favour of the validity of the Zanni-Shippey patents on the Continent. It is not unlikely that the Shippey system will be upheld by the owners, who claim the right to manufacture and supply all high candle-power vacuum lamps of 100 candle-power and upwards, as specified in the patents, also for their low resistance composite semi-metallic filaments of the improved King and Harrison types suitable for battery lighting. It may be mentioned that the validity of the Shippey patents has not yet been tested in an English court of law, as is generally supposed, as owing to mechanical difficulties no rebutting evidence was produced at the trial to support the validity of their patents."

Gas and Electricity at Taunton.—The *Taunton Courier* says:—"The statements made and the figures presented at the meeting of gas shareholders amply bear out the contention of the promoters of the electric light company that the competition would be a healthy competition, and that it would be beneficial rather than otherwise to the gas company. The improvement in the quality of the gas and the increased use of gas cookers has brought about a steady increase in the consumption, notwithstanding the discontinuance of the gas lighting in the central streets of the town. The shareholders have little cause for complaint inasmuch as they are receiving the full amount of dividend allowed by the Act, and the maintenance and improvement of the works is paid for out of revenue without affecting their dividends in the slightest. Thus, the establishment of a rival lighting company has not only conduced to the better lighting of the town, but has saved the gas company a capital expenditure which would otherwise have been necessary to enable the directors to cope with the growing demands upon them. The 'scare' which attended the introduction of the electric light is found to be entirely unjustified, as the spheres in which the two lights work are entirely distinct, and it will be a long time before the more brilliant illuminant becomes so widely adopted as to interfere with the success of the older and more established light, and gas shares will remain a valuable and profitable investment as long as Englishmen like good meals well cooked—a desideratum which housewives will more and more find attainable by the use of gas for cooking and heating purposes. The superiority of the electric light as an illuminant is fully recognised, and the recent action of the Bath Town Council in deciding upon an installation of twice as many lights as that at Taunton indicates that its claims are gradually being appreciated."

Eastbourne Central Station.—The Lighting and General Purposes Committee of the Eastbourne Town Council presented a report on the lighting of the town at the meeting of the Council last week, in which it states:—"A deputation from the Eastbourne Electric Light Company explained fully the reasons which prompted them to give the Corporation three months' notice to determine the contract for the lighting of the Grand and Marine Parades, and stated that the Company had incurred a serious loss in the working of the contract up to the present date. The Corporation are paying the Eastbourne Electric Light Company at the present time £25 a lamp per annum for 16 lamps on the Grand and Marine Parades, which amounts to the sum of £400 per annum, and the company are prepared to supply the light for the future at the rate of £35 per lamp per annum, which means an increase of £160 per annum upon the present contract price. As an alternative the company are prepared to supply the light by meter, charging 1s. per unit and a sum not exceeding £2 per week for the supply of carbons and cleaning. With regard to the lighting of the Royal Parade, the Company are only willing to supply the electric light at £35 per lamp per annum, or at the alternative charge per unit of force, provided the Corporation will enter into an agreement for five years for the lighting of both the Royal and the Grand and Marine Parades. The company offer to light the shelters on the parades (by meter) upon the same conditions as their present charge for lighting the Town Hall, viz., 1s. per unit, together with the cost of fittings and renewals. The following is a comparative statement of the cost of the electric light and gas on the parades, viz.:—Present cost of lighting Grand and Marine Parades: 59 gas lamps, £171. 15s. 11d.; 16 electric lamps at £25, £400; total, £571. 15s. 11d. Cost when price of electric light is raised: Gas, £171. 15s. 11d.; electric light, £560; total, £731. 15s. 11d. Estimated cost of lighting by gas only: 27 large lamps, at £10. 15s. 8d., £291. 3s.; 32 small lamps, at £4. 4s. 5½d., £135. 2s. 8d.; interest and repayment on £156 for 26 new Suggs' lamps, say £15; total, £441. 5s. 8d. Present cost of lighting Royal Parade: 9 large lamps, at £10. 15s. 8d., £97. 1s.; 6 small lamps, at £4. 4s. 5½d., £26. 6s. 9d.; total, £123. 7s. 9d. Cost of lighting by electric light: 6 electric lamps, at £35, £210; 15 gas lamps, half night, £40. 10s.; total, £250. 10s. In conclusion, the committee may mention that they have ascertained that the Corporation of Hastings pay £30 per annum for each arc lamp lighted on the parades, and at Brighton none of the public streets are lighted by the electric lamps, all such lamps being provided by tradesmen for the purposes of their business." At

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the meeting of the Town Council it was resolved to offer £30 per lamp per annum, the lamps to be extinguished at 11 instead of 11:30 as at present.

Mr. Willoughby Smith's System of Telegraphic Communication with Lightships.—It is well known that considerable difficulties are found in effecting telegraphic communication with lightships, and even with lighthouses on rocks at a distance from the shore. Mr. Willoughby Smith has, however, devised a method of effecting the object, which he has protected by patent, and which may probably be applicable to other purposes. He points out that at the present time, wherever electric telegraphic communication is established between the shore and a lighthouse, either floating or on a rock at a distance from the shore, it is effected through an insulated conductor or a telegraph cable; but much difficulty is experienced owing to the rapid wearing of the cable, so that it is liable to break whenever a storm comes on, and when consequently it is most required to be in proper working order. By his invention he is able to effect communication between the sending station and distant point without metallic connection one with the other. This is effected in the case of a lighthouse erected on a rock at a distance from the shore by submerging one or more metallic plates or masses on opposite sides of the rock, so that the two plates or sets of plates may be as far apart as practicable, and from each plate or sets of plates he leads an insulated conductor to a telephone in the lighthouse. A two-conductor cable is led from a signal station on the shore towards the rock. At a distance from the rock one of the conductors of the cable is led to a metallic plate submerged on one side of rock at such a distance from it as to be in water deep enough for it not to be affected by waves. The other conductor of the cable is similarly led to another metallic plate or mass similarly submerged at a distance from the opposite side of the rock. To communicate from the shore to the lighthouse an interrupter or reverser and battery are connected to the shore ends of the two insulated conductors, and the telephone in the lighthouse responds to the repeated makes and brakes or reversal of the current, so that communication can readily be carried on by the Morse alphabet. If a vibrating interrupter or reverser be used a short or long sounding of the telephone can be obtained by a contact key held down for short or long intervals. A more convenient way is to use two finger keys, one of which by a series of teeth on its stem, or in other more convenient way, produces a few breaks or reversals of the current, whilst the other key when depressed produces a greater number of breaks or reversals. In the same way communication could be carried on from the shore to a vessel at a distance from it, if the vessel were in the vicinity of two submerged plates or anchors, each having an insulated conductor passing from it to the shore, and if two metallic plates were let go from the vessel, so that these plates might be at a distance apart from one another. The position of the two submerged plates coupled to the submerged insulated conductors might be indicated by buoys. In this way communication might be effected between passing vessels and the shore, or between the shore and a moored lighthouse or signal station. A similar result might be obtained with a single insulated conductor from the shore by the use of an induction apparatus with the ends of the secondary winding coupled by insulated conductors to submerged plates at a distance apart.

The Holtz Machine as a Motor.—Historical Note.——Prof. E. L. Nichols contributes the following "Historical Note" to the New York *Electrical World*:—"A gentleman who witnessed the driving of a Holtz machine as a motor during one of the lectures of the regular course on electricity before the Sophomore class of Cornell University, has given a description of that experiment in the *Electrical World* in the issue of February 4th, 1888. Although not new, this is one of the most striking of lecture experiments. It is, however, not very generally known, if we may judge from the notice which the above-mentioned article received, and a few words concerning its origin may be of interest. Silvanus P. Thompson, in his text-book, 'Elementary Lessons on Electricity and Magnetism,' p. 53, makes mention of the reversibility of the Holtz machine, the discovery of which he ascribes to Mascart (*see* "Traité d'Electricité," Vol. II.). The first to notice this phenomenon was, however, undoubtedly Holtz himself, who describes the same in 1867, only two years after the appearance of the earliest form of his influence machine. After describing two other peculiarities of the machine, which was of the original type, with two horizontal plates driven in opposite directions, Holtz says:—'A third peculiarity of the apparatus showed itself when I connected the poles of the same with the poles of another influence machine. When the latter was put into motion, both plates, previously detached from the driving belt, began to revolve, but in opposite directions. The lower plate, however, soon came to rest, whereupon the other moved with redoubled velocity. When this one was held fast the lower one began to revolve very rapidly again. The force of these motions increased with the quantitative performance of the other machine; that is to say, with the force which the driving of that machine demanded. A comparison of these forces showed, however, great electrical losses. When the apparatus [previously used as a motor] was driven as an influence machine, the other machine, if freed from its belt and started in the reverse direction, would maintain its rotation alone. In this case the relation between the two forces in question was still more unfavourable. We may, then, assume that every apparatus which, through influence and mechanical motion, performs electrical work, will also, on the other hand, through influence and electrical work, perform mechanical work; that, however, the construction of a given machine will in each case be better adapted to one of these functions than to the other. The two pieces of apparatus which I connected were indeed good electrical machines, but poor machines for the development of power, and to this fact in particular we may ascribe the great loss of power or electricity' (*Annalen der Physik und Chemie*, Vol. CXXX., p. 170, 1867). We have here, then, from the inventor of the Holtz machine, not only a description of the phenomena upon which the experiment of that machine driven as a motor is based, but also a general statement of the reversibility of all forms of the influence machine. His statement of that principle is not couched in the precise terms now in vogue, but it is as clear a statement as could have been expected at that early stage in the development of the doctrine of energy. The matter was immediately taken up by the celebrated founder and editor of the *Annalen der Physik*, who described various elements of his own in subsequent volumes of that magazine (Poggendorff, 'Reaction zweier Influenzmachinen auf einander,' *Annalen der Physik und Chemie*, Vol. CXXXI., p. 495; also Vol. CXXXIX., p. 513), and later by Christiansen (Christiansen, *Annalen der Physik und Chemie*, Vol. CXXXVII., p. 490), Gruel (*Annalen der Physik und Chemie*, Vol. CXLIV., p. 644), and others; but the origin of the experiment unquestionably lies with Holtz; unless, indeed, we see fit to trace it to still earlier attempts to convert static electricity into motion. In such a case our quest would lead us backward into the eighteenth century, to end perhaps with Benjamin Franklin and his electrical turnspit."

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THE WOODHOUSE AND RAWSON FACTORIES.

Amongst the very limited number of private firms who achieved distinction during the earlier years of the electric lighting industry, undoubtedly one of the most prominent and successful was that of Messrs. Woodhouse and Rawson. Avoiding the temptation to enter upon the manufacture of dynamo machinery, to which nearly all their competitors of the same standing succumbed, Messrs. Woodhouse and Rawson devoted their energies chiefly to the manufacture and supply of the minor requirements of the trade, such as switches, cut-outs, electric bells, and measuring instruments for which, as they no doubt foresaw, electric lighting has created an almost inexhaustible demand. At an early date they commenced the manufacture of incandescent lamps, working out important processes, the details of which have never been made public. These lamps were held in high reputation by electrical engineers, and at one time the turn-out reached upwards of 2,000 per week. Notwithstanding the threats of proceedings on the part of the Edison-Swan Company they always had more orders than they could possibly execute, until the result of the action for a time established the plaintiffs' claims, and the Woodhouse and Rawson lamp factory, as far as manufacturing for England was concerned, was necessarily closed. They continued, however, the manufacture of lamps for abroad until they required to be exhausted, when they were sent over to the French factory to be finished. The tables having now been turned, the business has again been got under weigh. In the year 1885 part of the concern was turned into a limited liability company or rather into two companies, called respectively the Woodhouse and Rawson Electric Supply Company and the Woodhouse and Rawson Electric Manufacturing Company, there being two other companies, Woodhouse and Rawson (Limited) and the Woodhouse and Rawson Electric Contract and Maintenance Company (Limited) in Yorkshire. The extensive premises of the manufacturing company, of which Sir Leopold McClintock, of Arctic fame, is chairman, known as the Cadby Hall Works, are situated in the Hammersmith-road, West Kensington, close to Addison-road station.

Four large blocks of buildings, of which the front one is only partially occupied by the company, comprise the chief portion of the works, and in addition there are testing rooms, an engine and boiler house, and a smithy in separate buildings, together with a good-sized piece of waste ground in the rear affording room for future extensions. These premises, it may be mentioned, are the property of two of the shareholders of the company.

The most unique and therefore the most interesting portion of the establishment is, of course, the incandescent lamp factory, which occupies the two upper floors of one of the large buildings and the top floor of the next. Since the recent judgment by which the lamp trade has again been thrown open, the whole of the factory, as we have already intimated, has once more become the scene of active operations, and preparations are being made now, in the shape of two 30 horse-power boilers which have just been delivered, new dynamos, &c., for a large increase in turn out. The period of enforced leisure which has just been terminated has, moreover, been utilised by the company for the perfecting and simplification of the process of manufacture, and, as most of our readers will be aware, they have succeeded in making a remarkably hard and dense form of carbon, which has also a higher specific resistance than any graphitoidal carbon hitherto produced. Telephone carbon buttons of this material, and with a wonderful surface, are now being supplied by the company. The most valuable feature in the filaments made of this material is that they do not require to be "flashed" in order to acquire uniformity of structure. Messrs. Woodhouse and Rawson maintain, and, as we think, with good reason, that (apart from questions of litigation) other things being equal an unflashed filament is better than a flashed filament. Flashing is a process devised to remedy the defects of non-uniformity in resistance and irregularity of structure in the original filament; and although this purpose is undoubtedly fulfilled by the flashing process in a quite remarkable degree, yet it is obvious that a filament so treated does not really become homogeneous throughout, nor is it likely to possess so long a life as a filament whose structure is strictly homogeneous from the first. Messrs. Woodhouse and Rawson have, we understand, entirely overcome the difficulty of making any single filament uniform throughout its length, and their attention is now being devoted to perfecting the method of standardising, so that any number of filaments successively produced may have exactly the same voltage and candle-power, so that special orders may be quickly filled. It is worthy of note that the filaments of these lamps have a highly polished surface, and are of ribbon shape and not circular in section. Each of these points is of considerable interest on the theoretical side, and we hope a little later to publish a Paper in which the question of surface and section of filaments will be discussed in the light of the experimental and practical results now attained.

Considerable attention has also been given to the process of exhaustion, and the pump now in use, which is the survival of many efforts to arrive at the fittest, is of a very unique design. Indeed, it is so far original that its chief features are not even to be found in the well-nigh exhaustive lectures on "Mercurial Air Pumps" by Prof. S. P. Thompson. The company has succeeded in rendering the various processes in the manufacture of lamps as automatic as can well be conceived possible, with the result that the number of hands employed is reduced to the smallest limit. Like other lamp makers, they have learnt by experience to adopt many little devices and precautions which might appear of trifling importance to the on-looker, but upon which commercial success has been found largely to depend. The Woodhouse and Rawson Company have expended some thousands of pounds in perfecting these details. Amongst the specialities introduced by them we may mention in passing the silvered lamps, which, under certain circumstances, are used with such good effect; and also a new kind of frosted bulb, which will shortly be placed on the market.

At the time of our visit the works were largely engaged upon the completion of an extensive order for "electric automatic shocking machines," and also were engaged on the manufacture of other automatic machines, which latter, although not electric, the company possesses every facility for producing. It is well known that these automatic machines have proved a very profitable speculation for every one concerned, and the company have done a large amount of experimental work in these, at one time having nearly 20 different varieties being manufactured at the same time. The electric apparatus consists of a small battery and induction coil, the latter having a movable core which is inserted further into the coil as the handle on the outside is turned. A stiff spring opposes the motion of the handle, and the latter is connected with the secondary coil.

On the ground floor of the principal building there is the usual collection of machine tools, such as planing, milling and drilling machines, together with a considerable number of hand and power presses used chiefly for stamping out sheet brass for lamp-holders, switches, &c.

Descending to the lowest floor we find a 20 horse-power Marshall engine, a couple of Roots blowers, and an air pump. These latter machines are employed in maintaining a service of compressed air and vacuum pipes, which are carried throughout the building, This service is, of course, chiefly useful in the lamp factory, where a large number of blow-pipes are employed, but it is also very useful in other parts of the building. In an adjacent room some 15 dynamos of all sorts and sizes are at work. Some of these machines deliver current to the testing room, others to the lamp department, some are used for lighting the shops, and others for charging or forming accumulators. A large alternator is at work supplying current for experimental purposes. On this floor also one or two of the heaviest machine tools are placed, and the general millwrights' work is carried on here. The secondary battery, plating and polishing departments are on the same floor. The small secondary batteries, of which Messrs. Woodhouse and Rawson have made a speciality, for surgical and theatrical work, are made here. A

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number of accumulators of new types were also undergoing experimental tests.

Upon the first floor of the same block is the fitting shop. This is a fine room, measuring 100ft. by 30ft., and containing a large number of lathes and light tools. Some new models of automatic boxes were being made here, together with various descriptions of ammeters, voltmeters, automatic cut-outs, electric governors* and other instruments, such as Harcourt's pentane standard burners. At one end were being made the appliances to be used by the Institute of Medical Electricity at their new rooms. Our attention was also attracted by an ingenious appliance for stamping at any moment the date, hour, and minute, which Messrs. Woodhouse and Rawson are manufacturing for the inventors.

The top floor in this building is chiefly occupied by boys and girls engaged in making small and cheap switches, many hundreds weekly being made, and also the "Diamond" electric bell, which is sold at the retail price of half-a-crown. This low price for a good bell is made possible by the simplicity and ingenuity of the design, the fewness of the parts, and the employment of special tools and cheap labour in the manufacture. Here also is the department where coil-winding and lacquering is carried on, for which female labour is employed.

Crossing a bridge to the next block we come into the incandescent lamp department to which we have already alluded, and descending two flights of stairs, passing on the way the lamp tests rooms and photometer room, the latter fitted with all the latest appliances, we come to rooms where the new and interesting process of platinum plating is carried on under the patents of Prof. S. P. Thompson. The following is the method, as described by Prof. Thompson in his specification:—The metal or alloy is first brought to the state of chloride by known chemical processes. The chloride, after having been dried at a moderate temperature, preferably that of steam, is dissolved in distilled water or other soft water of adequate purity. To this solution is added a solution of a certain medium, also previously similarly dissolved, the weight of the medium taken being from 10 to 40 or 50 times as great as that of the metallic chloride. As mediums are employed phosphate of soda, or phosphate of soda mixed with borate of soda or carbonate of soda, or with tungstate of soda, or with any of these materials, or the corresponding salt of ammonia mixed with the soda salt. The mixed solutions of metallic salt and medium are then heated together, preferably to the boiling point; and to the liquor so produced is added one of the following brightening substances, namely, salammoniac, bromide of soda, carbonate of soda, bicarbonate of soda, carbonate of ammonia, hyposulphite of soda, hypochlorite of soda, chlorate of soda, or a mixture of two or more of them—for example, a mixture of salammoniac and carbonate of soda. Preferably such brightening substances are also similarly dissolved in a little water previously to being added to the solution. The mixture having then been preferably once more heated, it must be neutralised. If it is found alkaline, a few drops of hydrochloric acid or a solution of chlorine in water or other suitable substance are cautiously added. If it is found acid, carbonate or bicarbonate of soda is added. The bath so prepared should be warmed to a temperature of from 60° to 90° C. (140° to 194° F.), and is used in the ordinary well-known way, with a fairly strong electric current. The anode may be of carbon or of platinum; but in every case it will be found requisite in the daily use of the bath to add (preferably hot) further quantities of strong neutral metallic solution as the metal is withdrawn by deposition from the bath, and also from day to day to add small quantities of borate of soda or other medium, and also of carbonate of soda or of hydrochloric acid or chlorine water to correct the acidity or alkalinity of the bath.

There can be little doubt that this is an industry which has an important future before it. The cost of a platinum-plated article is but little higher than the best quality of silver plate, its appearance is almost identical, whilst it is far easier to keep clean, and for this reason it should last the longer.

On the same floor is a gas department, which was added to the establishment after they were stopped supplying lamps. Here was carried out all the early work on the well-known Wellsbach incandescent light; a new form of burner, called the "Schülke," is now undergoing test, and seems to promise successful results, 10 candle-power per cubic foot being obtained. On the floor below is the wood-working machinery, which is on a scale corresponding to the demands of the establishment. Other rooms on this floor are occupied by painters and polishers, and some alterations are being made with a view of adding several heavy machine tools.

On the ground floor is the primary battery department, and here may be seen the ingenious chlorine battery with which the name of Mr. Réné Upward* is associated. Power is supplied to this block by a second Marshall horizontal engine of 20 horse-power. The boilers and smithy are placed in a shed on the other side of a small yard, and special precautions are taken to carry the smoke away from the direction of the lamp factory. In this yard is the foundry, and beyond is the waste land already alluded to.

In the main court-yard is the testing room, under the charge of Mr. H. Davies, containing several ingenious instruments designed and manufactured on the premises, of which we shall perhaps give some account at a later date. Next to this is a room containing some special accumulators for testing purposes. One battery consists of a large number of small cells connected in series so as to give several hundred volts; there are also a number of very large Elwell-Parker cells, which can be connected either in series or in parallel, and in the latter case are able to deliver a current of upwards of 1,000 amperes.

With a glance at the stables and waggon house, &c., our tour of the establishment is completed.

In conversation with Mr. F. L. Rawson we have gathered that he attributes the success of the company largely to the fact that most of the hands have been with the firm since the commencement of the business, some six or seven years ago, thus having had a thorough training in and knowledge of the special features of the work. The firm have a considerable number of apprentices and a few pupils. The latter have the privilege not only of going through all the different departments of the works, but also of passing through the head offices in Queen Victoria-street and the other businesses with which the firm are connected. Many of those who had passed through the firm's hands are now employed by the P. and O. and other large shipping companies, who know the advantages of getting thoroughly well-trained youths. To give an idea of the spirit in which the business is carried on, we should add that one of the greatest difficulties the firm have had to contend with has been to keep the *employés* in good health, ill health from over-work having been very common. To counteract this we found on the notice board at the entrance to the works notices of various athletic sports, and we understand that the *employés* are well known for their proficiency in this respect. The interest taken by the heads of the company in these, together with the sick club and similar movements, has, no doubt, its influence on the men.

THE GRAY TELAUTOGRAPH.

For some time past Prof. Elisha Gray, the well-known inventor of the system of harmonic multiple telegraphy, has been at work on a new system of telegraphic transmission, the object of which is the *fac-simile* reproduction by telegraphy of the handwriting of the sender of a despatch. The idea of *fac-simile* telegraphy is, of course, not novel, and has been carried out in several ways, but the new system of Prof. Gray is based on an original method, and moreover it is able to do what no other writing telegraph has yet accomplished—that is, it permits the pen to be lifted and replaced on any part of the paper, so that any desired correction or erasure may be made, or any sketch or drawing, however elaborate, may be faithfully transcribed. As a consequence of this feature it is not necessary to write on a narrow strip of paper, ordinary letter

* For the Porte-Manville electric governor see *The Electrician*, Aug. 30, 884, p. 367.

* See *The Electrician*, July 2nd, 1886, p. 153; Sept. 17th, 1886, p. 385 and Feb. 25th, 1887, p. 349.

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or foolscap paper may be used; moreover, the paper written on remains at rest, so that the movements of the pen are exactly those of ordinary writing, and the transcription at the receiving end faithfully reproduces the spacing of the original. In most of the previous instruments, owing to the movement of the paper, any irregularity in the speed of writing, or any momentary pause, is marked by an increased space in the transcript.

The system consists primarily of two instruments, a receiver and transmitter, each provided with a pen. The transmitting pen is connected to operate circuit making and breaking devices, termed "interrupters," located in two electric circuits and arranged to interrupt the currents passing over the respective circuits at short intervals, producing current pulsations as the pen is moved in two directions crosswise of each other in forming characters, the number of pulsations in the respective circuits being determined by the distance which the pen is moved in the respective directions. These two circuits pass through the receiver and include two pairs of "receiving magnets," the armatures of which act to impart a step-by-step movement to the receiving pen in two directions at right angles to each other, the number of steps in each direction being determined by the number of times the respective circuits are interrupted. By this means the movements of the transmitting pen in the two directions operate through the interruptions in the currents passing over the circuits to impart corresponding movements to the receiving pen, and thus reproduce the matter written by the operator.

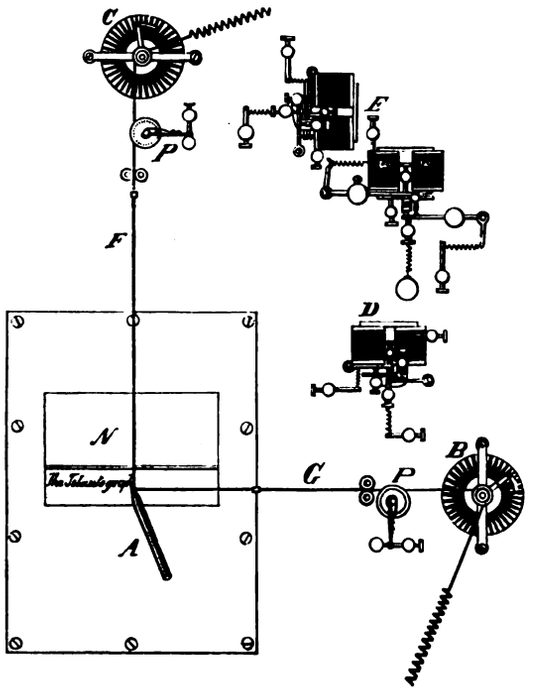

FIG. 1.

The method by which the receiving pen is made to follow the motions of the writer when he lifts his pen from the paper is extremely ingenious, although it is only attained by aid of a very delicate and complex piece of mechanism. In the American specification the full elucidation of the apparatus requires 26 figures, in which over 150 different index letters and numerals are referred to. Briefly, however, we may say that the lifting and replacing of the pen on the paper is controlled by mechanism which is primarily actuated by the pressure of the pen upon the paper at the transmitting station. The paper is placed on a frame supported by a very delicate spring. The pressure of the pen upon the paper is sufficient to close a contact in a local circuit which by means of a relay acting on a weighted lever transmits a signal to line. This signal consists of a certain number of makes and breaks transmitted in a certain pre-arranged order, and with pre-arranged, though very short-time intervals. This signal, arriving at the receiver, passes through a series of polarised and non-polarised relays, whose armatures are opened or closed in such order and in such fashion as finally to produce the required effect of lowering the pen upon the paper. The arrangement seems very complicated, but we have little doubt that a careful study of the conditions to be fulfilled would reveal the necessity for each link in the chain.

The shifting of the paper at the end of the line is, however, effected in a very simple fashion. At the receiving station the paper is in the form of a roll, which is weighted at the free end so that it would tend to travel over the table of its own accord if not prevented. The weight is, however, hindered from falling, when the instrument is in use, by a detent in connection with the armature of an electro-magnet. If the current in this circuit be stopped the weight descends over a space equal to the distance apart of the lines on the paper. The controlling magnet is energised by the current in each of the two main circuits, and its demagnetisation is effected from the transmitting end by opening both the circuits simultaneously. For this purpose a switch is provided, and the same movement shifts the paper to the same extent at the transmitting end.

The accompanying illustrations, Figs. 1 and 2, which, together with the following description, we take from the *Electrical World*, N.Y., show respectively a general plan of the transmitter and receiver, so far as relates to the motion of the pen in the plane of the paper. The transmitting pen A is connected at its point to two cords or other flexible connections F G, which extend horizontally at right angles to each other, and operate the two circuit making and breaking devices B C, termed the "interrupters," located in the two main circuits, connected to B and C. The arrangement is such that as the pen A is moved from left to right and *vice versâ* the circuit of B is made and broken repeatedly in quick succession, producing pulsations therein varying in number with the lineal extent of the movement of the pen, and varying in speed of succession with the rapidity of such movement; while, as the pen is moved up and down in forming the characters, the circuit of C is interrupted and pulsations produced therein in the same manner. The two interrupters B C are exactly similar in construction.

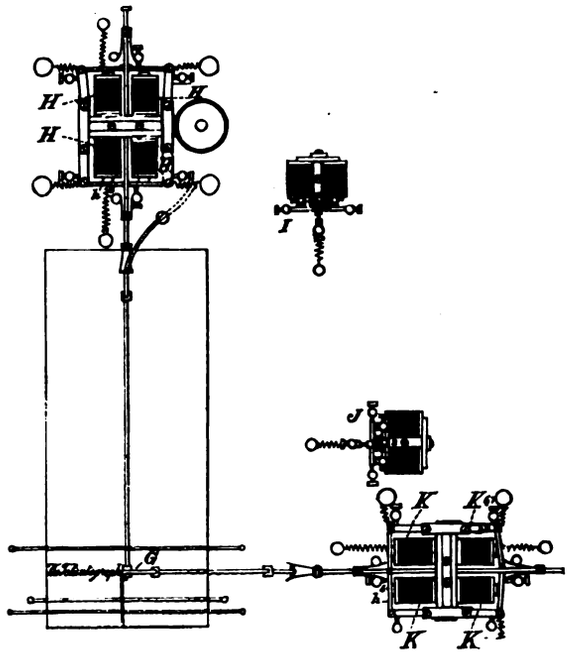

FIG. 2.

Each of the cords F G is wound upon a small drum upon a shaft to which one wire of the circuit is connected. The shaft is provided with an arm, the end of which carries a brush which sweeps in contact with the face of a metallic disc, to which the other wire of the circuit is connected. The face of the disc over which the brush sweeps is provided with insulating strips, so that as the brush sweeps over the face of the disc in either direction the current passing over the circuit in

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which the brush and disc are located will be made and broken repeatedly in quick succession. Each of the shafts is also provided with a second cord, which is wound upon the shaft in the direction the reverse of the cords F G, and is connected to a spring which keeps the cords F and G taut at all times. Each of the cords passes between guides located between the pen and the shafts, and the cords are provided with stops which engage with the guides and arrest the cords and limit the movement given to the shafts and brushes.

The transmitting instrument is also provided with two local circuits which include local batteries and a pair of pole-changers D E, which are located, respectively, in the main circuits of B and C, and which act to automatically change the polarity of the currents passing over the respective circuits whenever the movement of the transmitting pen in either direction is reversed.

The pole-changers D E are connected to the two poles of the main batteries and to the two wires of the respective main circuits in the usual manner. For the purpose of operating the pole-changers the cords F G pass around pulleys P P mounted upon shafts which operate circuit makers and breakers included in the respective local circuits. For this purpose the shafts are provided with arms which are frictionally connected to the shafts and have a limited movement between fixed stops. The arms and one of the stops of each arm are included in the respective local circuits, so that the rocking of the arms between their stops operates to make and break the local circuits, and thus operate the pole-changers D E to change the polarity of the currents passing over the main circuits of B and C at each vibration of the arms.

It will now be readily understood that as the pen makes the down strokes in forming the characters the cord F will be unwound from the shaft of the interrupter C, revolving the shaft and moving the brush over the disc, and interrupting the current over that circuit repeatedly and in quick succession, the number and rapidity of the interruptions being determined by the speed and extent of the movement of the pen.

As the pen makes the upstrokes the spring will rewind the cord F and move the brush in the reverse direction, interrupting the current in the same manner.

It will also be understood that as the pen moves upward the cord passing around the pulley P will close the local circuit of the pole-changer E and send currents of one polarity over the line to C; and as the pen moves downward the pulley will open the circuit of the same pole-changer, so as to send currents of opposite polarity over the same line.

What has just been said with regard to the C circuit also applies to the circuit of B when the pen is moved from right to left, the pole-changer D being then operated by the lower pulley and arm B, so as to change the polarity of the current according as the motion is from left to right, or *vice versâ*.

We now come to the operation of the receiving instrument, which is shown in Fig. 2. This consists of a pen connected by means of a tube with a supply of ink shown at the right adjoining the upper receiving magnets. The pen is connected to two rods which are placed at right angles to each other similar to the cords in the transmitter, and are jointed so to have a free movement sidewise. One of these rods passes through the frame carrying the magnets H H, which are included in the circuit of the interrupter C of the transmitter, and are provided with armatures which act upon the rod in such a manner as to impart a step-by-step movement to it in opposite directions, according as one or the other of the magnets is energised. The rod and the magnets H H and their armatures are so arranged that the rod passes between the adjacent ends of the two parts of each armature in such a manner that when the two parts of either armature are moved towards each other they will act first to grip the rod between them, and being then moved toward the magnet they will carry the rod with them and impart a corresponding movement to the pen G.

In connection with the magnets H H there is a polarised relay, I, which is so arranged that when its armature is on one contact, due to a current coming over the line in a certain direction, it sends that current into the lower magnets H H; but when a current of opposite polarity comes over the line it is carried to the other stop, and the current is sent into the upper magnets, the lower magnets being then short-circuited.

Now, it will be readily seen that when the pen A at the transmitting station is upward it sends current pulsations of one direction over the line. These are received by the relay I and sent into the lower magnets H H, which act as described above to grip and raise the rod to correspond exactly with the number of pulsations, which, of course, are determined by the amount of movement given to the transmitting pen A. When the latter is moved downward the current impulses are sent in similar way into the upper magnets, which grip and lower the rod in an analogous manner at each pulsation. The identical action also takes place with the current transmitted over the main line connected to the interrupter B, the current passing into the relay I and magnets K K, which act upon the rod at right angles to the first to move the pen sidewise in either direction.

From this it follows that any movement of the transmitting pen in any direction oblique to the line or intermediate between these two directions will cause the receiving pen to move in a corresponding direction, but with a compound movement made up of a number of steps taken at right angles to or crosswise of each other, the relative number of steps in each direction depending upon the obliquity of the direction in which the transmitting pen is moved. By this means the receiving pen is caused to substantially follow any movement of the transmitting pen, and thus reproduce a *fac-simile* of whatever is written or traced by the latter.

The irregular or wavy character of the oblique lines made by the receiving pen is said not to detract materially from the appearance of the writing, and is not sufficiently marked to prevent the handwriting of the person at the transmitting instrument from being readily recognised. The length of the steps with which the receiving pen is moved may be varied considerably; but the receiver is so adjusted that the pen takes from seventy-five to one hundred steps to the inch.

REPORT OF THE COMMISSIONERS OF THE PRIX VOLTA.

The following is a translation of the full text of the report made by the Commissioners in awarding the Prix Volta to M. Gramme, omitting only the preamble:—"In the year 1832, a few months after Faraday's discovery that electric currents were generated by the relative movement of a magnet and a conductor, Pixii constructed, under Ampère's directions, a machine intended to utilise the rotation of a magnet to generate continuous currents in this way, obtaining from mechanical work the electrical energy which, from the time of Volta, had been obtained chemically. This was the starting point of a great number of attempts to increase the utility and efficiency of these so-called magneto-electric machines. A supreme difficulty, however, remained for long an obstacle to the industrial application of these machines. The distance between armature coils and field-magnets necessarily changes periodically. They approach and recede alternately, and consequently give rise to alternating currents, which are of no use at all in many of the industrial applications of electricity. From the first it was sought to correct these currents by using a commutator which alternately presented the two extremities of the external circuit to those of the dynamo circuit. As soon, however, as these machines were made on a commercial scale the sparking at the commutator quickly destroyed it. It was reserved for M. Gramme to get over this difficulty, and to invent a commercial electromotor which has been the starting point of the marvellous development of electrical industries which we are at present witnessing. Giving up the idea of such an unsatisfactory form of commutator, electricians now set to work to make as much as possible of alternating currents for lighting purposes, &c., where rapid alternations were not an obstacle. It was possible even in these days to see the germ of the present growth of commercial electricity. Thirty years ago the Société l'Alliance was working the patents of M. Nollet for dynamo-machines with permanent magnets. The workshops of this company were in charge of one Joseph Van Malderen, a Belgian by birth, a man of considerable merit, and to whom several of the improvements made in the 'Alliance' machine were due. In 1860, Van Malderen employed M. Lénobe Gramme, a countryman of his, whom he had met at Brussels, but who was then working as a carpenter in Paris. Endowed with great reflective powers, M. Gramme tried to master the strange machine which he helped to construct. Two years

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later he was employed by Ruhmkorff to put finishing touches to the woodwork of influence machines, and here also M. Gramme found much to think about. Hardly knowing how to read or write he was but poorly prepared to understand the discussions and explanations which went on around him, so he endeavoured to form his own ideas about the mysterious force whose extraordinary effects he daily witnessed. To check the results of his meditations he purchased an elementary treatise on physics, which he perused painfully word by word by the help of a French dictionary. M. Gramme was greatly elated to find that the leaders of the scientific world were not much more certain of their ground than he was, and were reduced to much the same hypotheses. He had already tried his hand with but little success at several mechanical inventions, and he now hoped to be more fortunate in the field of discovery which lay open before him. His library consisted of two books—a treatise on physics and a dictionary; his laboratory was a modest kitchen, and contained a sheet of gutta percha, two magnets, and a few pounds of copper.

"In a patent dated 26th February, 1867, for improvements in the construction of alternate-current machines, M. Gramme described an electric pinion consisting of coils wound on the projecting teeth of an iron ring; he also pointed out the principles governing the excitation of the field-magnets by means of a current from the armature itself. But ill-luck pursued him. His want of money had delayed the application for a patent for over six months since the idea occurred to him, and in January, 1867, Wheatstone had communicated a Paper to the Royal Society upon the 'Self-Excitation of Dynamo Machines.' In the following year, while on a short visit to London, M. Gramme constructed his first continuous-current machine. The E.M.F. of this machine was to have been over 3,000 volts, but difficulties of insulation caused M. Gramme for the moment to give up the idea of a high-tension machine. In 1869 he constructed a new machine, with a magnet weighing 10 kilograms and a ring armature wound with 1 mm. wire. Satisfied with the results he obtained, M. Gramme now tried to get financial support in order to work out his idea. He addressed himself to Bréguet, whose standing and generosity were generally admitted. This eminent man was, however, ill-inspired on this occasion. He received the inventor with his habitual kindness, but showed him clearly that he had no illusions about the inanity of the dream. However, true to his generous instincts, Bréguet gave M. Gramme the 100fr. which were nccessary to enable him to take out a patent. We are inclined to doubt if the invention received much additional encouragement. The essential part of the Gramme machine is simply a soft iron ring, wound with a continuous wire and turning in a magnetic field. The currents induced in the two halves of the wire have, as starting and stopping points, two points, which are fixed in relation to space, but which are movable in regard to the ring itself. It is therefore only necessary that the two ends of the external circuit should terminate in two fixed bars, successively coming in contact with the armature coils, in order that the circuit should be traversed by a continuous current. This is the essential feature of the Gramme machine. Simple as it seems to us now it was nevertheless quite different then; it was quite unthought of, and it is easy to understand how little was anticipated from so simple a device.

"It ought to be mentioned that this principle was not absolutely new, and equity demands that the merit of first discovering it should be accorded to M. Pacinotti. In a note inserted in the *Nuovo Cimento* of June, 1864, M. Pacinotti described a little electro-magnetic machine, the principal feature of which was a ring similar to that of M. Gramme. It was a motor driven by a battery, and its commercial efficiency was about 10 per cent. 'Although these results,' says the author, 'do not place this new machine much above other small electro-magnetic machines, still, they are by no means bad, considering the imperfect mechanical construction.' M. Pacinotti also showed that if the electro-magnets of the machine were replaced by permanent magnets it could be used as a dynamo. 'I think the value of this style of machine is considerably augmented by the fact that it can be easily turned into a continuous-current magnetic machine. The electro-magnetic machine which results has the advantage of yielding induced currents in one direction without there being any necessity to separate dissimilar currents or to combine similar currents.' The eminent professor of Pisa never dreamt that this laboratory apparatus could become a commercial machine, and no one seems to have thought any more about the matter, for the communication to which we have just called attention remained hidden. Contemporary scientific journals hardly noticed it, it was not mentioned in any text book, and it was, in short, ignored until the undoubted success of M. Gramme's machine directed attention to previous researches, and amongst them to those of M. Pacinotti. Least of all was M. Gramme the person to have known of them, and nobody has ever questioned his *bona fides* or his claim to being the first to make the machine a practical success. We have seen how great were M. Gramme's discouragements, his absence of resources, and the incredulity of all competent men. Since 1869 M. Gramme has described and designed four different machines. In one of them the armature coils are under the influence of the magnetic field from both sides. In another there were two armatures and six poles. The third is the type of machine turned out by the Bréguet workshops for the last fifteen years. Finally, in 1871 the Académie des Sciences was shown a four-pole machine, and the very many scientists who visited the factory of MM. Mignon and Rouart on that occasion saw with astonishment a continuous-current dynamo which did not absorb more than four horse-power, and which was capable of transforming a 10-metre copper wire into a garland of fire. At this date the inventor had studied minutely the *rôle* played by the different parts of his machine. He was in possession of empirical formulæ, which enabled him to reduce weight to a minimum, to arrange the proper distribution of iron and copper, to calculate the diameter of the wire, the number of turns, and the necessary speed, so as to obtain in every case the greatest efficiency compatible with safety and durability. His capabilities were soon put to a severe test. From the year 1854 MM. Christofle had tried with but little success to replace the cumbersome and noisome batteries then employed in electro-plating by magneto-electric machines. Struck by M. Gramme's success, MM. Christofle set him the following problem to solve:—'Construct a machine which will deposit 600 grammes of silver per hour on a given surface, in four baths arranged in parallel; the machine to run at 300 revolutions per minute.' In spite of the progress made in recent years in the determination of the correct values of the different electrical units and the properties of iron, what *savant* of to-day would be able to solve this problem without the aid of the empirical formulæ of the workshop? Three months later M. Gramme handed over to MM. Christofle a machine constructed as specified, which from the very first deposited 600 grammes of silver per hour, and ran at 300 revolutions a minute. This was a genuine triumph, and was the signal for a revolution in the electro-plating trade. Two years after the inventor built for M. Wohlwell, of Hamburg, a machine which yielded 3,000 amperes at 8 volts, and deposited 800 kilogrammes of refined copper in 24 hours. From this date batteries disappeared from electro-metallurgical works.

"Success was now assured, but M. Gramme had not the gifts necessary to turn his inventions to the best account. He was fortunate enough to discover an eminent engineer willing to be his pupil, to collect his ideas, and to undertake the commercial part of the business. Legitimate success was soon attained, and the inventor obtained an unlooked-for fortune. M. Gramme's colleague administered his affairs himself, and saved his partner all the worry of financial operations. As for M. Gramme, he has ever remained a simple workman, completely immersed in the congenial task of improving the details of his machines, and creating every year new types for lighting factories, ships, lighthouses, and open spaces. M. Gramme has also paid attention to such accessories as the regulation of arc lamps and the regulation of the speed of motors in transmission of power of installations, evincing in every direction an ingenious and practical mind. M. Gramme works entirely by himself. He sketches, elaborates, and realises his plans without any assistance other than that afforded by two men, once entire strangers to both electricity and mechanics, namely, a stonecutter and a bookbinder. He does not care to appear in public, and avoids all occasions where his modesty may be troubled by praises. So obstinately does he adhere to his solitary workman's life, that an eminent foreign scientist, who had vainly tried to get sight of him, professed to disbelieve in his existence.

"Since the date of M. Gramme's invention, commercial development of electricity has gone on at a great pace. A large army of inventors have followed in his steps, and almost all, if not quite all, of the innumerable types of machines in the market which furnish continuous currents are of the Gramme-ring pattern. Science has benefited the most. Thanks to the dynamo, physicists have at their disposal currents which it would have been impossible to obtain in the days of the voltaic cell. M. Gramme certainly cannot be placed side by side with men of genius like Ampère and Faraday. Neither can M. Gramme's work be compared in importance to that of Graham Bell, the inventor of the telephone. Still, according to the words of the Institut, 'it forms a memorable epoch in the history of electricity,' and it is well included in the scope of the Ministerial decree of the 10th November, 1882. Volta's discovery remained a laboratory one; its commercial applications were very few, in spite of the many attempts and hopes which Faraday's discoveries gave rise to. Since M. Gramme's time, however, electricity has taken its place by the side of steam, and its part becomes daily more important. In awarding the Volta prize to M. Gramme, the committee thought that it was fulfilling the ideas of the founder, and that it was following the lines laid down by the Institut. It is confident that its decision will obtain the cordial assent of all *savants*, practical men, and those interested in the progress of science and industry."

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PHYSICS IN PUBLIC SCHOOLS.

IN an American review for the present month, and bearing the above title, there appears an article which might have been penned by an Englishman, and may certainly be read with advantage by everybody interested in the teaching of science in our English schools. Possibly the conclusions arrived at by the writer, Mr. C. J. H. WOODBURY, are not altogether those which we should ourselves endorse; but the facts disclosed are pretty much what are common experience with us, and being stated in sober seriousness, not as facetiæ extracted from an examiner's note-book, we are able to comment upon them with the same useful purpose which the writer had in view. The circumstances under which he has written arose as follows:—There was a High School to be started, and at least one prospective vacancy to be filled in the classical High School, besides several similar ones in the Grammar Schools. The positions were such that the head teachers, it was considered, ought to possess some knowledge of modern science, if only as a test of general intelligence and for guiding the miscellaneous reading of scholars upon technical subjects "even though not included strictly in the prescribed course of studies." Accordingly a teachers' examination was held, the series of questions including a few upon physics and chemistry. Only one related to electricity, and ran as follows:—"Explain the principle of the Bell Telephone." The notoriety of this invention and the prominence given to it in the newspapers induced the examiners to think, not unreasonably, that the answers given by the candidates would fur-

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nish evidence of their habits of observation and of general reading, to say nothing of their scientific training.

Now, that the candidates had received some scientific training, or, rather, had acquired a considerable smattering of scientific phraseology, is plain to be seen from their answers both to this and the other questions in physics and chemistry; but as to their habits of careful observation and exact thought with which this training had endowed them we may leave our readers to judge for themselves. It should be mentioned that the candidates were of the gentler sex; but any allowance to be made on this account is rather discounted by the fact that they were women of proved superiority, being graduates of High Schools of excellent repute, or of the leading academies in New England. The answers, therefore, were not those of school children, either girls or boys, but, as the writer says, of "ladies who had received the benefits of the best public school instruction given in the oldest of our New England States." This being premised, we may now proceed to analyse the ideas these highly educated persons had formed, first with regard to the Bell Telephone.

Only ten of the number attempted any answer at all, and about half of these appear to have had no conception that the telephone was an application of electricity, or that it was other than a superior kind of speaking tube. Number 1 essays that the telephone is based "on the principle that sound may be transmitted a great distance along a wire." Number 2 confines herself to the safer assertion that "sound, having a medium to carry it, will travel." Numbers 9 and 10 are fuller and far more ambitious in their use of scientific terms, though not a whit nearer the mark than the other two. "By means of the telephone communication can be carried on by articulation." So far Number 9 is on sure ground; and hardly less so when she specifically describes the Bell Telephone as "a small wooden arrangement attached to a wall." After this, her memory of what she has evidently seen, but not understood, is lamentably at fault, for she speaks of an "opening for the mouth, and also a small piece connected to the instrument by a cord to hold it to the ear." With these appliances "sounds are transmitted in waves along the wire, and coming in contact with the air strike the ear drum and are transmitted through the chain of bones to the openings on the inside, and thence by the optic nerves to the brain." This young lady plainly does not mean to let her scientific vocabulary grow rusty for want of airing. Number 10, who is equally profuse in this respect, after a preliminary flourish of generalities, makes a dash at exact description as follows: "It" [a platinum disc] "vibrates against a magnet to which are connected two magnets which wind around two screw cups, and then pass through the instrument to the distant station." A few of the answers betray a certain suspicion that electricity plays some part in the business; but nowhere is there the remotest attempt at defining it. "It is," says one, "carried on by that mighty power electricity." This is a good beginning; but she immediately relapses into fatuity: 'We ring an electric bell. When we speak we hold a cup or handle to our mouth"—and so forth. Number 4 succinctly avers that "the principle of the Bell Telephone is based first upon electricity." But she stops at that, and, perhaps wisely; for the lady following her explains that as a membrane with a tube could only be employed for short distances, "electricity was applied to make them [the sounds] stronger, and iron plates were used instead of membranes." Another candidate speaks of the voice causing "waves of condensation and rarefaction to undulate through the wires;" while the next one spoils a promising beginning by a similar blunder; and the eighth finishes up with "two posts connected with the permanent magnet, one going into the ground and the other all connected with the receiver at the distant station."

The answers to the questions in physics need not detain us long. With definitions of well-known terms the candidates could not go very far astray; but here again we find the same hesitation, the same vagueness, or the same audacity of ignorance repeating the disjointed phraseology of the text-books, and often giving right answers, but unfortunately to the wrong questions—a trick of memory with which every examiner is only too familiar. "Force," we are told, "is a push and a pull;" "force is the attraction which one body has for another;" "inertia is the rate of motion;" "inertia is that force by which a body may be moved from one place to another;" unit of heat is defined as "a regulation made by which to reckon a decrease or an increase;" and, as "an amount of heat required to heat a certain body." Mr. WOODBURY assures us that the questions were framed on the text-books of physics actually used by the majority of the applicants; and he is careful to state that the subjects were accurately and clearly treated of in those books. For our part we need no such assurances, the answers in no way surprising us. Briefly, our comment on this part of the case is that where a true answer can be given only by an effort of memory, and not from experience and observation, the chances are about equal that the candidate will stumble on the wrong answer.

These New England candidates were from different institutions, but all alike exhibited the same failings, and Mr. WOODBURY attributes this to some radical fault in the methods of instruction. The radical fault, it seems to us, of all such methods of instruction, both in America and here, is that it attempts to substitute book learning for that training of the active faculties without which all learning by rote is mere waste of time and brain power. Had their eyes and understandings been properly disciplined these very learned ladies would have grasped the principle of the Bell Telephone without the aid of the newspapers; and as regards elementary physics, they might have been saved from their worst blunders by a few illustrative experiments. Instead of this, memory alone is cultivated, and in most instances with results which are a snare to the teachers and a mockery to the examiners. Mr. WOODBURY observes that in chemistry the lady candidates show greater proficiency, "because excellence in that study is the result of memory" rather than of the exercise of the other faculties. So far as the examination is concerned this may well be the fact; but for all useful purposes thereafter what is true of physics is true also of chemistry, viz., that laboratory and workshop practice should be given in all cases concurrently with the study of books.

ELECTRIC TRACTION ON THE INNER CIRCLE.

BY S. EVERSHED.

(Continued from page 441.)

It need hardly be observed that the estimate made in the last article of the maximum power required by a train is a very liberal one, and serves only to guide us in our choice of motors. Thus, four motors may be used, one on each car, capable of developing 75 horse-power each, without undue strain or excessive heating during twenty to thirty seconds. As the stationary plant must be able to meet the maximum demand from the whole line, we will, before going on, consider the conditions of maximum traffic during the Exhibition

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season, for example. For one or two hours in the morning the City-bound trains are fully or even over-loaded, and the Kensington trains are at the same time often from one-half to two-thirds filled, the trains between Kensington and Edgware-road being comparatively empty. Thus, there may be about twenty trains of 100 tons, an equal number half-loaded, which may be put at 85 tons, and the light trains at 75 tons, the average weight being 87 tons. For the present the average weight of a train during times of heavy traffic will be taken as 90 tons.

The average power required per train will be nearly independent of gradient, except where gradients occur at starting and stopping places, in which case work is done in starting trains up, which is not recovered by the trains running down the gradient. Let us allow for a gradient of ·5 per cent. during starting, therefore, and the total work done on a 90-ton train during the run from a station to the point at which power is cut off works out at 5,290,000 foot-pounds; of this amount nearly 2,200,000 foot-pounds are done in the first 20 seconds and the remaining 3,100,000 foot-pounds in 100 seconds, *corresponding to rates of* 200 W.H.P.* and 56·5 W.H.P.; and if the motors are assumed to work at an average efficiency of ·6 during starting and ·85 at full speed, and the gearing is supposed to absorb 15 per cent. of the power, we require 393 E.H.P. and 78 E.H.P. respectively at the motor terminals.

To keep the output of the power stations as constant as possible an arrangement must be made to prevent more than a certain proportion of trains from starting at once. If we imagine the stations at exactly equal distances, it is clear that in order to do this the time interval between the trains must be greater or less than that from station to station. Let the former be 20 seconds greater than the latter, so that there will be a train every 170 seconds. We still require some system by which an even distribution of trains may be secured; the writer suggests that a train while starting from a station should cut off the power from the conductors at the next station in the rear until it has passed over the space required for reaching full speed. This compels the trains to run with the right time interval, and also works as an automatic block system. It is obvious that on a circular line worked in this manner the number of trains must be at least one less than the number of stations, otherwise every train on the circle might be blocked by a train in front. As we have already increased the time interval to 170 seconds, there can only be about 50 trains on the circle, or 25 trains on each rail, and as there are 27 stations there will be at least two trains free to start.

The method of leading the current from the mains to the motors will not be discussed in the present article; it is generally agreed that there would be no great difficulty in applying either the "centre," "side" or "overhead" conductor system to the Underground Railway. The writer, however, doubts whether it would be advisable to use the rails as a return circuit in a case where the working potential difference will necessarily be high, and possibly dangerously so, and will therefore allow for double mains. What is the highest potential difference which can be employed consistently with public safety and ease of working? Five hundred volts is used in some instances, with perfect freedom from accident so far; a sense of the fitness of things suggests 1,000 volts as perhaps the limit beyond which it would be unwise to go. For the present purpose it will be convenient to put the E.M.F. at the motor terminals at 746 volts, not because of any peculiar virtue in this happy medium, but because amperes and horse-power become synonymous. The number of power stations depends to a great extent on the spaces available as sites; probably suitable positions could be found at or near Gloucester-road, Edgware-road, King's Cross, Aldgate, and Victoria. Each of these five stations would operate ten trains on about 2·8 miles of line, the mains thus extending not more than 1·4 mile on either side of the station. It will probably be found convenient to divide the feeding mains into two sets: first, a heavy main to feed those sections in running over which the motors are working at maximum power (we shall call this the *starting* main); second, lighter mains, sufficient for those parts of the line where only average power is required (these will be referred to as *ordinary* mains). The contact conductors should also be divided into corresponding starting and ordinary sections. The writer does not feel called upon to solve "the most economical main" problem; the mathematical solutions usually arrived at in similar cases have no practical significance whatever, as mathematical mains are destitute of insulation and cost nothing to lay down, while the capitalist is assumed to be a philosopher who carefully balances waste of power against interest of money. As a matter of convenience, however, it will be advisable to proportion the ordinary mains so that the working potential difference is fairly uniform and the loss moderate; they may, for example, be calculated on the basis of a maximum waste of 15 per cent. Taking as a unit the 1·4 mile of line forming one-half the circuit of each station, we see that it may be necessary to maintain all the trains on this section at full speed; in other words, the mains must be able to supply five trains at 78 E.H.P. each. The longest circuit will require a main 2·8 miles in length to carry 78×2 amperes with a drop of 132 volts; the resistance is therefore $\frac{132}{156} = \cdot 85\omega$ nearly, the sectional area being ·146 square inches, and weight 8,300lb. The next circuit will be 1·8 mile in length. It will carry the same current with the same drop, and its resistance is therefore ·85ω, area ·093, and weight 3,440lb. The shortest main is ·8 miles in in length, area ·042, and weight 680lb. Thus, the total weight of ordinary mains for 1·4 mile of line will be 12,420lb., or, say six tons, which allows for mains from power stations a short distance from the line.

Now for the starting mains. Since the time occupied in starting is 20 seconds, and the whole cycle takes 150 seconds, not more than $\frac{20}{150}$, or let us say one-seventh of the total number of trains can start at once, and as there are only five trains on the section under consideration, it is obvious that the starting main will never be required to supply more than one train, but that train may be at any point on the 1·4 mile. There being only one train dependent on it, uniform potential difference is not of much consequence, and its area may be calculated on the basis of a train starting 1·4 mile from the power station, and with a loss of 15 per cent. at full speed, as in the ordinary mains. If the speed of a train increases at a uniform rate, the average back E.M.F. of the motors during starting will be about half the maximum, the average current being therefore about half that necessary with maximum E.M.F., or the current must equal $393 \times 2 = 786$ amperes, unless provision is made for putting the motors 4 in series for the first 5 seconds or so, then in two parallels of 2 in series for 5 seconds more, and all in parallel for the remaining 10 seconds, when by moderate variations in the motor fields (an automatic variation with series-wound machines) the average E.M.F. may be kept as high as ·75 of the maximum, needing an average current at 525 amperes to give the average power required. Now as the dynamo at the power station must run at 878 volts in order to supply the motors when they reach full speed, and 132 volts are to be wasted when the motors are taking 746 volts and 393 amperes, we have $\frac{132}{393} = \cdot 336\omega$ as the resistance of the 2·8 miles of starting main; but at half-speed, assuming the means of regulation indicated above to be dispensed with, the drop in volts will be 505, while the current at this time is 786 amperes, so that the resistance should then be ·65ω nearly; in short, either the motors must be regulated, or the dynamos used to supply the starting main must be quite independent of those feeding the ordinary mains, so that some at least of the enormous waste in starting may be avoided. Gearing which permitted the motors to start at full speed and full power at once, while only gradually increasing the train speed, would, of course, solve the problem in the most perfect manner.

However, taking the lower resistance given above, viz., ·336ω, the sectional area would be ·367 square inches, and weight 21,000lb, or, say, 10 tons. If the highest estimate of maximum power be taken, namely, 300 W.H.P., the starting main would weigh 15 tons, but as, so far as the writer can learn,

* The letters W.H.P. will here be used to signify horse-power *delivered to the wheels.*

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the maximum gradient is under 1·5 per cent., and the places where trains will require more than 200 W.H.P. very few, 12 tons of copper per section will be ample for the starting mains.

The size of the contact conductors may be arrived at by considering the average power required per train during the time current is supplied from the power stations. As 5,290,000 foot-pounds are done between two stations, and the current is on for two minutes, the average power is about 80 W.H.P., or, roughly, 125 E.H.P. As the loss in the conductors will depend to some extent on the nature of the moving contact it will be useless to allow for any specified loss, and we will therefore put the sectional area at ·125 square inches. There would probably be a separate pair of conductors for each road, so that $1·4 \times 4 = 5·6$ miles will be required in a section, and the weight will be 14,200lb., or say 6·4 tons. It is not unlikely that copper would prove unsuitable when used for contact conductors, but the above weight may as well be included in the total, which now amounts to:—

Ordinary mains = 6 tons.
Starting main = 12 „
Conductors = 6·4 „

Total weight of copper per section = 24·4 tons.

As there are five power stations operating two sections each the total weight of copper for the whole circle will be 244 tons. It will be seen that this estimate assumes the conductors to run over the whole line, inclusive of stopping places. It is not without interest to remark that the sum of the areas of the conductors at any point on the line will be nearly constant, since on gradients the increased size of conductors on the up road is nearly compensated for by the diminished area of those serving the down road. Again, corresponding with each starting section, where the conductors are, of course, very heavy, is a section on the opposite road where they will be light; these differences do not neutralise one another exactly, and if the motors are used as dynamos while stopping, heavy conductors will be required on both roads at each end of a station.

We will now ascertain the total amount of generating plant required. Here it will be best to take one train as the unit. As each train uses power at the average rate of 125 E.H.P. for two minutes, and then no power for half a minute, it is clear that the generating plant need only supply $125 \frac{2}{2·5} = 100$ E.H.P. to the motors; the loss in the mains we have put at 15 per cent., so that the generating plant must have an output of 117·5 E.H.P. per train, or allowing for spare machines, &c., 120 E.H.P.; giving a total, for fifty trains, of 6,000 E.H.P., divided into five stations of 1,200 E.H.P. each. The efficiency of the dynamos may be safely assumed to be ·9; the loss in engine and other friction ought not to exceed 15 per cent., giving a combined efficiency between indicated and electrical horse-power of $·9 \times ·85 = ·765$, and the engine must, therefore, be capable of indicating 7,850 horse-power—that is, 1,580 I.H.P. at each power station.

The efficiency between indicated horse-power and power delivered to the wheels is about 45 per cent., but would very probably not exceed 40 per cent., and if we take the coal consumption of the engines at 2lb. per I.H.P. hour we have 5lb. per W.H.P. hour, and therefore $5 \times 64/12 = 26·7$lb. per train mile, a quantity which appeals to railway men, but which has not much meaning apart from the weight of the trains moved. We may note, however, that from 25lb. to 30lb. of coal per train mile is a very usual consumption for such trains as those under consideration.

Having thus roughly outlined a complete scheme for working the Inner Circle electrically, we are in a better position to foresee and discuss the difficulties which would certainly occur than if they had been noted as they arose. There remains to be considered the brake question, which is really of the first importance, and some remarks should also be made with respect to automatic blocking and other matters incidental to railway working. It may be well to point out here that, although the service of circle trains has been assumed to work quite independently of the extension trains, no very material change would be made in the amount of plant required should it be decided to adhere to the present system of working. It might, for example, be possible to dispense with one power station, either that at Edgware-road or Gloucester-road; but it would be preferable to use the possible surplus power from these two stations, consequent on the infrequency of trains between them, to work the traffic electrically over a portion of the branches.

(To be concluded.)

THE BARCELONA EXHIBITION.

(FROM OUR CORRESPONDENT.)

August 18th, 1888.

Although it is now some thirteen weeks after the official opening of the Exhibition, I regret to say that the electric lighting is still in a somewhat unfledged state. The greater portion of the main building is as yet only fitted with lamps and leads, the evening shades being left in undisturbed possession as soon as the sun sets; indeed, it is only within the last four or five weeks that any part of the Exhibition has been regularly lighted. An International Exhibition left in darkness every evening is a decided novelty in these days, and it is certainly to be regretted that the first Exhibition of the kind ever held in Spain should distinguish itself in this unhappy way. It is only fair to mention, however, that circumstances certainly do not warrant any great extravagance. The average daily attendance is only some seven or eight thousand, and, except on saints' days and Sundays, only a few dozen individuals are to be seen in the grounds after nightfall; and there seems but little hope of the number of visitors being swelled to any great extent unless we have a rush of foreign tourists within the next few weeks. I will now give a detailed account of the electric lighting plant and the electrical exhibits of interest to be seen at the Exhibition.

The lighting of the buildings and grounds is divided between four firms, each of different nationality, so that the Exhibition is thoroughly international in this respect at any rate. The Compania Espanola de Electricidad, the only electrical engineering enterprise of importance in Spain, has 10 dynamos at work, all of native manufacture, supplying at present 120 arc lamps of 2,500 candle-power, and lighting the Gardens, the Fine Art gallery, the Science section, and the large restaurant. This is a tolerably stiff piece of work, owing to the scattered nature of the installation and the distances to be traversed by the wires. Later on this company will operate 3,400 16 candle-power incandescent lamps, though when I cannot say. The dynamos are driven by two powerful engines of 200 horse-power each, which also drive the machinery in the Exhibition. These engines have 23ft. fly-wheels, whose mammoth proportions greatly impress the Catalonian peasants. The Compania Espanola de Electricidad was formed in 1881, with a capital of £80,000, and has been a most successful venture. At the present moment this enterprising concern has a central lighting station at Barcelona, which supplies 80 2,500 candle-power arcs and 500 incandescents for public lighting, and 70 arcs and 500 incandescents to private consumers. Messrs. Ganz and Co., of Budapest, have a few large and small dynamos at work, but all detailed information is refused by the superintendent in charge. The Compagnie Continentale Edison makes, in my opinion, the best show of any. Their plant comprises two 200 horse-power boilers, two 150 horse-power compound condensing engines, running at 170 revolutions a minute, and two Weyher-Richemond dynamos having an output of 800 amperes and 125 volts at 350 revolutions a minute. These two machines are probably the largest in Spain. This company has contracted to light 75 750 candle-power arc lamps and 750 20 candle-power incandescent lamps. It would be difficult to surpass these lights in brilliancy and steadiness.

The Anglo-American Brush Corporation light the orna-

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mental fountains. Their plant comprises three high-pressure boilers, of 200 total horse-power; a high-pressure compound vertical Browett and Lindley engine, working at 225 revolutions, and driving a couple of 40-unit "Victoria" dynamos. An underground passage, 95 metres long, runs from the engine house to a room under the fountain, where the coloured lights are operated. The arc lamps are of special design, and are each of 4,000 candle-power. They are arranged in multiple series. The Anglo-American Brush Electric Light Corporation obtained the contract for this fountain in March, and notwithstanding the numerous difficulties which were encountered in cutting out the foundations and building the basin, the whole was put successfully to work on the evening of June 14th. The general features of the fountain are similar to those of the first example of this interesting exhibition, which was constructed under the personal superintendence of the late Sir Francis Bolton, at South Kensington. Advantage has been taken of the experience there gained, and many improvements have been introduced, which greatly enhance the effect. From the centre a jet mounts to an enormous height, estimated by eye-witnesses to be 120ft. Six jets around this rise to about 80ft., and eight outer jets to 40ft. These, with the sprays which surround them, are fed by very powerful steam pumps, and are illuminated by 15 projectors, throwing vertical and concentrically inclined rays of white and coloured lights. The fountain has made a great sensation in Barcelona, and has been greatly praised, on account of its exceptional beauty, by members of the Exhibition Committee, who, previous to its installation, inspected some two or three similar fountains which were at work in England last year. The power employed to produce the above results is about 100 horse-power for the electric light, and from 150 to 200 horse-power in the pumps.

Messrs. R. E. Crompton and Co. (Limited) exhibit two of their well-known dynamos, only the smaller of which is at work. Messrs. Julius G. Neville and Co., of Liverpool, show a No. 10 "Castle" dynamo, driven by a Davey-Paxman engine. This machine supplies five arc lamps and 20 incandescent lamps, the light being remarkably steady. Messrs. Schuckert, of Nürnberg, have a mixed installation, 45 incandescent lamps and several arc lamps being run off the same machine. This dynamo, I may mention, is driven by an "Otto" gas engine; in fact, gas engines are very prominent in the Exhibition, and are as plentiful as blackberries.

C. Conradty, of Nürnberg, exhibits a great variety of carbons for electrical purposes; they are of all sizes and shapes, from long rods as thick as walking sticks to almost invisible filaments. The Société Anonyme de Barcelona shows some beautifully-finished incandescent lamp globes. Malagrida y Casellas, of Barcelona, exhibit a few electric light cables, but it is a poor display, more remarkable for the difficulty of obtaining information than anything novel or practical. The India-Rubber, Gutta Percha, and Telegraph Works Company have a fine and unique selection of their well-known goods; while the firm of Felten and Guilleaume, of Mülheim, make a similar and equally creditable display. The Electrotechnische Fabrik, of Leipzig; the Société Générale des Téléphones, and MM. Ch. Mildé, Fils et Cie., of Paris, have exhaustive exhibits of all things appertaining to telephonic work. The Spanish official section is of great historic interest; everything relating to telegraphic and telephonic enterprise in the Peninsula from the earliest days of their introduction being carefully exhibited. The Barcelona Institute sends several noteworthy exhibits, amongst which I noticed a monster pile of Leyden jars of all shapes and sizes. A varied display of electro-medical apparatus is made by Messrs Meyer and Metzer, of London. Messrs. J. E. Spagnoletti and Crookes have, at present, a very incomplete stall; they only show what they call an electrical fire-announcer, about which mysterious exhibit no information is to be obtained. Finally, three large electric organs are to be seen in the Fine Art Gallery; they are made by Señor Aquilluo Amerzna, of Barcelona, and are a very praiseworthy piece of work.

These are the chief electrical exhibits at Barcelona, and I must say, considering all things, the display is by no means unworthy of the first international fair which has ever been held on Spanish soil.

REVIEWS.

Eclairage a l'Electricite: Renseignments Pratiques. By HIPPOLYTE FONTAINE. Second Edition. (Paris: Baudry et Cie., 1888.)

Although this is nominally a "second edition," yet when we mention that the work made its first appearance in 1879, and that in the 688 pages of the volume now before us the whole subject of electric lighting is, with some few exceptions, brought well up to date, enough has been said to show that the author has practically given us a new work under an old name. There is no existing book in the English language which covers quite the same ground as this of M. Fontaine. Of elementary text-books and introductory treatises, in which the leading facts and principles of electrical science are more or less cursorily traversed, we have enough and to spare; books on electric lighting well adapted for amateur or "popular" audiences we also possess in sufficient number for our present need; nor do we even lack thoroughly technical treatises on particular branches of electrical engineering. But we have not at the present time any comprehensive work in which the subject of electric lighting is systematically treated, and which may be consulted with a reasonable probability of discovering the fact or the description of which we may be in search. This, however, is a position which for the French reader is very fairly well occupied by the work of M. Fontaine.

The introductory chapters have been greatly enlarged from the first edition; they are well and clearly written, whilst avoiding all but the most necessary and elementary mathematics. Nearly all the diagrams in these chapters have been specially drawn, and although some old friends are met with there is on the whole a refreshing novelty in the illustrations throughout the book. The chapter on the mechanical generation of the electric current is well conceived and explicit, and the sectional diagrams of the various types of field-magnets are convenient for reference, and are somewhat more numerous than can be met with elsewhere. The subject is not, however, viewed from the modern stand-point of the magnetic circuit, which indeed the French electricians seem very slow to adopt. The two chapters on arc and incandescent lamps in this section are full of interest, and much of the information here given is gathered together for the first time. This remark also applies to the succeeding chapter on photometry, which is full and accurate. We find, for instance, a summary of Mr. Dibdin's very able report* on the pentane standard.

The second part of the volume is devoted to a descriptive and historical account of dynamo machinery, arc and incandescent lamps, and methods and apparatus of distribution. In the first chapter, on continuous-current dynamos, the author affords considerable space to the early history of M. Gramme's invention, and some eight or nine different types of machines designed by M. Gramme at different dates are illustrated and described. All the best known machines made in this country are referred to; but the selection of American machines for description does not strike us as being the best that might have been made. M. Fontaine illustrates, amongst others, the Clarke dynamo, which for our own part we regard as a monstrosity, and of which he mildly and more politely remarks that it is "a little complicated, and possesses nothing extraordinary in the way of efficiency." The machine is, however, in use in the United States. M. Fontaine does not, in fact, cumber his pages with many actually obsolete types, although amongst this class we must distinguish the Elphinstone Vincent and the Bürgin, both of which are here illustrated. The numerous tables in this part of the book are evidently taken bodily from the price lists issued by the makers, and in fact the prices of machines of various sizes are in many cases quoted. We may add that the cheapest machine we have ever come across is one supplied by a Belgian firm for 45fr. The output is put down as 8 amperes at 70 volts; but we fancy the price quoted must be a misprint.

We have already said that the author does not consider the dynamo machine from the modern point of view, and conse-

* See *The Electrician*, Aug. 12th, p. 287, and 19th, p. 309, 1887.

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quently we find no data for establishing a definite comparison between the performances of any of the machines described.

The chapter on arc lamps is particularly good; we think it, in fact, the most valuable in the whole volume. No fewer than fifty-seven arc lamps, besides "candles" and "semi-incandescents," are here described, and the chapter contains sixty-six drawings and diagrams relating to about forty different lamps. The illustrations here, as all through, are beautifully clear, and the author spares no pains to make every detail of the mechanism perfectly intelligible. Very many of the lamps described as being in use on the Continent are little known in this country; such, for instance, as the Cance, the de Mersanne, and the Mondos in France; the Jaspar in Belgium; the Poege and the Kremensky in Germany. The de Mersanne is a very singular lamp; the carbons are placed horizontally, and are fed forward by grip wheels. The mechanism is somewhat complicated, but is said to work with great regularity. The lamp may be seen in action in the Plâce du Carrousel, in Paris. The classification adopted in this chapter, in which the author divides the lamps under the titles of the countries in which they are used, is distinctly misleading. Under the head of "Lamps used in England," we find only three names—Crompton, Lever, and Rogers. This last is a lamp which has hitherto escaped our observation. As for other lamps well known in this country, we have to look for them under the title of the country in which they originated: the Brush and the Thomson-Houston under the United States; the Siemens, Pilsen, and Gülcher under Germany, and so on. The Brockie lamp is relegated to a final section under the heading of *Appareils Divers*. We would suggest for the author's consideration, in view of later editions, the propriety of adopting a principle of classification for arc lamps based upon the leading principles of their construction. It would not be difficult to select a small number of leading types, to one or other of which, with a few exceptions, all lamps might be shown to conform. The attempt would, at least, be instructive. This chapter ends with a chronological table giving the dates of the principal inventions or improvements in arc lights, from the Foucault lamp of 1844 down to the Gramme lamp of 1861. From some reason or other the name of Duboscq has been omitted from the list.

The chapter on conductors contains a good deal of information on the Edison, Siemens, and Berthoud-Borel systems of laying and jointing underground wires. The three-wire system is briefly considered, and some attention is given to Prof. Elihu Thomson's ingenious method of carrying out the principle by means of single dynamo, the E.M.F. in the two halves of the circuit being automatically balanced by means of a motor-generator.* We notice, by the bye, that M. Fontaine repeats the common statement that the three-wire system effects an economy of 25 per cent. in the total weight of copper. In a Paper published in *The Electrician*, March 28th, 1885, p. 412, it was shown by the present editor of this journal that if the system be properly carried out the saving amounts to nearly 40 per cent., even when the third lead is of the same size as the other two.

In the chapter on transformers both alternate and continuous-current apparatus is dealt with. On the first-named subject the information is tolerably complete, considering the rapid rate at which the subject is still growing.

M. Fontaine is, we believe, in error in ascribing to Mr. Gordon the first use of an impedance coil for replacing an extinguished lamp on an alternating circuit. The idea is only of practical utility in connection with transformers worked in series, and it seems to have originated with Messrs. Sharp and Kent. What Mr. Gordon did was to place an impedance coil in series with an arc lamp so as to prevent a sudden rush of current if the arc failed to be struck.

Part III. is entitled "Prix de Revient," and although somewhat unconventional is one of the most interesting sections of the work. The author first considers the question of the efficiency of dynamos, conductors, and lamps, and calls attention to the progressive increase in the efficiency of dynamos up to the year 1886, since which period little has remained to be done in this direction. M. Fontaine has himself carried out some valuable experiments on the efficiency of arc lamps, and he finds that with a continuous current the mean intensity may be taken as approximately equal to double the horizontal intensity. The results of the Philadelphia tests on arc lamps, and the Munich tests on incandescents, are also summarised. In the next chapter the "cost of an installation" is considered. Twenty years ago a dynamo machine with an output of 2,500 watts cost about 4fr. per watt; in 1881 the price ranged from 0·5fr. up to 2fr. per watt; while to day the Gramme dynamos of the "type supérieur" cost only 0·28fr. per watt. In England, we may add, a machine of this size would probably cost at the present time rather less than £10 per unit, or, say, 0·25fr. per watt. We are next furnished with a table showing the price of 28 different types of arc lamps. Unfortunately, the current which each lamp is designed to take is not given. The prices quoted vary from 300fr. down to 125fr., the average being about 190fr. Average prices are then quoted for incandescent lamps, switches, fuses, conductors, ammeters, and voltmeters, &c. The author next gives the cost in detail of some actual installations carried out in France at various dates.

The cost of arc lighting in France at the present time for an installation of 30 lamps of 1,500 candle-power is taken at 500fr. per lamp, or 33fr. per candle-power, but this is for the electrical plant alone. Some very detailed estimates, from recent practice in incandescent lighting, are furnished, the results coming out as follows:—

No. of 16 candle-power lamps.	Total cost of electric plant per lamp.
30	61·87fr.
60	54fr.
120	51·29fr.
250	47·56fr.

The style of fittings allowed for may be gathered from the fact that 6fr. per lamp is allowed for brackets, &c. Somewhat lower figures are quoted for "industrial" installations. Roughly speaking, the actual cost may be about doubled when engines and boilers are taken into account. In Paris, however, where the Popp system of distributing motive power by compressed air is so widely extended, probably not more than about 60 or 70 per cent. would be added to the first cost for motive power. The chapter ends with a very short paragraph on accumulators, which commences with the significant words: —"We do not look upon the accumulator as an industrial apparatus. . . . ."

The chapter following deals with working cost. The value of a (French) horse-power hour is quoted as follows:—

0·01fr. to 0·03fr. for water.
0·03fr. to 0·15fr. for steam.
0·35fr. to 0·60fr. for gas.

In Paris the average value may be taken at 0·1fr. for steam with engines of from 25 to 100 horse-power, and 0·5fr. for gas engines of from 4 to 25 horse-power. M. Popp's tariff is not quoted.

After dealing with the cost of carbons and renewal of incandescent lamps M. Fontaine works out the average running cost as follows:—

For an installation of 20 arcs, each of 1,250 candle-power, burning 2,000 hours per annum, and assuming that the electric plant cost 500fr. per lamp, and that the mechanical plant amounts to the same total, and taking interest and depreciation at 10 per cent., the annual cost would be 16,800fr., or 0·42fr. per lamp hour. The consumption of carbon is taken at the rather large rate of 80mm. (3·15in.) per hour; this, however, includes the ends wasted in the holders.

For an installation of 200 incandescent lamps of 16 candles, working 1,500 hours per annum, driven by steam, and valuing the electric plant at 42·82fr. per lamp the cost would be 11,034fr. per annum, or ·0366fr. per lamp-hour. These figures, as might be expected, agree very fairly with average English practice, and for that reason we think it the more useful to quote them. It may be added that the cost of engine plant in the last case is taken at 17,500fr., which would perhaps be a little high for this country.

Passing over some highly interesting and detailed descriptions of theatre lighting, we come to the important subject of

* See *Electrician*, May 13th, 1887, p. 9.

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Central Stations, to which, however, only some 38 pages are devoted. The author's remarks on the causes for the comparative failure of central station lighting in Europe, as compared with the remarkable success achieved in the United States, are of a highly judicious character. He points out the fact, which is often overlooked, that light for light a central station must necessarily cost more to install than a private installation (except when the latter is of the smallest dimensions). Not only is the cost of distributing plant entirely disproportionate, but the ratio of total plant to mean-plant-in-use (if we may be allowed the phrase) is far higher. To this has to be added rent of buildings, expenses of management, &c., so that while central station distribution is, of course, an enormous convenience, and brings the electric light within reach of hundreds of people who would never dream of laying down a private installation, yet, as a rule, electric lighting companies will not be able to supply current at a cheaper rate than that at which in fairly large buildings it can be generated on the spot. We also find ourselves in emphatic agreement with M. Fontaine when he says that the attempt to compete in price with gas is a fallacious and a mistaken policy. The electric light is essentially a luxury, and as soon as that fact is fully realised it must and will be paid for as other luxuries are paid for, without demur. To talk about reducing the cost to that of gas is simply to defer the time when people will be willing to accept it at its proper valuation. People do not hesitate to burn wax candles because they cost more than tallow. Just so it will be eventually with the electric light; the only especial and inherent difficulty which arises in the latter case is that at present, while the taste is still being developed, it is not always easy to find a sufficiently large number of people by whom it has already been acquired, and who happen to live in sufficient proximity to justify the commencement of operations at a really remunerative tariff.

We fear that M. Fontaine is justified in complaining that many of the central stations which already exist in Europe leave much to be desired in several important respects; the *matériel* is not used to the best advantage, the organisation is often defective, the expenses are unnecessarily high, and the record of breaks-down is by no means a creditable one.

The author does not furnish anything like an exhaustive account of any existing central station. Some details are given respecting the two Edison stations at New York, which are now supplying a total of 13,000 lamps, and employing a staff of 31 persons. We learn that for the year 1886 the total working expenses amounted to 397,482fr., or 30·57fr. per lamp of 16 candle-power; but this does not include interest or depreciation charges. The arc lighting at Detroit and Minneapolis is also briefly dealt with.

Returning to Europe, the author describes the lighting of the harbour at Havre and the Edison station at St. Etienne at some length; he also discusses the various attempts which have been made to establish central stations in Paris on a permanent basis. Only two of these are in existence at the present moment, namely, that of the Cité Bergère, which is now supplying some 1,400 lamps in the neighbourhood of the Boulevard Montmartre, and that of the Plâce du Carrousel, where a small number of arcs are to be seen. The rest of the chapter contains a general survey of the state of things in the French provinces, in Germany and in Italy; but although the information given is instructive and interesting, we fail to find anything of special value with which the readers of this journal have not already had an opportunity of becoming acquainted. Singularly enough, no mention whatever is made of central lighting stations in this country.

The remaining pages deal with the application of electricity in navigation, and with the use of primary batteries for "domestic lighting."

Here we must take our leave of this important work, and although the limit of our space has hindered us from dealing with the volume as fully as its merits deserve, yet we trust that what has been said will have been sufficient to show that from beginning to end it is crammed with information of value to the electrical engineer. The work is one which cannot fail to add to the already very high reputation of its author.

A REVIEW OF THE PRESENT CONDITION OF THE THEORY OF THE ELECTROLYSIS OF SOLUTIONS.*

BY F. KOHLRAUSCH.

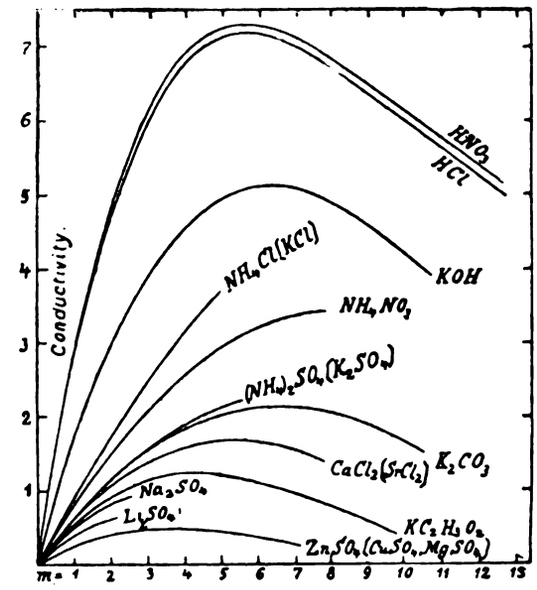
(Concluded from page 467.)

10. *General Facts Relative to Conductivity.*—If water be added to an electrolyte the conductivity at first increases with the strength of the solution. As a necessary consequence, however, of the general law that pure fluids are bad conductors, the conductivity must reach a maximum when a certain definite strength has been attained, after which the addition of more of the electrolyte will diminish the conductivity, and this is found to be the case with all sufficiently soluble bodies. In connection with this, it is always found that from the beginning of solution the conductivity increases less rapidly than the strength of the solution.

11. *Examples.*—Fig. 2 shows the curves obtained for a number of substances where the molecular strength m of the solution is taken as abscissa, and the corresponding conductivity as ordinate.

These curves, although representing the conductivity of very different substances, are clearly of the same general character. (These curves are for the most part taken from a Paper by the author in Wiedemann's *Annalen*, Vol. VI., p. 148, and Tables I. and II., 1879. They are drawn for a temperature of 18°, and each millimetre of the ordinates represents a millionth of the conductivity of mercury. The best conducting electrolytes have, at ordinary temperatures, a conductivity equal to about $\frac{1}{14000}$ of that of mercury.)

Fig. 2.



The principal point brought out by the diagram is that similarity of chemical constitution carries with it a similarity in the march of the conductivity. (If the strengths of the solutions be given in terms of percentage composition instead of in terms of the chemical equivalents, this general similarity in the curves will disappear, they will cut each other frequently, and there will no longer be an agreement between the curves corresponding to bodies of similar chemical constitution, thus giving an additional proof of the fact that the chemical equivalent is the natural unit of measurement in electrolytic actions.)

Salts of ammonium and of potassium behave so nearly alike that, on the scale of the diagram, their curves cannot be distinguished. The sulphates of magnesium, zinc, and copper are also represented by the same curve. The mono-basic mineral acids, hydrochloric, hydrobromic, hydriodic, and nitric, almost coincide. There is very little difference also between the behaviour of the salts which these acids form with the same metal.*

12. *Influence of Temperature.*—Electrolytes differ from metals—firstly, in that their conductivity increases instead of diminishing with increase of temperature, and, secondly, in that the effect of temperature is much greater in their case, the conductivity at 40deg. being on an average double that at 0deg. The increase is generally fairly regular. The relations described in §11 are not

* *See* F. Kohlrausch and Grotrian, Poggendorff's *Annalen*, Vol. CLIV., p. 236, 1875; F. Kohlrausch, *ib.*, Vol. CLIX., p. 268, 1876; Wiedemann's *Annalen*, Vol. VI., p. 148, 1879.

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altered by change of temperature, as it is found that substances which behave in nearly the same way at any one temperature undergo similar changes when the temperature varies, so that if the curves coincide at one temperature they will continue to do so when the temperature is changed.

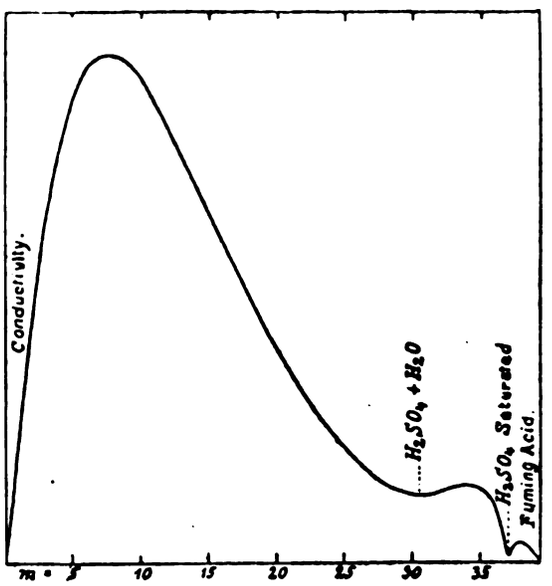
All dilute solutions exhibit about the same change in conductivity with change of temperature, in general about $\frac{1}{38}$ to $\frac{1}{46}$ per degree, but the hydrogen compounds, alkaline hydrates, acids, and acid salts vary to a somewhat less amount, about $\frac{1}{70}$ to $\frac{1}{100}$.

A remarkable general law, deduced from these investigations, is that the conductivities tend toward equality as the temperature increases.*

13. *Sulphuric Acid.*—The behaviour of sulphuric acid (Fig. 3) is instructive in several ways. The conductivity, as in the case of other substances, increases at first less rapidly than the degree of concentration until a maximum is reached, when the solution contains about 30 per cent. of H_2SO_4 or $m=8$. From this point the conductivity diminishes, and attains its lowest value with the concentrated acid, fuming H_2SO_4; but the decrease is not regular, but reaches a minimum when the solution contains about 85 per cent. of H_2SO_4; it then undergoes a slight increase, after which it decreases more rapidly than before, until the solution consists of concentrated H_2SO_4.

The minimum value occurs when the relative proportions of acid and water are those which form the crystallisable chemical compound $H_2O+H_2SO_4$, confirming our former conclusion that the conductivity is less for a chemical compound than for a mixture.

Fig. 3.



The conductivity is much less again for the more stable compound H_2SO_4. If anhydrous sulphurous acid (SO_3) be now added to the concentrated H_2SO_4 the conductivity will again increase slightly, and finally fall almost to zero.

The two minima corresponding to $H_2O+H_2SO_4$ and H_2SO_4 being no less than the values observed is in agreement with the known fact that these compounds are not very stable even at ordinary temperatures, and that hence, through dissociation, they contain separated water.

The curve for sulphuric acid does not coincide with those for nitric acid and hydrochloric acid, which fact affords a confirmation of the chemical theory which assigns to the former (dibasic) acid a different constitution from that of the other two. In the case of extremely dilute solutions, however, the curves show a much greater similarity, from which it would appear that when sulphuric acid is largely diluted with water it tends towards the constitution of a monobasic acid.

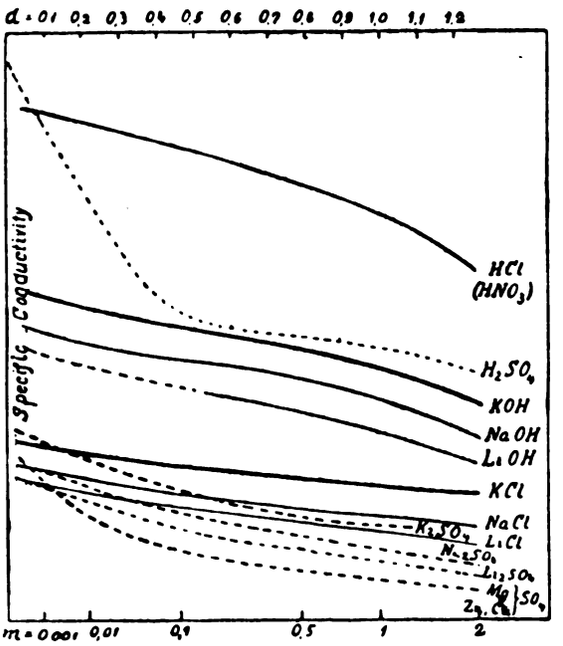
14. *Influence of Viscosity on Internal Friction.*—There is indisputably a connection between the electrical resistance and the mechanical viscosity of solutions. In the first place, namely, a series of salts arranged in order of conductivity agrees in general with the series arranged in order of fluidity.†

The maximum value of the conductivity is also generally attained sooner in the case of electrolytes of greater viscosity than in the case of those of less, and again we find, for example, that the minimum conductivity of sulphuric acid (§ 13) corresponds to a maximum value of the viscosity. Lastly, there is found to be a remarkable agreement between the effects of decrease of temperature on the viscosity and on the electrical resistance. Both of these are, in the first place, of the same order of magnitude, and secondly, different electrolytes, arranged according to the two effects, give approximately the same series.*

As is well known, endeavours have been made to determine the absolute magnitude of molecules from various optical, thermal and mechanical properties of bodies. According to these investigations, for example, a milligramme of water contains from 10 to 20 millions of molecules. Now the moving force due to the difference of potential in a circuit may be expressed in mechanical measure. Making the assumption that the electrolytic friction is of the same order of magnitude as the mechanical friction, the requisite thickness of a single layer of molecules in order to give the resistance actually observed can be calculated, and the order of magnitude of a molecule determined in this way agrees with the results obtained by methods.†

A number of instances are known in which substances continue to conduct electrolytically, even when they become solid. In reference to this, it is noteworthy that if a solution be solidified by the addition of gelatine, very little effect is produced on the conductivity.‡

Fig 4.



This result does not tend in any way to disprove the existence of a relation between viscosity and electrical resistance, for mechanical rigidity and viscosity are by no means identical properties, and moreover gelatinous bodies are not homogeneous.

15. *Specific Conductivity, Linear Molecular Density.*—If the conductivity were proportional to the number of electrolytic constituents in a given volume the curves of Fig. 2 would necessarily be straight lines. The curvature of these lines shows that the molecules introduced later do not increase the conductivity in the same extent as those introduced earlier. These relations may be shown most clearly by the following modification of our former method of representation.

In the first place, instead of taking the values of the conductivity k, we will take the values of the ratio of the conductivity to the number of electrolytic molecules m in unit volume of the solution—viz., the specific conductivity of the electrolyte in the solution. This quantity k/m may clearly be regarded as the rate of

* F. Kohlrausch, Wiedemann's *Annalen*, Vol. VI., pp. 191 and 196, 1879.

† G. Wiedemann, Poggendorff's *Annalen*, Vol. XCIX., 1856, p. 228; Grotrian, Poggendorff's *Annalen*, Vol. CLVII., 1876, p. 237. Experiments which have been carried out at my suggestion by Herr Kreichgaller on a number of similar solutions ($m=$) give almost identical series in order of viscosity and of electrical resistance respectively. This result has been confirmed by Arrhenius, British Association Report, 1886, p. 387.

* Grotrian, *ibid* and Vol. CLX., 1877, p. 238, and Wiedemann's *Annalen*, Vol. VIII., 1879, p. 529; Stephan, Wiedemann's *Annalen*, Vol. XVII., 1882, p. 673.

† F. Kohlrausch, Wiedemann's *Annalen*, Vol. VI., 1879, p. 207.

‡ Buff, Liebig's *Annalen*, Vol. XC., 1854, p. 257. Beetz, Poggendorff's *Annalen*, Vol. XCII., 1854, p. 457; Jubilee Volume, 1874, p. 23; E. Wiedemann, *ibid.*, Vol. CLIV., 1875, p. 318; W. Kohlrausch, Wiedemann's *Annalen*, Vol. XVII, 1883, p. 642; Warburg, *ibid.*, Vol. XXI., 1884, p. 622, and others. Also Arrhenius, British Association Report, 1886, p. 344.

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migration of the electrolytic constituents. Secondly, instead of expressing the strength of the solution in terms of the number, m, of electrolytic molecules in units of volume, we will measure it by the linear density, d, of these molecules—viz., by the number of molecules intersected by a line of unit length in the solution.*

This linear density, therefore, will be taken as abscissa in Fig. 4, and the specific conductivity k/m as the ordinate.

The approach of the curves towards the axis of abscissæ, like the curvature in Fig. 2, shows that the rate of migration k/m decreases as the density increases. The present method of representation shows that in the case of many electrolytes this decrease is very nearly proportional to the linear density. An approximate expression for the conductivity k as a function of m, the strength of the solution, is therefore, in the case of these substances, given by the formula

$$\frac{k}{m} = a - b m^{\frac{1}{4}}.$$

In the case of sulphates, especially those of magnesium, zinc, and copper, the decrease is greater when the solution is very dilute than later. Sulphuric acid itself behaves quite abnormally, its curve apparently consisting of two distinct portions.†

16. *Relation between the Conductivity and the Migration Coefficients.*—If we compare the conductivities as represented in Fig. 4, confining our attention for the moment to the positive ions, we see that the best conductors are the hydrogen compounds or acids. The conductivities of salts are considerably less, and in descending magnitude; they are throughout in the order K or NH_4, Na, Li. This order also holds good for the hydrates. Referring now to Fig. 1, and considering the group of chlorine compounds, we see that the velocity of the hydrogen is relatively much greater than that of the chlorine; after hydrogen comes potassium, then sodium, and lastly lithium. Other compounds containing these elements behave in the same manner; for example, the nitrates and sulphates. The three hydrates, KOH, NaOH, LiOH, also occur in the same order.

If we now turn our attention to the negative constituents, we see that for salts of a given metal those formed with OH are the best conductors, then the chlorine salts, and so on, the acetates coming much lower down, as shown in Fig. 2 in the case of $KC_2H_3O_2$. Fig. 1 shows clearly that the length of path traversed by the negative constituent, measured in the figure from the lower boundary, has the greatest value for OH, is less for chlorine, &c., and least for $C_2H_3O_2$.

We may sum up these facts in the statement that hydrogen is the element which travels with the greatest facility, then follows K, then Na, and lastly Li. Of the negative constituents, the rate of motion of OH is the greatest, then follows Cl, &c., and lastly comes $C_2H_3O_2$.

The conductivity is obtained by adding together the separate speeds of the ions.

17. *Definite Speeds of Ions in Dilute Solutions.*—In the case of dilute solutions of electrolytes with monovalent acids, these results admit of a simple quantitative expression, viz., every constituent possesses a certain definite speed of its own, whatever be the compound in which it occurs.‡

The numerical values of some of these ionic speeds are given below, for a concentration for which $m = 0{\cdot}1$, this value being taken since very few of the numbers have been determined for more dilute solutions. This value of m corresponds to from 1¼ to 2 per cent. by weight of salt, according to its equivalent weight.

K	NH_4	Na	Li	Ag	H	Ba	Mg	Ln
+51	50	33	25	42	272	31	25	24

Cl	I	NO_3	ClO_3	$C_2H_3O_2$	OH
−54	54	48	43	27	146

Adding the speeds of the two constituents of a salt, we obtain its specific conductivity for $m = 0{\cdot}1$; for example

KCl	51+54=105
$AgNO_3$	42+48= 90
$NaC_2H_3O_2$	33+25= 58
HCl	272+54=326

The relative distances traversed by the ions are obtained by division; for example

$K/Cl = 51/54$; $Ag/NO_3 = 42/48$; $K/C_2H_3O_2 = 51/27$; $H/Cl = 272/54$.

The numbers thus obtained are found to be in close agreement with those determined by experiment. Thus Ostwald* has experimented upon a large number of acids and salts, and has confirmed the law of definite speeds. According to his researches the speeds of compound acid radicals are in general smaller. For example, he finds for the radicals of the fatty acids:—

Formic Acid.	Acetic Acid.	Propionic Acid.
CHO_2	$C_2H_3O_2$	$C_3H_5O_2$
−37	−27	−23

Butyric Acid.	Valerianic Acid.
$C_4H_7O_2$	$C_5H_9O_2$
−20	−18

Multivalent acids and their salts cannot at present be included in this system. When more extended observations have been made on extremely dilute solutions this restriction may possibly be removed.

18. *Absolute Velocity of the Ions.*—By means of the above numbers, which represent 107 times the specific conductivities referred to mercury units, the absolute velocities of the ions for a given slope of potential may be determined when we know the electrochemical equivalent, and the ratio of the ohm, to the Siemens, or mercury unit. For example, let the slope of potential be 1 volt per millimetre, then the absolute velocities of the ions in the direction of the current will be obtained in millimetre-seconds by dividing the tabular numbers by 900.† Doing this we get for hydrogen 0·3, for potassium or chlorine 0·06, and for lithium 0·028 millimetre-seconds. These numbers are of course for $m = 0{\cdot}1$, and for very dilute solutions they would be some 10 to 20 per cent. greater.

It is evident that the electrolytic movements cannot be regarded as of such a nature that all the constituents should have identical velocities at any given moment. There may be only one, or more probably a very limited number moving at any one time in the direction of the current. Their velocities, too, will by no means be all equal, and may not be at any time in the direction of the fall of potential, since there are other molecular motions to be considered. The above numbers, therefore, represent merely the mean values of the velocity components, in the direction of the current, of all the constituent molecules. This, however, is all that can be determined or that has to be considered in reference to the total strength of current.‡

Recently, the theory has been broached that in the case of extremely dilute solutions all aqueous solutions of the same molecular strength conduct equally well, and that, therefore, the velocities of both the ions must be equal.§ This simple relation is, however, by no means proved; indeed, all the known facts are strongly opposed to it. A point worthy of special attention is that some substances, such as sulphates and sulphuric acid, which in the case of strong solutions are bad conductors, become more like other substances when greatly diluted.‖

Before the true significance of this fact can be understood, we must know more about the part played by water in dilute solutions.

19. *Conductivity and Diffusion.*—Electrolysis depends on the differences in the motion of the constituent molecules. The dispersion of entire molecules through a liquid is known by the name of diffusion, a phenomenon which is really caused by the molecular motions due to heat. It is well known that different substances have very different diffusibility in water, and it is an interesting fact that electrolytes which are good conductors are for the most part substances which diffuse rapidly; and the converse also holds. It follows that those substances which allow great freedom of motion to the constituent molecules are in general those in which the entire molecules move most freely.¶

20. *Conductors of a Lower Order.*—A large number of hydrogen compounds, both acids and bases, exhibit an incomparably lower conductivity than those hitherto considered; for example, on the one hand, sulphide of hydrogen, prussic acid, boracic acid, carbonic acid, and acetic acid; on the other, ammonia and many organic substances of both classes. Aqueous solutions of these bodies conduct in general so many times less than the others that no comparison can be made between them; for example, the best conducting solutions of acetic acid or ammonia have a conductivity some 500 times less than that of the mineral acids and alkaline

* d will have the value $\sqrt[3]{m}$. F. Kohlrausch, Wiedemann's *Annalen*, Vol. XXVI., 1885, p. 197, and Plate II.

† The earlier portions of the curves, particularly those for acids and bases, have been drawn on the assumption that the downward concavity observed in these earlier portions is due to secondary causes. F. Kohlrausch, *ibid.*, p. 198, and Plate II. With regard to the behaviour of dilute solutions, *see* Lenz, "Mémoirs de St. Petersburg," Vol. XVII., 1878; Arrhenius, *Bihang Svenska Vet.-Akad. Handl.*, Vol. VIII., 1884; Bouty, *Annales de Chemie et de Physique*, sixth series, Vol. III., 1884; Ostwald, *Journal für Practische Chemie*, Vol. XXX., 1884, p. 226, Vol. XXXI., 1885, p. 437, and Vol. XXXI., 1885, p. 300.

‡ F. Kohlrausch, Wiedemann's *Annalen*, Vol. VI., 1879, p. 163, and Vol. XXVI., 1885, p. 213.

* "Zeitschrift für Physikalische Chemie," Vol. I., 1887, p. 74.

† F. Kohlrausch, Wiedemann's *Annalen*, Vol. VI., 1879, p. 202. O. J Lodge has given a simple method of determining the velocities directly in the B.A. report for 1886, p. 389.

‡ *See* Clausius, Poggendorff's *Annalen*, Vol. CI., 1857, p. 347.

§ Bouty, *Annales de Chémie*, 2nd Series. Vol. XII., 1884.

‖ Lenz, "Mémoires de St. Petersburg," Vol. XVII., 1878, and Bouty in Paper previously referred to.

¶ Long, Wiedemann's *Annalen*, Vol. IX., 1880, p. 613.

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hydrates. With one another, however, these acids and bases give salts, acetate of ammonia, for example, whose conductivity is not inferior to that of the salts previously considered.

In connection with this the following facts have been observed, which may lead to an explanation of the phenomenon.

In the first place this great difference disappears in the case of very dilute solutions.* A trace of acetic acid or ammonia dissolved in water gives a conductivity of the same order of magnitude as an equivalent quantity of a good conductor. A numerical investigation of this important phenomenon is difficult, owing to the impossibility of obtaining perfectly pure water.

21. *Conductivity and Rapidity of Chemical Reaction.*—In the second place, an interesting relation is found to exist between the conductivity and the chemical activity of these substances. Acids are called strong acids when they act rapidly ; for example, hydrochloric acid, sulphuric acid, nitric acid, &c. The action of acetic acid is much less rapid. This rapidity of reaction can be determined by observing the time taken to cause conversion of cane sugar or some other similar slow operation. Observations have shown that the conductivity of acids and bases is closely related to the rapidity of their chemical reactions.†

22. *Dissociation. Active Molecules.*—A theory to account for the simultaneous increase of the rapidity of chemical reaction and of the conductivity may be deduced from a hypothesis proposed some time back by Clausius.‡ The forces of chemical affinity are, without doubt, of great strength. Suppose, then, that an electrolyte is composed of molecules firmly bound together by chemical affinity, then we should expect that electro-chemical decomposition could only begin when the electrical separating force attained a certain value. On the other hand, this deduction seems to be disproved by the fact that Ohm's law is obeyed by electrolytes, and that decomposition begins with any E.M.F., no matter how small (compare §9). Clausius assumes, therefore, that an electrolyte is not in such a condition of stable equilibrium, but that of the dissolved molecules a certain number are dissociated, probably by the action of the water, and that these free molecules are the first which are acted on by the electrical forces, and that the decomposition then extends by interchanges to the others.

In this case the degree of dissociation, measured by the number of free molecules, would be of the greatest importance relatively to the conductivity. If we now make the further assumption that the chemical action also of an acid, &c., starts, not from the molecules in combination, but from the dissociated molecules, which would therefore be the really "active molecules," then the relation between conductivity and rapidity of chemical reaction at once become explicable.§

The scientific goal of the theory of electrolysis is the explanation of electro-chemical phenomena by means of mechanical actions, and their reduction to mechanical or electro-mechanical laws.

In the foregoing Paper a number of data have been given by means of which we may endeavour to reach this goal. Its attainment would be of even more importance in relation to molecular physics and chemistry than for its own sake simply.

The true nature of solution is still shrouded in darkness, nor do we know any more about the ultimate nature of chemical forces. There can be no doubt that there exists a close connection between these forces and electricity.

Electrolysis is one of the simplest and most powerful means which we possess for learning more about the nature of matter. The borderland of chemistry and physics now offers a field of research which promises to be fruitful in results of the greatest importance.

* F. Kohlrausch, Poggendorff's *Annalen*, Vol. CLIX., 1875, p. 263 ; Wiedemann's *Annalen*, Vol. VI., 1879, p 189 ; *ibid*, Vol. XXVI., 1885, p. 205 ; Ostwald, *Journal für Practische Chemie*, for 1885, Vol. XXXI., p. 437 and Vol. XXXIII., p. 300.

† Arrhenius, *Bihang Svenska Vet-Akad*, Vol. VIII., p. 12. Ostwald, *Journal für Practische Chemie*, Vol. XXX., 1884, p. 93.

‡ Clausius, Poggendorff's *Annalen*, Vol. CI., 1857, p. 338.

§ Arrhenius, memoir cited, p. 5.

The India-Rubber Trade of Upper Burmah.—Mr. Warry, of the British Consular Service in China, and at present political officer at Bhamo, has made an interesting report on the india-rubber trade of the Mogung district. Rubber was first exported from Upper Burmah in 1870, and until 1873 the trade was free to all. Since then the forests have been worked by five Chinese firms, who employ the Kachins in tapping the trees. In the present year the sale of the right to work the forests produced a lakh of rupees. In spite of plentiful blackmailing and transit difficulties, the trade is a very paying one to the *concessionnaires*.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER IX.—*Magnetic Fields.*

(Continued from page 476.)

125. *The Moment of a Magnet Measured by its Field.*—The two methods, due to Gauss, by which the moment of a magnet may be determined can now be easily understood. By the first method the magnet is placed so that its normal line (para. 121) is in the same magnetic meridian as the magnetometer needle, the distance between the centres of the needle and magnet being known. In Fig 96, let the circle represent the magnetometer in plan, properly mounted and adjusted. A wooden table, A, is placed close to the magnetometer board, its surface being marked out in cross lines indicating distances in centimetres from the centre of the suspended needle, and its height such that magnets placed on it are in the same horizontal plane as the needle. The line drawn longitudinally along the centre of the table must lie in the magnetic meridian, and be the continuation of the line joining the zero points on the scale (the line *m m*, Fig. 94) ; the suspended needle will then lie in the same line before any magnet is placed on the table.

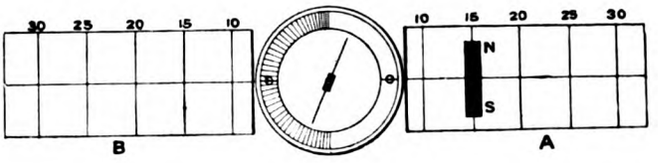

FIG 96.

Now let a magnet, N S (Fig. 96), whose moment is to be determined be placed on the table, so that its polar line agrees with one of the cross lines at a certain distance from the needle, and its normal line coincides with the central line along the table. The magnetometer needle is then deflected, and the natural tangent of the angle of deflection is the scale reading divided by 100 (para. 123). Now, in the region of the needle we have two fields (H of the earth and f of the magnet) superposed at right angles to each other, and by para. 119 the ratio of f to H is the tangent of the angle a between H and the resultant field. That is,

$$f = \mathrm{H} \tan a \text{ (in C.-G.-S. units),}$$

the angle a being that moved through by the magnetometer needle from its position of rest in the field H. Also the intensity of field on the normal line of a magnet at a point r centimetres from either pole has been shown to be the moment of the magnet divided by r^3 (para. 120) ; that is—

$$f = \frac{\mathrm{M}}{r^3} \text{ (in C.-G.-S units).}$$

From these two values for f we obtain the relation

$$\frac{\mathrm{M}}{r^3} = \mathrm{H} \tan a ;$$

whence

$$\mathrm{M} = r^3 \mathrm{H} \tan a.$$

The only observations to be made, then, are the tangent of the angle of deflection and the distance r. Knowing the distance d of the magnet from the needle, we have (para. 120)

$$r^2 = d^2 + \left(\frac{l}{2}\right)^2 ;$$

whence

$$r^3 = \left[d^2 + \left(\frac{l}{2}\right)^2 \right]^{\frac{3}{2}},$$

where l is the length of the magnet.

In order to eliminate error in placing the magnet, or in observing the deflection, another observation is taken with the magnet reversed on table A giving the deflection on the opposite side of zero. Again, the table is moved to the other side B, where two similar readings are taken. It is better to have two

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tables, carefully adjusted and fastened down in position so that a number of observations may be taken of different magnets without altering that adjustment. All screws or clamps used in the making of the tables or securing them in position must be of brass, not of iron.

The sum of the four readings so taken divided by four gives the mean deflection, which is then used in the calculation.

Example.—(1) Determination of the moment of a galvanometer controlling-magnet. (Fig. 65.) Mean of four observations, 60 divisions on the tangent scale, distance between centres 30 centimetres. Whence tan $a = \cdot 6$,

$$r^3 = (30^2 + 7\cdot5^2)^{\frac{3}{2}} = (956\cdot25)^{\frac{3}{2}},$$

and H being ·18 C.-G.-S. units, we have

$$\text{Moment} = (956\cdot25)^{\frac{3}{2}} \times \cdot18 \times \cdot6.$$

This is most readily worked by logarithms thus:—

$$\log (956\cdot25)^{\frac{3}{2}} = \frac{2\cdot9806 \times 3}{2} = 4\cdot4709$$

$$\log \cdot18 = \bar{1}\cdot2553$$

$$\log \cdot6 = \bar{1}\cdot7782$$

$$3\cdot5044 = \log 3194$$

The required moment is therefore 3,194 dyne-centimetres, and the distance between the poles of this magnet being 15 centimetres, the strength of each pole is

$$\frac{M}{l} = \frac{3194}{15} = 213 \text{ C.-G.-S. units.}$$

(2) A compound horseshoe magnet (Fig. 62), consisting of 8 separate magnets and measuring 8·8 centimetres between the centres of its poles, gave a mean of 131 divisions. Distance between centres 35 centimetres. Its moment was therefore—

$$(35^2 + 4\cdot4^2)^{\frac{3}{2}} \times \cdot18 \times 1\cdot31 = 10{,}351 \text{ dyne-centimetres}$$

and strength of pole $= \frac{10351}{8\cdot8} = 117\cdot6$ C.-G.-S. units.

(3) A powerful steel bar magnet 1 foot in length (30·48 centimetres), gave a mean of 87·5 divisions. Distance between centres 45 centimetres.

Its moment was therefore

$$(45^2 + 15\cdot24^2)^{\frac{3}{2}} \times \cdot18 \times \cdot875 = 16{,}890 \text{ dyne-centimetres,}$$

and strength of pole

$$\frac{16890}{30\cdot48} = 554 \text{ C.-G.-S. units.}$$

(4) A similar sized magnet under the same conditions gave a mean of 83·25 divisions. Hence its moment (by comparison with the preceding) was—

$$16890 \times \frac{\cdot8325}{\cdot875} = 16{,}070 \text{ dyne-centimetres,}$$

and strength of pole

$$= \frac{16070}{30\cdot48} = 527 \text{ C.-G.-S. units.}$$

By the second method of Gauss the magnet is placed so that its polar line passes through the centre of the magnetometer needle at right angles to the meridian, the distance between the centres of the needle and magnet being known.

The table must therefore be placed at right angles to its former position, as in Fig. 97, in which the magnetometer needle is shown deflected by a magnet. One reading is taken with the magnet placed as shown, a second reading with the magnet reversed, and two similar readings with the table placed on the other side of the magnetometer, the mean of the four being finally taken.

Now, in para. 120 it was shown that the intensity of field f at a point on the polar line of a magnet situated d centimetres from its centre was expressed by

$$f = \frac{2M}{d^3\left(1 - \frac{l^2}{4d^2}\right)^2},$$

and in para. 119 the ratio of two magnetic fields of intensity f and H superposed at right angles to each other was shown to be equal to the tangent of the angle a between H and the resultant; that is—

$$f = H \tan a;$$

whence, equating these two values of f,

$$\text{magnetic moment (M)} = H\frac{\tan a}{2} d^3 \left(1 - \frac{l^2}{4d^2}\right)^2.$$

Example.—(1.) A small bar magnet, 10·3 centimetres long, gave a mean deflection of 105·5 divisions, the distance between centres being 20 centimetres. Its moment was therefore

$$\cdot18 \times \frac{1\cdot055}{2} \times 8000\left(1 - \frac{106\cdot09}{1600}\right)^2$$

$$= \cdot18 \times \cdot5275 \times 6978\cdot8$$

$$= 662\cdot6 \text{ dyne-centimetres.}$$

(2). The same magnet was placed with its centre at 30 centimetres distance from the centre of needle. The mean deflection was then 29 divisions; the moment was therefore

$$\cdot18 \times \frac{\cdot29}{2} \times 27000\left(1 - \frac{106\cdot09}{3600}\right)^2$$

$$= \cdot18 \times \cdot145 \times 27000 \times \cdot9419$$

$$= 663\cdot7 \text{ dyne-centimetres.}$$

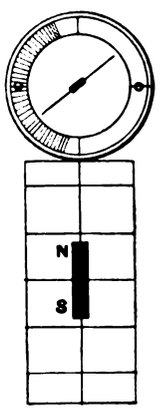

FIG. 97.

This last was taken to check the former reading, the mean of the two results being 663 dyne-centimetres, and

$$\text{strength of pole } \frac{663}{10\cdot3} = 64\cdot3 \text{ C.-G.-S. units.}$$

(To be continued.)

BOOKS, &c., RECEIVED.

"*Proceedings* of the Royal Society." Vol. XLIV., No. 270. (London: Harrison and Sons.)

"Information on the Patent Law of Great Britain, Ireland and the Isle of Man." By W. FAIRBURN HART. (London).

"Dynamo-Electric Machinery." A Manual for Students of Electrotechnics. By SILVANUS P. THOMPSON, D.Sc., B.A. Third edition, enlarged and revised. (London: E. and F. N. Spon.)

"Mrs. Peter Purdie, of Selkirk, and the Telephone." By A. Bee.

Tapping the Telegraph.—The Austrian War Office is very much perturbed by the somewhat late discovery that in time of war telegrams can be easily read by the enemy by means of the simple device of running a short length of wire parallel to the telegraph line and inserting a telephone in it. Herr Heinrich Discher proposes to get over the difficulty by duplexing the lines, one station sending the actual message, the other an agreed upon despatch, so that the listener at the telephone would only hear a confused *pot-pourri* of sound. We should have thought a good cipher would have been more to the point.

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THE RECHNIEWSKI ALTERNATE-CURRENT MOTOR.

We illustrate herewith a motor designed by M. W. C. Rechniewski to work with alternating currents, and constructed by Messrs. Goolden and Co. at their Halifax works. The motor does not differ from the ordinary continuous-current type, except that the field is of laminated iron. The armature is of the drum type with Paccinotti teeth. For the sake of economy in the manufacture both the armature and field-magnet cores are stamped out of one sheet. Fig. 2 is a section of the iron cores.

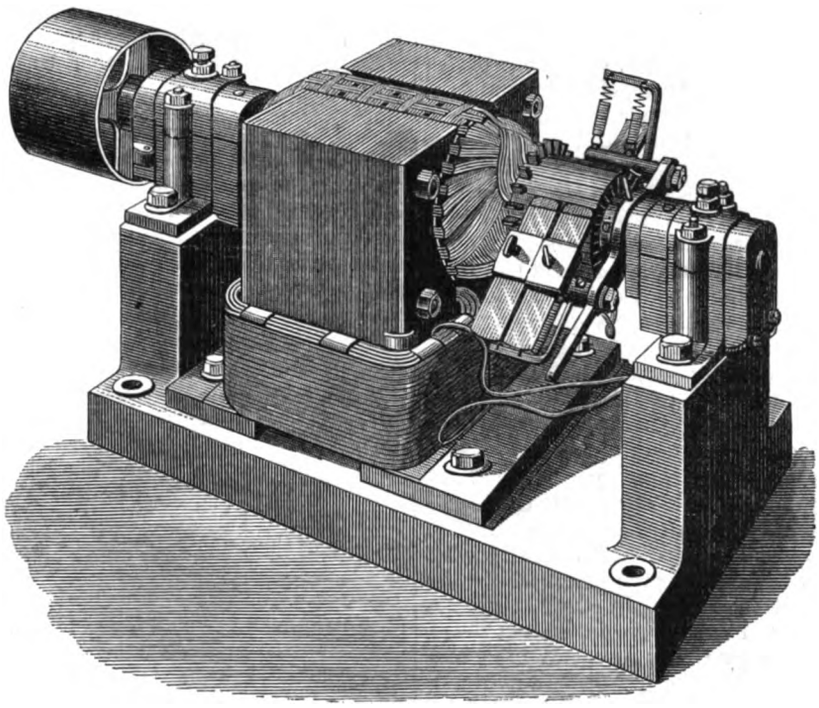

FIG. 1.—The Rechniewski Alternate-Current Motor.

The following figures relating to a machine of fifteen horse-power have been furnished us :—

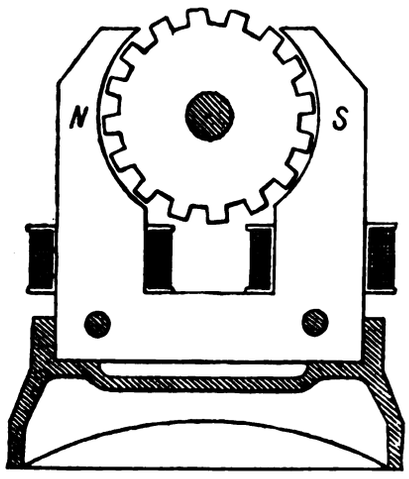

FIG. 2.

Volts at terminals, 115.
Current, 100 amperes.
Revolutions per minute, 1,400.
Diameter of armature, 8in.
Peripheral velocity in feet per minute, 2,800.
Weight of iron in field, 440lb.
Weight of iron in armature, 108lb.
Section of iron in field, 42·5 sq. in.
Section of iron in armature, 33·5 sq. in.
Induction in armature, 3,700,000 lines.

This motor is not, of course, self-regulating.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *August 11th*, 1888.

This city was visited last Saturday by a very severe thunderstorm, which inflicted damage for many miles around, and made itself specially felt in the various electric offices and plants. The 300 or 400 night operators in the Western Union building were treated to a brilliant display of dancing fires, and work on the telephone lines, cables, &c., was temporarily suspended. As forty or fifty places were struck in New York and the neighbourhood, it is not surprising that the electric light stations, too, should have been among the number. One large station visited was that of the United States Company uptown. It is not quite known whether the stroke came directly or from one of the circuits ; but at any rate there was a very lively fire, and the result was that a number of machines were left in bad shape. At Mount Vernon, also, near this city, the dynamos in the electric light stations were burnt out, and I heard of one or two other places where armatures were injured. Altogether the experience went to show that electric light stations are not sufficiently protected against incursions of this kind, and, timely enough, the subject was taken up at the meeting of the Edison Association this week, as mentioned below.

The meeting of the Edison Association, which is composed of local electric light companies operating under license from the parent company, or on the cash basis, took place this week at Boston, at a large hotel on one of the fine beaches which abound near the Hub. Although the convention was thus called for an extreme corner of the New England States, the attendance appears to have been large, there being about seventy-five members and visitors in attendance, many coming from remote parts of the country. What has been said in various ways with regard to the serious competition brought to bear against the continuous current for incandescent lighting might reasonably have led to the belief that the convention would meet under somewhat depressing circumstances ; but, on the contrary, the tenor of feeling was very cheerful, and Mr. E. H. Johnson, president of the parent company, was able to report, as indicating the confidence of capital, that a few days previous to the meeting he had organised a new company in the city of

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Minneapolis, with a capital of half a million dollars, the plant to be running as soon as possible. As you may be aware, the Edison Convention, unlike the meeting of the National Electric Light Association, is held with closed doors. Of course, where there is so much of the private relations between the parent and sub-companies to be discussed, this practice is natural, but at the same time there is undoubtedly much else that would be of general interest, and much that the Association would do well to give the general public the opportunity of learning with some degree of fulness. It may be mentioned that among the subjects discussed was the use of the current generated in Edison stations, not only for lighting but for motive purposes, and the supply of the current was also advocated for telegraph offices, various successful attempts having already been made in this line. One of the evenings was given up to a very interesting Paper by Mr. W. J. Jenks, one of the most capable men in the electric light business in this country, on the subject of lightning and the methods by which electric light companies might be protected from it. The frequency with which stations have been struck or visited has at last become noticeable, and while provision is made in not a few stations, it is safe to say that in the vast majority the precautions taken are altogether inadequate. Mr. Jenks, I understand, suggested various remedies as to arresters and lightning rods, and in view of the fact that a good deal of contumely has been heaped of late on the rod in some quarters, it is significant to see that it has still its position as an effective protector. But the most striking part of Mr. Jenks's Paper, aside from, and in addition to, its practical bearing, was his reference to the divining rod. He remarked that one theory which had been entertained of late years was that subterranean watercourses were points or lines of attraction representing the earth's electrified condition. That being the case, Mr. Jenks has undertaken to see whether the peculiar property which has been attributed to the divining rod could not be utilised in determining the places where the lightning would be most likely to strike. In company with a divining rod operator, he visited several places, and in every instance was able to determine by the lines marked out and indicated by the bending of the rod, the spots where lightning had actually struck. All the determinations were verified by subsequent inquiries, and received in some cases most startling verification. One case was that at Amesbury, in Massachusetts. Certain residents of that place were very sceptical as to this method of indication, so they took the experimenters out on a long stretch of broad highway, and then ironically invited them to tell where the lightning had struck. It did not seem at all a likely place, but in a short time three lines were marked out, and where they intersected was said to be the point of greatest danger. This declaration silenced the sceptics, who themselves then produced an old history of the place wherein it was recorded that in 1802, right on that very spot, a man with two yoke of cattle had been struck, and with his four animals instantly killed. The divining rod, I might add, though perhaps the fact is pretty well known, is generally a stout forked twig of apple, peach or hazel bent over in the hands of the operator, and thus under a strain. It is most singular in this connection, that should the operator put on rubber boots or goloshes his power to obtain indications at once leaves him. All this is undoubtedly very interesting. Mr. Jenks made his experiments very cautiously, and is known to be a thoroughly careful and experienced experimenter, so that every reliance may be placed on his statements. It is to be hoped, however, that he will follow up this line of inquiry, as he may have something even more interesting to tell us about it later. It will be rather funny if, after all, we have to enrol the divining rod man among our electrical experts.

The subject of the supply of current to telegraph offices occupied the attention of the convention as noted above. Its importance may be gauged by the fact that both the Western Union Company and the Postal Telegraph Company in New York are now using dynamo current for a very large part of their work. The *Electrical World* illustrates this week a plant which Mr. F. W. Jones, the electrician and assistant general manager of the Postal Company, has just put in to replace several thousand batteries. This plant consists of a group of eight special Edison machines, run by two 10 horse-power engines. The steam for the engines is taken from the steam mains in the street, but the company has also its own battery of boilers, and has taken a further precaution against the interruption of the service by putting in an electric motor to take current from the street, with which to drive the generators in case both steam supplies should give out. A pretty little piece of work consists in the use of Edison lamps as resistances. These lamp resistances are adjusted to two ohms to every volt, so as to prevent any damage by overheating should the wires get crossed or grounded at or beyond the main switchboard. The glowing of the lamp detects instantly such trouble, which heretofore has been made known by the ordinary relay tests. Altogether the plant is said to be extremely successful, and it yields even better results than were expected.

A statement was made by Mr. T. D. Lockwood, in a recent number of the *Western Electrician*, to the effect that only one exchange in the world, that in New York, had as many as 7,000 subscribers. A correspondent of that paper writes to it challenging the statement, stating that there are 10,000 subscribers in the Berlin Exchange, which is operated by the German Government. But the point that Mr. Lockwood was making was with regard to the number of wires brought directly to one exchange, meaning thereby one switch-board or operating-room, and in that view of the case Mr. Lockwood is, as usual, correct in his statements. It may be questioned whether there is any exchange in the world which approaches the New York one by some thousands, and when the big board here is in full operation it will certainly be one of the greatest electrical sights in this country. Work on the board is still going on, but I believe that it is not expected that everything will be in thorough readiness for at least two or three months.

CORRESPONDENCE.

ALTERNATING-CURRENT ELECTROLYSIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It does not appear to be known to the readers of *The Electrician* that electrolysis has already been performed by the means of the alternating current, and described by Jamin in *Comptes Rendus* about six years ago.

Recently the experiment was repeated in this laboratory under the direction of the chief electrician, Mr. John F. Kelley, with good results. The current from a transformer working at about 6,000 alternations per minute was passed through a resistance, a copper mercury arc, and an Ayrton and Perry magnet ammeter; so long as the copper rod made actual contact with the basin of mercury no deflection was observed on the ammeter, but as soon as an arc was struck a permanent deflection to one side was observed which proved capable of reversal by changing the wires in the ammeter. Afterwards a copper depositing cell was connected in shunt with the resistance, and immediately copper was torn from the anode and deposited on the cathode; finally the electromotive force at the ends of the resistance was measured by a tangent galvanometer, and found to be equal and opposite to that at the terminals of the arc, while around both no deflection could be observed though the Cardew voltmeter at the same points indicated the full electromotive force of about 100 volts. This actual rectification of the alternate current seems to be due to the arc being a seat of electromotive force acting internally in one direction and externally in the opposite, precisely as a battery does; whether the action is a thermo-electric effect or something of the nature of electrolysis we have not yet been able to determine, all experiments having so far proved negative in character, though those of Jamin point to a thermo-electric explanation, as he says that the same effect may be observed with an arc between any materials provided only there is a considerable difference in their size.

However, I hope to repeat these experiments at an early

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date, and to continue them in connection with actual measurements of the phenomena, in hopes of arriving at some conclusion which I may send you.—Yours, &c,

FREDERIC A. C. PERRINE, Sc.D.,
Assistant Electrician United States Electric Lighting Company.

29, Plane-street, Newark, N.J., August 9, 1888.

TELEPHONIC COMMUNICATION WITH SHIPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your No. 526, Vol. XXI., appears an interesting communication from the Postmaster-General of South Australia respecting the above subject. Perhaps it may be of interest to your readers to hear that telephonic communication with ships has been in constant use here since February, 1884, viz., with the Messageries Maritimes (and for some time with the Clan line and Arab line of steamers, until they discontinued running here).

The system varies slightly from that in use at Adelaide. The cable is shorter, but we are compelled to place the buoy almost in mid-channel, so that ships anchor on both sides of it, thus making the task more difficult. The ships are in direct communication with the "Exchange," and the telephone is in frequent requisition from exchange subscribers as well as the agents.

When two ships are connected at the same time a switch is placed on board one of them, with an extension bell in circuit, and a cable run out to the other, thus saving a second main cable and aerial wire.—Yours, &e.,

HENRY GOODWIN, Electrician and Manager.

Oriental Telephone Company (Limited),
Port Louis, Mauritius, July 25th, 1888.

UNIPOLAR INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I referred your correspondent, Mr. Snowdon, to the experiments of Exner and Czermak described in the *fourth* paragraph of Art. III., page 203. Mr. Snowdon's reply is an assault upon some experiments of Fessel's, which are incidentally stated, in the *third* paragraph of the article referred to, to have been confirmed by Exner and Czermak. Mr. Snowdon, however, admits that induction may be produced by the aid of sliding contacts in a circuit which remains fixed in an invariable field, due to a revolving magnet, which is exactly the point denied by the advocates of the theory that the lines of force of a magnet remain fixed as the magnet revolves.

Mr. Snowdon's statement that it is an incontestable fact that the one condition necessary for a current to be induced is not that the number of lines within the circuit should vary—in other words, that Faraday's law of electro-magnetic induction given in italics on page 203 is untrue—is hardly one that requires any comment. It is of course necessary that the E.M.F's at the different parts of the circuit should not balance, for if they did the total E.M.F. round the circuit would be zero. Faraday's law states the conditions under which an E.M.F. round a circuit can be produced, but it would hardly be profitable for me to take up your space and my own time in setting forth the evidence on which it is based, as this can be found in almost any elementary text-book; at any rate until something of more weight than Mr. Snowdon's bare assertion is brought against it.—Yours, &c., G. W. DE TUNZELMANN.

ELECTRICALLY-FORMED COPPER PIPES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of August 10th, p. 431, you have a notice of the new method of making electro-deposited copper steam pipes by the agate-burnisher process.

I recently had the opportunity of passing ten days at Mr. Elmore's Mill at Cockermouth, and witnessed the whole *modus operandi* of this interesting and valuable invention. The first impression one gets is the complete absence of the noise and dirt which necessarily accompany the usual method of making copper pipes. One finds no smelting or refining furnaces with their sulphurous fumes loading the atmosphere and destroying vegetation all around. At Cockermouth beautiful roses climb the walls of the mill in which the tubes are manufactured, a picturesque watercourse runs through the mill grounds (which cover six acres), trout and other fish may be seen in the clear, pure water, and beautiful flowering shrubs afford a haunt for nearly every kind of English song-bird in full enjoyment of its natural element.

This is a marked and pleasant contrast to the copper works of Swansea, where miles and miles of country are completely destitute of vegetation.

Even the hum of the dynamo machine is absent in the tank rooms, only a silent transfer of copper from the anodes to the rotating mandrel in the tank, and one looks through the clear blue solution at a copper tube being built up molecule by molecule under one's very eyes.

Ordinary electro-deposition is always a beautiful process, but in this case Art steps in to assist Nature, and seems to say, "Please let us have these molecules of copper pressed closer than has ever yet been done." And so a copper pipe is built up *automatically* and *directly* from the impure and crude copper in the operation of refining the latter, and this merely by the passage of a current of electricity and an astonishingly small amount of manual labour.

As to the question of cost to which you refer, we know that 6040·8 amperes passing for 144 hours will deposit 1 ton of copper, and if we multiply this by ·5 volt, which is a very liberal allowance to overcome the resistance of the bath, we get 3020·4 watts, which is equal to 4·04 horse-power. One horse-power is produced by the combustion of 3lb. of coal per hour, and therefore $144 \times 3 \times 4{\cdot}04 = 1745{\cdot}28$lb. of coal, which equals ·779 ton. Add for loss of power in dynamo, engine, slipping of belt, &c., the large allowance of 50 per cent. = ·389 ton, we get 1·168 ton of coal consumed to deposit one ton of copper. Then, taking the cost of coal in a manufacturing district such as Birmingham or Cockermouth at 6s. per ton, we have, say, 7s. as the cost of fuel expended in the production of one ton of tubes.

It is difficult in the face of these considerations to see how the ordinary mechanical processes of drawing in which a large amount of manual labour is involved can possibly compete with this new process.

We may fairly look for an enormous development of electrolytic operations of this kind, in which the burnishing method can be used to give the marvellous strength and homogeneity indicated by Mr. Parker's independent tests, especially when it is borne in mind that it is just as easy by this process to make a 9ft. diameter calico-drying cylinder or a paper-maker's cylinder or a brewer's or distiller's boiling pan, with the bottom all in one piece.—Yours, &c.,

CHAS. J. SIMMONS.

18, Southampton-buildings, London, W.C., Aug. 22, 1888.

DETERMINING PERCENTAGE OF COPPER IN A CYANIDE SOLUTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to the inquiry of Mr. D. Corrie in your last issue it may be suggested that the best way of determining the percentage of copper in a cyanide depositing solution would be first to deposit the whole of the copper by a strong and long-continued current upon a platinum cathode with a platinum or iron anode. The purity of the deposit could then be tested by ordinary chemical analysis. After this the amount of potassic cyanide present might be found by means of a standard solution of nitrate of silver in the usual manner. But if the solution is very impure the process will, no doubt, be found troublesome.—Yours, &c., ELECTROLYSIS.

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PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

11,312. J. HAMER. Halifax. Certain improvements in scoring boards used by billiard players and others, and in means for operating the indicating devices by electricity. August 4, 1888.

11,328. W. BOGGETT. London. Improvements in obtaining electricity for electric lighting motive power and other like purposes. August 4, 1888.

11,338. L. KELNER. London. Improvements in telephone line circuits. August 4, 1888.

11,352. J. SCHOLEFIELD. Leeds. An improved electric pen or pen and holder, specially applicable for stippling and similar purposes. August 7, 1888.

11,376. G. DRAPER and W. H. ASH. London. Improvements in syphon recorder telegraph instruments. August 7, 1888.

11,388. J. L. E. DANIEL. London. A system of and means or apparatus for automatically and electrically indicating the breaking of a train, or for actuating signals on railways. August 7, 1888.

11,403. H. H. LAKE. London. Improvements in apparatus for the propulsion of vehicles by electricity (F. J. Weis, United States). August 7, 1888.

11,411. A. W. MESTON. London. Improvements in armatures for dynamo-electric machines. August 7, 1888.

11,441. H. A. GALLIERS and F. KLAERR. London. A combined shade and globe or chimney for oil lamps, chandeliers, gaseliers, electric lamps, and the like. August 8, 1888.

11,475. C. BLANKE. Manchester. An improved electric stop-motion for automatically arresting the operations of apparatus for folding envelopes and similar articles of paper. August 9, 1888.

11,479. T. PARKER and A. E. ROBINSON. Manchester. Improvements in the manufacture of iodine and iodoform by electrolysis. August 9, 1888.

11,490. A. E. COCKBURN. London. Improvements in lock switches for electric circuits. August 9, 1888.

11,491. D. NICHOLL. London. Improvements in the insulation of electric conductors and for the preparation of wires to prevent vibratory sound when used for telephonic and other electrical purposes. August 9, 1888.

11,495. J. J. MANN and J. CUTLAN. Improvements in the arrangement and construction of telephonic exchange systems. August 9, 1888.

11,503. L. S. M. PYKE and H. S. BARNETT. London. Improvements in electric generators. August 9, 1888.

11,511. J. L. E. DANIEL. London. An improved system of automatic electric signalling for railways and means or apparatus for use therewith. August 9, 1888.

11,514. S. R. DOUSE. London. Electrically controlled apparatus for checking, extinguishing, and preventing the spread of fire, and for simultaneously giving the alarm. August 9, 1888.

11,529. W. TOWLE, London, and W. E. LANGDON, Derby. Improvements in electric lighting. August 10, 1888.

11,544. J. G. CUMMING. Edinburgh. Improvements in electrical coin freed machines. August 10, 1888.

11,568. W. SHEDLOCK. London. Improvements in electric batteries. August 10, 1888.

11,569. H. PIEPER. London. Improvements in secondary and other electric batteries. August 10, 1888.

11,570. H. PIEPER. London. Improvements in electric arc lamps. August 10, 1888.

11,573. H. HEAD and L. SAUNDERSON. London. Improvements in electric lamps. August 10, 1888.

11,582. F. H. VARLEY. London. Improvements in apparatus for the electro-deposition of metals and for the separation of chemical compounds or bases therefrom. August 11, 1888.

11,681. E. LIEBERT and S. A. ROSENTHAL. London. Improvements relating to electric batteries and to exciting liquids or compounds therefor. August 13, 1888.

11,703. E. CROWE. Middlesborough-on-Tees. Improvements in electric dynamos and motors. August 14, 1888.

11,705. W. P. THOMPSON. Liverpool. Improvements in apparatus for measuring electric currents and recording the amount of electric energy consumed in a given circuit (the Westinghouse Electric Co., United States). August 14, 1888.

11,718. J. GOZO. London. An induction apparatus—a substitute for dynamo-electric machinery—for the generation of electricity without converting the energy of mechanical motion into the energy of electric currents, *i.e.*, without moving coils of wire past magnets or magnets past coils of wire. August 14, 1888.

11,737. G. BINSWANGER. London. Improvements in electric bell pushes.

11,749. J. S. SELLON. London. Improvements in the manufacture of carbons for electric lamps. August 15, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

August 11, 1888.

10,611. R. P. MILBURN. Newcastle-upon-Tyne. Improvements in electric batteries. August 2, 1887.

10,833. F. R. BOARDMAN. London. Improvements relating to electric lamps. August 6, 1887.

10,838. F. L. RAWSON and W. WHITE. London. Improvements in electrical switches. August 6, 1887.

10,952. L. ANSPACH and L. GERARD. London. Improvements in or connected with dynamo-electric machines and electro-motors. August 10, 1887.

11,802. A. SHIPPEY. London. Improvements in and relating to the manufacture of incandescent lamps, and the methods adopted for converting old lamps into new, materials used therefor and in combination therewith. Aug. 31, 1887.

12,203. T. L. HEMMING. Birmingham. Improvements in dynamo-electric machines. September 9, 1887.

13,320 J. G. STATTER and S. L. BRUNTON. London. Improvements in electric regulators. October 1, 1887.

13,558. P. EVERITT and P. R. ALLEN. London. Improvements in or relating to casings for electrical conductors and apparatus. October 6, 1887.

13,567. A. M. CLARK. LONDON. Improved automatic electrical firing mechanism for naval ordnance (P. Oriolle, France). October 6, 1887.

14,024. N. DE BENARDOS. London. Improvements in secondary batteries or electrical accumulators. October 15, 1887.

14,029. F. C. ALLSOP, Bexley. Improvements in electrical tramways and railways. October 15, 1887.

5,681. C. S. SNELL. Saltash. Improvements in switches used for electrical purposes. April 17, 1888.

August 18, 1888.

13,720. A. DE KHOTINSKY. London. Apparatus for effecting electrical measurements and contacts. October 10, 1887.

12,247. W. PARKINSON. Manchester. Improvements in dynamometers (J. Wallace, India). October 20, 1887.

15,455. W. S. ROGERS. London. Apparatus for connecting a number of separate electrical conductors to one main conductor. November 11, 1887.

713. T. COAD. Forest Gate. Improvements in voltaic or galvanic batteries. January 17, 1888.

7,619. G. J. WEIR. Glasgow. Primary electric battery. May 24, 1888.

PATENTS SEALED.

August 10, 1888.

7,865. F. GEORGE. Gloucestershire. Improvements in dynamo-electric and electro-dynamic machines. March 31, 1887.

9,191. G. A. SCOTT. London. Improvements in type printing telegraphs. June 28, 1887.

9,843. W. T. GOOLDEN and S. EVERSHED. London. Compensating electric measuring instruments for temperature. July 13, 1887.

10,519. J. B. PETTER. Yeovil. Improvements in posts, such as fencing, telegraph, direction, lamp and other similar posts. July 28, 1887.

10,606. L. GERARD. Brussels. Improvements relating to the distribution, storage and regulation of electric currents. July 30, 1887.

10,748. A. SCHANSCHIEFF. Gipsy Hill. Improvements in portable batteries for the production of electric light. August 4, 1887.

13,005. F. VILLIERS STEAD and E. R. HEDGMAN and J. SPRATT. London. Electrical automatic boxes for the delivery of small articles. September 26, 1887.

13,954. W. E. IRISH. United States. Improvements in or appertaining to electrical railways. October 14, 1887.

1,406. M. TURTON and S. TURTON. Tipton. Portable combined electric and mechanical clock alarum. January 31, 1888.

1,851A. J. Y. JOHNSON. London. A sound-conveying tube for telephones, graphophones and like instruments (The Volta Graphophone Company, United States). February 7, 1888.

4,524. W. J. S. BARBER-STARKEY. Shropshire. Improvements in portable galvanic batteries. March 24, 1888.

6,237. A. MILLAR. Glasgow. Improvements in jars or cells for primary or secondary electric batteries. April 27, 1888.

6,481. H. H. LAKE. London. Improvements relating to the electrical transmission of power and to apparatus therefor (N. Tesla, United States). May 1, 1888.

6,502. H. H. LAKE. London. Improvements relating to the generation and distribution of electric currents and to apparatus therefor (N. Tesla, United States). May 1, 1888.

August 17, 1888.

8,240. J. R. HARD and T. WILSON. United States. Improvements in galvanic batteries. June 8, 1887.

8,500. R. S. WARING. United States. Improvements in conduits for electric wires or cables. June 13, 1887.

8,701. J. ROSS. Dundee. Improvements in and relating to the production and application of electric energy for lighting or other purposes. June 16, 1887.

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10,071. W. B. Sayers and W. H. Sturge. Birmingham. Improved fittings for electric incandescent lamps. July 19, 1887.
10,740. S. Mathis. Morlanwez, Belgium. Improvements in regulators for electric lamps. August 4, 1887.
13,601. J. H. Davies and A. Thompson. London. Improvements in automatic coin-freed electrical machines, and in the method of displaying advertisements therein. October 7, 1887.
14,346. A. P. Lundberg. London. An improved bell push electric light switch. October 21, 1887.
15,703. J. Court. London. A galvanic battery for medical purposes. November 16, 1887.
2,703. F. Hargrave. London. Improved means or apparatus for sounding at sea and elsewhere by electricity. February 23, 1888.
3,752. O. Imray. London. Manufacture of composition for the construction of roadways, pavements, building blocks, telegraph poles, railway sleepers and similar articles, and for the manufacture of fireproof and preservative paint (G. S. Lee, United States). March 10, 1888.
6,076. A. Gross. Newcastle. Electrical appliances for a mariner's compass to give alarm upon deviation from the ship's course. April 24, 1888.

SPECIFICATIONS PUBLISHED.

10,131, 1887. Forbes, G. Meters for electricity. (Price 8d.)
10,157, 1887. Garrett, T. A. Transmitting, &c., electrical signals. (Price 8d.)
11,252, 1887. Mower, H. Secondary batteries. (Price 8d.)
11,901, 1887. Scott, R. A. Lamp holders for incandescent electric lamps. (Price 8d.)
12,015, 1887. Lönholdt, W. Incandescent electric lamps. (Price 8d.)
12,683, 1887. Laurent-Cely, F. M. A. Spongy lead for electrical accumulators. (Price 8d.)
12,718, 1887. Tate, J. Electrical speed indicators. (Price 8d.)
4,221, 1888. Coad, T. Holders for incandescent electric lamps. (Price 6d.)
7,852, 1888. Thompson, W. P. (Westinghouse, jun.) Electric distribution. (Price 8d.)
10,200, 1887. Bull, H. C. and Co., and Bull, H. C. Dynamo-electric generators and motors. (Price 8d.)
13,207, 1887. Morley, A., and Wilson, H. W. Indicators for electric bells. (Price 8d.)
13,221, 1887. Holmes, J. H. Controlling automatically armatures, &c. (Price 8d.)
13,333, 1887. Gibbs, J. D., and Fesquet, E. Secondary generators, &c., of electricity. (Price 8d.)
13,338, 1887. Hartnell, W. Electric lamp attachments. (Price 8d.)
4,759, 1888. Lake, H. H. (International Dudley Signal Co.). Telephonic apparatus. (Price 1s. 3d.)
9,332, 1888. Stityel, F., and Weinedel, C. Electrical connection of railroad rails. (Price 6d.)

THE "STEAM CYLINDER LUBRICATOR."

The introduction of sight-feed lubricators for steam-engine cylinders is of quite recent date, and they constitute a very great improvement over the clumsy and wasteful oil and tallow cups which engineers were long in the habit of fixing to their engines. They enable the engineman to give a regular and visible supply of oil to the cylinder, which is of great importance for economy in working.

Notwithstanding their advantages over the old-fashioned tallow cup, the sight-feed lubricators, as generally constructed, have several defects, which impair their usefulness. They depend for their working on the displacement principle, whereby the condensed steam from the condenser displaces a certain quantity of lubricant, according to the degree of condensation taking place.

If anything should occur to prevent condensation of the steam they fail to act, and the engineman has to resort to the tallow cup, to supply the engine with lubricant.

This want of certainty in their action is a serious drawback, and most enginemen provide for the defect by retaining the old tallow cups in case of emergency. With displacement lubricators, also, the quantity of oil which can pass through them depends on the efficiency of the condenser, while it is often necessary to give a steam cylinder a flush of oil—as, for instance, in case of priming—which cannot be done by an ordinary sight-feed lubricator.

The lubricator shown in Fig. 1, which has lately been introduced by the Steam Cylinder Lubricator Company of Manchester, has been designed to overcome these defects, and to provide an apparatus which is automatic in its action, supplying a regular and visible feed to the cylinder, and perfectly under control. The oil is displaced, not by the accumulation of condensed steam, but by the direct pressure of the live steam acting on the underside of a piston, whose surfaces are of unequal areas. The action of the lubricator is thus positive in its nature, not liable to derangement;

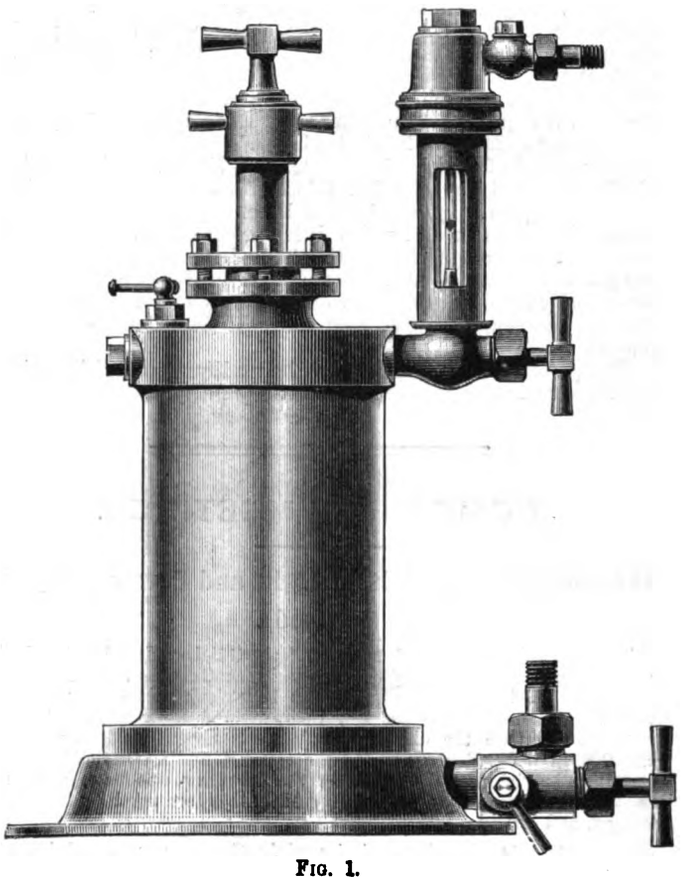

Fig. 1.

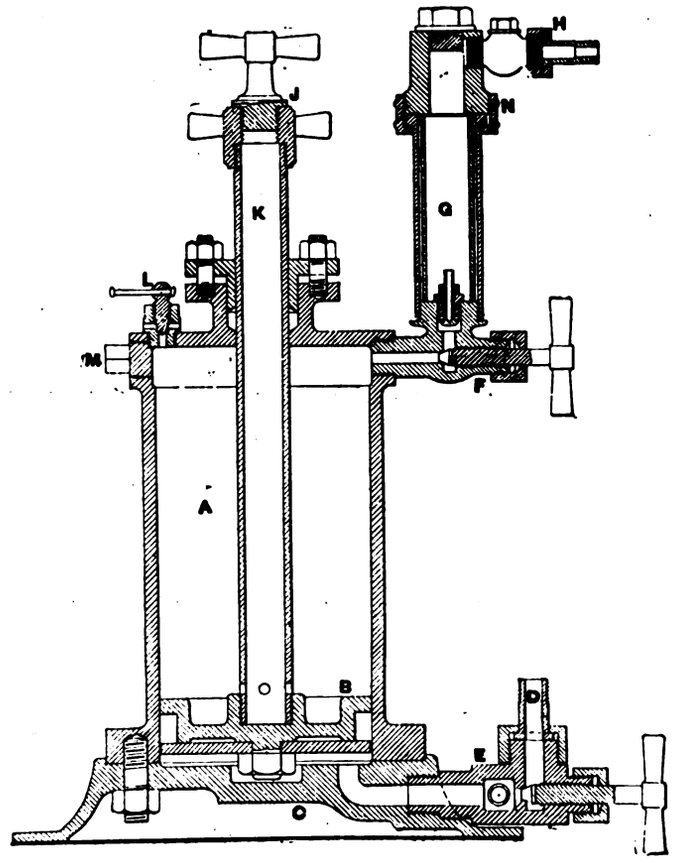

Fig. 2.

and an important feature is, that the piston-rod acts as a tell-tale, indicating the gradual consumption of the oil, and showing when it requires to be replenished.

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In Fig. 2 A is the oil chamber, in which works a steam-tight piston, B, which is asbestos packed, having screwed into its top side a hollow steel piston rod, K, which works through a stuffing box. This piston rod also serves as an indicator showing the level of the oil. At the top end of the rod is a filling plug, J, through which the oil is delivered into the chamber A, the oil passing through the small holes at the bottom of the tube; D is the steam inlet, H the connection to the cylinder, G the sight feed, L an air valve, M a plug which can be unscrewed and the sight-feed G inserted, if required, at the other side, E is a run-off valve, and C is the base to which the lubricator is fixed.

The method of working is as follows:—When the piston B is at the bottom, and the chamber filled with oil, steam is admitted through the pipe D by opening the lower valve to the underside of the piston, the area of which is larger than the top side by the amount of the area of the rod K. This difference of area causes the piston to be raised within the cylinder, and so displaces the oil above, which finds its way out to the engine steam pipe or chest through the upper valve F, past the sight-feed G and connecting pipe H.

The quantity of oil displaced can be readily regulated by adjusting the outlet valve to give any desired quantity.

COMPANIES' MEETINGS.

The Gulcher New Electric Light and Power Company (Limited).

The first ordinary general meeting of the Gülcher New Electric Light and Power Company (Limited) was held at Cannon-street Hotel, on Thursday, the 9th of August, 1888, at 12 o'clock when the Chairman reported the formation of the new Company and the conditional agreement to purchase the old Company's assets for £16,000 in cash and £20,000 in deferred shares. On the conclusion of the ordinary general meeting a special general meeting of the Company was held, when the following resolution was proposed by Mr. Lloyd, seconded by Mr. Binswanger, and carried:—

"*That the Articles of Association of the Company be amended as follows:*

"*Article 7, by omitting all words after the words 'Ordinary Shares,' and in place thereof inserting, 'The Preference Shares shall be entitled to receive out of the net profits of each year a preferential dividend of £10 per centum. After provision has been made for such preferential dividend, the surplus net profits or so much thereof as shall be sanctioned at the annual meeting of the Company shall be distributed upon all the shares, both Preference and Ordinary, rateably in proportion to the amount paid up, or credited as paid up, thereon respectively. In the event of a winding up of the Company, the surplus assets shall be applied, first, in repayment to the holders of Preference Shares of the amounts paid or credited as paid thereon; then in repaying to the holders of Ordinary Shares the amounts paid or credited as paid thereon; and the residue shall be divided as to one-third part amongst the holders of the Debenture Stock of the Company, as to one-third part amongst the holders of Preference Shares, and as to the remaining third part amongst the holders of Ordinary Shares.'*

"*Article 12, by inserting after the word 'registration' the words 'and shall have been duly registered as a shareholder in the books of the Company, whereof the production of a share certificate in his name shall be sufficient evidence.'*

"*Article 46, by striking out the words '31st December,' and in lieu thereof inserting '30th day of June.'*

"*Article 60, by inserting after the word 'member' the words 'who shall be registered as a holder of a preference share or shares.' By inserting after the word 'each' the word 'such.' By adding at the end of the article the words 'And every member who shall be registered as a holder of an ordinary share or shares, shall have one vote for each such share up to five shares, and one vote for every additional five shares beyond the first five shares held by him up to fifty shares, and an additional vote for every ten shares held by him beyond fifty shares.'*

"*Article 75, Sub-section (c), by inserting after the words 'Acts of Parliament' the words 'Provisional Orders.' Sub-section (j), by inserting after the word 'debentures' the words 'or debenture stock.'*"

The Pilsen-Joel and General Electric Light Company (Limited).

An extraordinary general meeting of the shareholders of this Company was held at the Cannon-street Hotel on Friday, the 10th inst., Sir Rawson W. Rawson, K.C.B., the Chairman, presiding.

A circular had previously been sent to the shareholders, signed by the Chairman and the other two Directors, and two members of the committee appointed at the last meeting of the Company, held on June 27th, in which it was stated that no tenders had been received for the patents, plant, stock and goodwill of the Company's business in response to advertisements which had been issued in several papers. Mr. Gwynne, a member of the committee, however, had made an offer for the purchase of the entire undertaking of the Company, taking over all assets and liabilities as they stood on July 26th, for £4,550. Mr. Gwynne's intention according to the circular, was to provide forthwith considerable further capital (£10,000 or more), and then to continue the business by the formation of a new company, with a small body of shareholders. He was prepared, should his proposal be favourably entertained, to at once buy any partly paid shares at 4s. per share, and any fully paid shares at 18s. per share, and would afford holders of not less than 100 shares an opportunity of joining him in his new company. The alternatives, other than the sale to Mr. Gwynne, appeared to be that the remainder of the Company's capital would be called up for the extension and development of the business on the Company's own account, or that voluntary liquidation should be entered upon for realisation of the assets and distribution thereof amongst the shareholders, after satisfying the liabilities. In this latter alternative the risk of the uncalled capital being called up in the liquidation, though eventually returned, was to be borne in mind. The opinion of the Directors was that the proposal of Mr. Gwynne should be accepted, as no better course presented itself. Of the members of the committee Mr. Fyfe dissented, Mr. D. Parrish was absent from England, and Mr. Phillips was in agreement with the Directors; the fourth member of the committee was Mr. Gwynne himself.

The notice convening the meeting having been read,

The CHAIRMAN said: I have no doubt you have all received the circular which explains the circumstances under which we meet to-day and the view that the Directors take of our present position, and of the only offer that has been made to us, that of Mr. Gwynne. At the last meeting a committee was appointed and instructed to consider the best means of disposing of the property of the Company, and as an alternative to consider the advisability of continuing the business. Accordingly the Directors have met those members of the committee, and the result is communicated in the circular. We issued advertisements for tenders in accordance with the desire of the shareholders, and the result has been that there has not been a single offer and only four applications to become acquainted with the nature and value of our business. Under these circumstances, Mr. Gwynne, a member of the committee, whose attention, it appears, has been called to this matter for some considerable time, has made an offer, and this the Directors now submit to the shareholders for their consideration with their recommendation that it should be accepted upon the ground that it makes an offer to those who do not desire to invest any more money in this Company, and at the same time offers to those shareholders who have confidence in the future of electric lighting and who are prepared to pay the balance of calls, amounting to 12s. per share an opportunity of joining Mr. Gwynne in the future management of the business, sharing equally with him in the advantages and profits, whatever they may prove to be. I wish to say that I am aware that a circular has been issued to the shareholders by Mr. Fyfe since the appearance of this circular; he has not thought it necessary to send me or my co-Directors a copy of it, but I am perfectly aware of its existence, and there is one point in it which contains an error which I desire to correct. It states that the balance of assets which Mr. Gwynne will obtain possession of when this contract is carried out amounts to £1,500. I wish to say that that is entirely an error; it does not amount to a third of that sum. That is a mistake, and on the whole the Directors are of opinion that inasmuch as this offer gives nearly as much as the market value of the shares at the present moment, as it imposes upon Mr. Gwynne all the responsibility of finding the capital for carrying on and extending the work, which it is admitted by all parties is absolutely necessary, and inasmuch as Mr. Gwynne encourages all those to join him who hold such an interest in the Company that he can secure their acting with him for the benefit of the Company and for no other purpose, we consider that it is an offer which it is to the interest of the shareholders to accept. There are but two alternatives. We presume that the shareholders are not prepared to adopt one of them. The alternatives are, first, to carry on the business, calling up the 12s. a share remaining due, or to dispose of the business. The shareholders at previous meetings have declared their opposition to paying further calls. The Directors have endeavoured to obtain an offer for the business, and to dispose of it on the best terms that they can, and it will rest with you to-day to decide whether this offer shall be accepted or declined. There is one thing which I must point out, that under any circumstances, whether Mr. Gwynne's offer or anybody else's offer be accepted, the only way of carrying out the object which we all have in view is by voluntary liquidation, by means of which the Company, when reconstituted, will start clear, with only a liability for the capital invested in it, and will get rid of that which has been the difficulty of the Directors and will be the difficulty of the Company if carried on by paying up the further calls, namely, the nominal value of the patents and goodwill, which stands at £25,000. Until that is arranged in some way you cannot divide profits. I do not think I have anything more to say. I wish to avoid all points likely to lead to unnecessary discussion or recrimination, and therefore I put the question before you as a mere matter of business to accept this offer or not to accept it. I propose this resolution:—

"*That the undertaking of the Company be sold to Mr. Gwynne, he taking over all assets and liabilities as they stood on July 26th, 1888, at the price of £4,550, and upon such other terms as may be arranged between the Directors or the liquidators of the Company and Mr. Gwynne.*"

That latter clause has reference to the arrangement which Mr. Gwynne has proposed, and by which he is prepared to abide, but which our lawyers have found very difficult to put into black and white.

Mr. WHATELY seconded the resolution, explaining in more detail than the chairman had done the terms of the offer made by Mr. Gwynne and the conditions upon which he was willing to admit other large shareholders to participation in the future conduct of the business. He re-

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marked that there were suggestions that if they waited a little while they would get a better offer, but he could only say that this question of the sale of the Company's plant and business had been before the world a very long time, and they had received absolutely no offer at all but that of Mr. Gwynne. With regard to the absence of Mr. Parrish's signature to the circular, that gentleman was aware of the offer, and had sent in his proxies to vote for it. Mr. Gwynne, he might say, did not confine his offer of participation to those who already held 100 shares; anyone having less than 100 shares who liked to buy more to make up that number would be equally welcome.

After a somewhat prolonged discussion, Mr. GWYNNE complained of the unfair way in which he had been treated and attacked by Mr. Fyfe, and said he declined to keep his offer open. It must be either accepted or rejected at that meeting. As the result of a desultory discussion, he was prepared to increase his offer to £6,000, provided the condition as to other large shareholders having the option of joining him were omitted. He concluded his remarks by saying that at the last meeting he was one of the men who led an attack upon the Directors. In consequence of the statements made to him by Mr. Fyfe, he entered into the inquiry thoroughly saturated with prejudice against the Directors, believing them to be the essence of all that was bad. He had now gone thoroughly into the matter, had been to the works dozens upon dozens of times, and he was bound as an Englishman and a gentleman to confess that he had been deceived. Instead of finding a gang of men doing all they possibly could to rob the shareholders, he found a body of gentlemen who were prepared to do the best they possibly could for the interests of the shareholders. He had not the pleasure of a personal acquaintance with the chairman, but by his courteous, honourable, and straightforward conduct he had not only removed the prejudice he had previously felt against him, but had brought him to feel that he should be delighted to be associated with Sir Rawson Rawson in any business with which he was connected. He placed implicit confidence in him, in the other Directors, and in the officers of the company. He could only openly apologise for the gross mis-statements he had made respecting them.

Mr. F. L. RAWSON said, that on behalf of Woodhouse and Rawson (Limited), he had looked into the business and had made the Pilsen Company an offer, which, however, was not accepted. He considered that Mr. Gwynne's offer ought to be accepted, as it gave those possessing over 100 shares a right to become part purchasers of the business upon the same terms as Mr. Gwynne himself.

Mr. FYFE, replying to some remarks at an earlier stage by Mr. Gwynne, said that he had never intended that that gentleman should get the business for less than it was worth, and he thought it was worth more than was now offered for it.

Mr. ROPER said he preferred the offer of £6,000 made by Mr. Gwynne, and he moved as an amendment that that offer should be accepted, with the view of testing the views of the meeting. He had implicit confidence in the Board. He believed that, badly as the affair had turned out, they were in no way in fault.

Mr. LAYTON seconded the amendment.

Mr. F. L. RAWSON thought if the shareholders accepted that offer they would make a great mistake. In his opinion, with good management, such as he believed that Company would have and had had, considerably more might be made of it.

After further conversation, Mr. Roper withdrew his amendment, and the original motion was put to the meeting, with the result that 13 voted for it and 12 against. A poll was demanded and taken, the voting being 6,352 for and 1,424 against. The resolution was therefore carried.

Mr. GWYNNE said the shareholders had behaved badly in robbing the Directors of their fees, but it was his intention that they should be paid.

The CHAIRMAN moved that the Company be wound up voluntarily.

Mr. WHATELY seconded, and the motion was carried, as was a further resolution appointing Mr. W. H. Trentham, the secretary, liquidator of the Company.

A vote of thanks to the Chairman terminated the proceedings.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 17th, 1888, amounted to £4,596.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 17th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £3,813.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The traffic receipts of this company for the half month ended 15th August, 1888, were £2,533, as compared with £2,048 in 1887.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—At the usual meeting of the directors of this company, Mr. Frederick Walters, of 12, Tokenhouse-yard, E.C., and partner of Messrs. Huth and Co., in Valparaiso, was elected to a seat at the board.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, August 22, 1888	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending August 22, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	40½ 41½	3 6 3	Jan., Apr., July, Oct.	40½	40
2,614,820	Stock	10/0	Do. Preferred	67 68	4 0 11	,, ,,	67½	67
2,614,820	Stock	nil.	Do. Deferred	13½ 13⅝	...	February	13½	13¼
130,000	£10	3/0	Brazilian Submarine	12⅝ 13⅛	5 6 8	Mar., June, Oct., Dec.	13⅛	13
16,000	10	9/0	Cuba Submarine xd	13½ 13⅝	6 3 8	February and August	13⅝	...
6,000	10	10/0	Do. Preference xd	18⅝ 19⅛	5 2 6	,, ,,	18⅝	18 5/16
12,931	5	4%'87	Direct Spanish (£4 paid)	3⅜ 4	4 0 0	March & September	3⅜	...
6,000	5	5/0	Do. Preference	9½ 10½	4 15 3	April and October	10⅜	...
60,710	20	2/0	Direct United States	9⅛ 9⅜	4 5 3	Jan., Apr., July, Oct.	9⅜	...
880,000	10	4/0	Eastern	12⅛ 12⅜	4 17 0	,, ,,	12 3/16	12 5/16
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜ 15¼	3 19 0	,, ,,	15	14⅞
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	108½	...
250,000	10	2/6	Eastern Extension	12⅞ 13⅛	4 19 0	Jan., Apr., July, Oct.	13⅛	12⅞
22,050	10	8/3	German Union Telegraph and Trust	9 9⅛	7 7 4	January and March	...	...
179,177	10	3/0	Globe Telegraph and Trust xd	6⅜ 6½	5 3 8	Jan., Apr., July, Oct.	6 13/16	6⅜
178,992	10	3/0	Do. 6 per Cent. Preference xd	13¾ 14	4 5 9	,, ,,	14	13 13/16
150,000	10	7½%'87	Great Northern	13¾ 14¼	5 5 3	Jan., July, and April	...	...
17,000	25	37/6	Indo-European	37 39	6 6 9	April and October	38	...
33,348	10	3/0	London Platino Brazilian	6 6½	...	May and November	...	...
9,000	8	4/0	Reuter's	7⅛ 8	5 0 0	April and October	...	...
338,225	Stock	13½%	Submarine xd	135 145	10 0 0	February & August	...	...
30,000	10	6/0	West Coast of America	6½ 7	7 3 0	January and July	7	6⅞
150,000	Stock	8%	Do. Debentures	110 115	6 19 2	June and December	...	...
88,321	10	nil.	West India and Panama	1⅜ 1⅝	...	...	1 5/16	1 3/16
34,563	10	10/0	Do. 1st Preference	11⅜ 12¼	...	April and October	12⅜	12¼
45,181	15	9/0	Western Brazilian	11⅝ 11⅞	...	March & September	12⅛	11 7/8
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	103 105	5 14 3	March & September	...	...
			TELEPHONES.					
224,850	14/0	£5 7s. '87	Consolidated Telephone and Maintenance	9/16 1 1/16	5 10 0	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	5/16 7/16	...	...	...	...
80,000	5	10/0	United	13¼ 13⅜	5 9 1	June and December	13⅝	13⅜
50,000	5	2/6	United River Plate	5¼ 5⅜	...	April and October	5 5/16	5⅛
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3 3⅛	...	...	3¼	...
23,692	5	nil.	Do. (fully paid)	4 4⅛	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2⅜	...	...	...	...
312,000	½	5% '86	Maxim-Weston	1/16 3/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39 40	5 19 9	March and July	39⅜	39¼
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works xd	17 18	5 14 3	February & August	17⅜	17 5/16

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

The failure of the Westinghouse Company to sustain the Gaulard-Gibbs patent in the United States comes to us with considerable surprise. It is generally known that the American patent was drawn up very differently from the English specification, and that the principal claims were made to rest upon the feature of the closed *metallic* circuit upon which the dynamo is worked. Notwithstanding the ingenuity of this construction, the American Courts have gone behind the specification and have invalidated the monopoly upon the ground that the first published description of Messrs. Gaulard and Gibbs' invention referred solely to the use of transformers in series, and that parallel working is presumably of later date. If this decision is supported on appeal, it is evident that the Westinghouse Company will be dethroned from the position of supremacy which they have hitherto occupied in the United States. Whether the decision will have any effect upon their contemplated raid on British territory remains to be seen.

In an interesting letter on "Flashed Filaments and Lamp Voltages," a correspondent suggests that if the makers of transformers were to wind the secondaries to give slightly different E.M.F.'s from the normal 100 volts now generally adopted, they would probably be able before long to buy better lamps at a cheaper rate. Our correspondent's views are based upon the idea that in the process of making unflashed filaments there will always be a certain number which deviate slightly on either side of the standard voltage, and that the makers will be unable to get rid of these lamps under ordinary conditions. It seems to us, however, that our correspondent addresses his appeal in the wrong quarter. If the lamp makers were from time to time to advertise the sale of so many thousand lamps of 98 or 102 volts at a reduced price, no doubt they would very soon find plenty of purchasers. Meanwhile, it is perhaps more important to insist on the desirability of using lamps of lower voltages in connection with transformers. We hope that the 100-volt lamp on transformer circuits will soon become a thing of the past.

The resuscitation of the British Electric Light Company is an event of some importance, though as to its wisdom we hesitate to express an opinion upon the evidence before us. A winding-up order was made by Mr. Justice Kay in February, 1886, and the proceedings were still pending when (according to the terms of the circular recently issued) it was discovered that "there are good grounds for believing that the interest of the company under two licenses—one from the Edison Electric Light Co. (Limited), and one from the Manchester and District Edison Electric Light Co. (Limited)—is now of considerable value, and that the licenses may be operated with at a profit, and that it will be beneficial to the creditors of the company, both secured and unsecured, as well as to the shareholders, that an arrangement should be made between the company and its creditors, both secured and unsecured, for the satisfaction of the company's debts, with a view to the resuscitation of the company as a going concern for the purpose of working under these licenses." The creditors and debenture-holders having been jointly and severally induced to adopt this view, the process of resuscitation is now in an advanced stage. We are at present quite in the dark as to the nature of the licenses alluded to. If they are for the manufacture of lamps they may possibly be of some value, but we are unable to imagine that any other license which it is in the power of the Edison Companies to grant can be of any value whatever.

The report of the meeting of the shareholders of the Pilsen-Joel Electric Light Company, which we published last week, was inaccurate in one particular, the resolution to accept Mr. Gwynne's offer having, as a matter of fact, received the approval of a majority of the shareholders present. Since then, however, Mr. Fyfe, who is strenuously opposed to the policy of the directors, has obtained an injunction from the Court of Chancery restraining the Board from effecting the sale. The company is now to be wound up voluntarily.

In the number just issued of the *Proceedings* of the Royal Society Dr. J. Hopkinson has a Paper "On the Magnetic Properties of an Impure Nickel," in which twenty-one curves are drawn, showing the relation between the magnetising force and the induction for various temperatures—a subject on which a good deal was written in the earlier part of the last volume of this journal. When Dr. Hopkinson commenced the investigation he was under the impression that the nickel was fairly pure; a subsequent analysis showed, however, that only 95·15 per cent. of that metal was actually present, cobalt, copper, iron, and carbon all being represented in comparatively large quantities. It is, nevertheless, interesting to note that Dr. Hopkinson's experiments confirm the results arrived at by earlier observers as to the temperature at which the magnetic permeability of nickel suddenly and rapidly falls off. In *The*

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Electrician of January 20th, 1888, will be found a set of curves obtained by M. LEDEBOER, in which the temporary and permanent magnetisations are distinguished, with the curious result that the temporary magnetisation *increases* continuously up to about 270° C., and then falls with great rapidity, whilst the temporary magnetisation slowly falls off almost from the commencement of the heating; both magnetisations arrive simultaneously at minimum values at a temperature of about 320° C. Dr. HOPKINSON's methods did not permit him to distinguish between the permanent and the temporary inductions, but on the other hand he has noted the effects of magnetising forces of different values—a point which M. LEDEBOER apparently neglected. The temperature at which the induction begins to diminish is not appreciably affected, however, by the value of the magnetising force within the limit of the experiments.

OUR readers will, no doubt, remember that last winter a good deal of interest was aroused by the suggestion that this property of nickel might be employed upon a commercial scale for the direct conversion of heat into electric energy. As usual, the suggestion arose in at least two independent quarters at or about the same time, though up to the present it has had no practical outcome. We do not know what Mr. EDISON is doing with his thermo-magnetic generator, but we are sorry to say that M. MENGES (whose designs seemed by far the more promising of the two) has for some time past been hindered from prosecuting his experiments. At the date when we last heard from him he had, however, by no means given up the idea, and hoped before long to be again at work.

FOLLOWING up its recent attacks on the management of the Metropolitan telephone system, the *Financial News* now publishes the report of a "technical expert" commissioned by that journal to inquire into and compare the electrical arrangements provided respectively under the National Telephone Company in Glasgow and district, the Lancashire and Cheshire Telephone Company in Manchester and its district, and the United Telephone Company in the metropolitan area. On the whole, the commissioner is justified in stating that as regards the latest and most valuable improvements in telephony, including wiring, switching, exchanges, and uninterrupted service, the two provincial companies named are far ahead of the parent company. Whereupon the *Financial News* falls foul of the United Company in what seems to us a very sweeping and inconsiderate fashion. That the oldest company is saddled with the oldest appliances is as natural as that the youngest has provided itself with the newest. The only serious doubt still remaining is whether the United Company is taking steps, as opportunity offers, to replace its old-fashioned and inefficient plant by newer and better; and as to this the report is rather encouraging than otherwise.

ON two other points the report is incidentally more dogmatic than the evidence it adduces would seem to warrant, namely, the relative efficiency of the systems, and their economy. We hear of the complaints in London, but it is rather too much to assume that there are none outside London because they do not reach us; and as regards economy of working it is no doubt true, as the reporter alleges, that it is cheaper in the end to adopt this and that improvement. It must also be remembered that some of the greatest difficulties with which telephone companies have to contend—difficulties both in the switch rooms and on the line routes—tend to increase almost in geometrical progression as the number of subscribers is extended; so that, under the best possible management, and with the most perfect appliances hitherto known, the difficulties of the telephone service are necessarily and enormously greater in an exchange such as that of London, with four or five thousand subscribers, compared with those of Manchester or Glasgow, with less than two thousand.

AT the same time we have no hesitation in expressing our unqualified admiration for the degree of perfection which has been attained in the telephone service, both in Manchester and in Glasgow, each of which exchanges we have ourselves visited. By a singular coincidence we commence this week the publication of a detailed description of the work of the National Telephone Company in the Glasgow district, from the pen of Mr. D. SINCLAIR, the electrician in charge.

DURING one of the recent balloon ascents made from Olympia by the late Mr. SIMMONS that ill-fated æronaut had a very narrow escape of being caught in a thundercloud which was engaged in active operations. By dint of clever manipulation he succeeded, however, in keeping beyond the limits of the actual discharge. We are aware of only one instance in which a balloon has remained within the zone of a thunderstorm; this occurred last summer during an ascent made from La Villette by M. LECOQ. This intrepid æronaut was brave or rash enough to court the terrors of the unknown, and appears to have purposely timed his ascent so as to get well within range of an approaching storm. At the height of 600 metres the balloon moved rapidly towards the storm-cloud, as if attracted by it. At 7:40 p.m., and at a height of 1,100 metres, it entered a mass of grey-green cloud, which was momentarily lit up by fitful lightning flashes, followed by immediate and deafening thunderclaps. The discharge appeared to take place between this cloud and another directly overhead, and the balloon was tossed to and fro between cloud and cloud, and set spinning round and round in a manner both bewildering and dangerous; and which reminds one of the well-known experiments in which pith-balls are placed between oppositely electrified plates. That these oscillations were due to electrical attraction and repulsion seems to be proved from the fact that a strong gale was blowing at the time, which could be felt in the car, and which the balloon therefore did not wholly obey. As a rule, an æronaut scarcely feels the wind, however strong, since the balloon is carried along at the same rate. Neither M. LECOQ nor his companion felt any ill effects beyond the usual sense of oppression which accompanies such atmospheric conditions. There were no brush discharges visible upon the cordage of the car, but gusts of warm air were felt every now

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and then, which expanded the gas and carried the balloon further aloft. In one of these upward movements the balloon rose to a height of 1,600 metres. At this altitude the storm attained its greatest intensity, constant discharges taking place between the cumulus in the middle of which the balloon was floating and a cirrus formation above it. "This ascent seems of interest," says M. LECOQ, in concluding his narration, "on account of our prolonged stay in the storm cloud, a circumstance of rare occurrence. I was particularly struck by the very violent agitation of the air, and by the ascending and descending whirls which existed in the heart of the cloud, as well as by the very strong attraction experienced by the balloon and light bodies floating in the air."

H.M.S. "Sanspareil."—The new armour-clad, the "Sanspareil," is to be fitted with three electric search lights.

The Price of Copper.—The price of copper was further advanced yesterday, £90 to £90. 10s. being the quotation for Chili bars.

The Telephone in China.—The Viceroy of the Two Kwang and the Governor of Canton have made arrangements to have their respective Yamens connected by telephone.

The Tesla Motor.—It is stated that the Westinghouse Company has purchased the Tesla alternate-current motor patents, and intends shortly to put some of these machines upon the market.

Arc Carbons.—The Brush Company of Cleveland has recently added to its electric light carbon plant, but orders have been so numerous that the company is said to be behindhand to the extent of 400,000 carbons.

Railway Telegraphs.—The coroner's jury in the Hampton Wick accident added a rider to their verdict that all signal-boxes ought to be in direct telegraphic or telephonic communication with the boxes on either side.

Versailles.—A company has just been formed at Versailles for the purpose of supplying that town with electric light. It is proposed to have the station at Marly, and to transmit high-tension currents from there to Versailles, a distance of over six miles.

Tynemouth.—At a meeting of the Tynemouth Town Council, to be held on Friday next, a recommendation from the Trade and Commerce Committee will be submitted to apply for a Provisional Order for lighting the public buildings and streets with the electric light.

The Telegraph in China.—M. Lemaire, the French Plenipotentiary at Pekin, is negotiating at the present moment with the Chinese Government with a view of obtaining a convention permitting the Tonkin telegraph system to be connected with that of China.

Cuban-Mexican Cable.—The *Madrid Gazette* of August 20th contains a Royal order granting permission to Don Augusto Ghirlanda y Hemandez to lay and work a submarine cable between the coast of the Island of Cuba and the Mexican peninsula of Yucatan.

Science and Art Scholarships.—Among the successful candidates in the competition for the Whitworth Scholarships and Exhibitions for 1888 we notice Benjamin Young, aged twenty-three, electrical engineer apprentice, of Belfast. The value of the scholarship in his case is £100 a year for three years.

A Reservoir Destroyed by Lightning.—A terrible thunderstorm occurred at Toulon on Saturday night. The lightning struck and burst open the aqueducts of the reservoirs at Saint Antoine, the water rushing down the hill and causing great damage to property.

Cable Laying.—Mr. Henry Stott, writing from ss. "Minia" at Halifax, N.S., on August 13th, says:—"Perhaps it might interest some of your readers to know that we used 44 knots of the Trott-Hamilton patent hemp cable on the repair of the Brest-St. Pierre cable, at a depth of 1,600 to 1,900 fathoms, with perfect success."

Madrid.—The Spanish Government has refused to alter the date fixed for the compulsory introduction of the electric light in the Madrid theatres, and no place of entertainment will be allowed to open this autumn unless lit by electricity. The majority of the theatrical managers have, however, already complied with the ministerial decree.

Glasgow.—The Anglo-American Brush Corporation have recently opened a new office at 123, Hope-street, Glasgow, which has been placed under the charge of Mr. W. Geipel, their Superintendent for Scotland. A room on these premises has been fitted up as a show room, and a large assortment of Benson's artistic fittings are on view.

An Electrical Society in Japan.—We are officially informed that an electrical society has been formed in Tokio, Japan, and that at the first meeting upwards of 800 members were announced. The president is Viscount Enomotto, Minister of the Department of Communication, and Mr. R. Shida, who represents the Society of Telegraph-Engineers in Japan, is chairman of the Council.

Electric Connection with Lightships.—According to the *Dover Chronicle*, a Mr. Goodman has been exhibiting at Dover and other places an invention of his for preventing electric cables attached to lightships becoming damaged by fouling the chains when the vessel rides round. We have no particulars of Mr. Goodman's appliance. Meanwhile we have reason to believe that the experiment at the Sunk Lightship under the direction of the Telegraph Construction and Maintenance Company is proving satisfactory.

A New Cable.—We understand that the new cable between Warnemönde and Gjedser will probably be finished next month, and Messrs. Felten and Guillaume have undertaken to have it laid by the middle of September. The laying of the cable will begin on the German side, and probably the large cable steamer of the Great Northern Telegraph, "H. C. Oersted," will be employed for the purpose. The cable will contain four wires, and have a length of 50 kilometres. The cost of laying will be borne by Germany and Denmark in common, and Denmark is to execute all necessary repairs.

The Western Counties Telephone Company at Swansea. The Western Counties and South Wales Telephone Company have with much thoughtfulness and liberality just attached the Swansea and Llanelly Hospitals with all the works, manufactories, and all places of business connected with their telephone system in the neighbourhood free of charge. This company stands alone, we believe, amongst telephone companies in giving free connection to the police station, chief fire brigade station and the general hospital or infirmary, as well as the important charitable institutions of all towns in which it has an exchange.

Swansea.—At a recent meeting of the Swansea Town Council the announcement of the gas company that they intended to raise the price of gas supplied to the public lamps was discussed. In the course of the discussion Mr. Burnie said it was time the Corporation should look round determinedly with the object of seeing if a new method of lighting—elec-

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tricity, for instance—could not now be introduced. There were electric lighting companies who would guarantee the street lighting for a less sum than that now paid. There was ample margin in £3,770 a year to make it worth their while to consider the question of electricity.

The London Electric Supply Corporation.—The above company has made application to the Board of Trade for a license, under the Acts of 1882 and 1888, to supply electricity in the undermentioned localities, namely, the Greenwich District, the St. Olave District, the St. Saviour's District, the City of London, the Strand District, the parish of St. Martin-in-the-Fields, the parish of St. James's, Westminster, the combined parishes of St. Margaret and St. John, Westminster, the parish of St. George, Hanover-square, the parish of Chelsea, the parish of St. Mary Abbotts, Kensington, the parish of St. Marylebone, the St. Giles District (comprising the parishes of St. Giles-in-the-Fields and St. George, Bloomsbury), and the Holborn District, the districts above-mentioned being taken as defined in the Schedule B appended to the Metropolis Management Act, 1855.

The Telegraph and the Recent Manœuvres.—Sub-Lieutenant H. A. B. Shrubb, the officer in charge of the Intelligence Department on board the "Hercules" during the recent manœuvres, has submitted an interesting report to Sir George Tryon on the telegraphic information received by him as to the movements of the opposing fleets. It appears that 20 letters and 602 telegrams were received by the flagship during the time the B Squadron lay in Berehaven. These came principally from coastguard stations on the coast, signal stations established at Cahermore and Browhead, and from Lloyd's and other local sources. The character of the information received was most satisfactory, only 3 per cent. of the news sent being unimportant. This is highly creditable to the senders, as to most of them the work was entirely a new experience. The value of similar information in the case of war would, of course, be incalculable, but Mr. Shrubb points out that it would also be considerably increased if the various coastguard stations were connected with one another by electric telegraph. A hope is expressed that no time will be lost in carrying out this suggestion.

The Public Lighting at Fleetwood.—A meeting of the ratepayers of Fleetwood was held last week to consider the question of the price charged for gas in the town, and also the best means of improving the public lighting. Mr. T. Seed (chairman of the Improvement Commissioners) presided. The first resolution submitted was to the effect that the price of gas ought to be greatly reduced, which was carried unanimously. A committee was then formed to make inquiries as to the methods of lighting adopted in other places, and the cost thereof, and to report to a subsequent meeting. A communication was read from the Public Streets Lighting Company offering to light the whole of the streets of Fleetwood with petroleum oil lamps, as now in use at East Moulsey and elsewhere. A communication was also read from Messrs. Chamberlain and Hookam (Limited) with reference to the illumination by the electric light at Leamington, and inviting a deputation from Fleetwood to meet them at that place, and gather opinions as to this method of lighting both houses and streets. These communications were left to be dealt with by the committee.

Liverpool Electric Supply Company (Limited).—On Saturday the staff and workmen employed in this company journeyed by saloon and reserved carriages to Blackpool for their annual trip. On arrival various pleasures were indulged in for about three hours, after which the party proceeded to the Derby Hotel, where an excellent dinner awaited them. Dinner being concluded, the secretary, Mr. B. H. Collins, speaking on the continued success of the company's undertakings, said that the public of Liverpool would most probably witness a large extension of electric lighting in their city in a comparatively short period, and both the private and commercial community, he hoped would not be slow in still further adopting this light and source of power now that they are becoming more fully alive to its special advantages. "Success to the Firm and Messrs. Holmes and Vaudrey, the Managing Directors," was proposed by Mr. Collins, seconded by Mr. A. Clough, the foreman, and most heartily received. In the evening the party again met at the hotel, and after a concert arranged among the members was concluded, the company returned to Liverpool, thoroughly pleased with the day's excursion.

St. Thomas, Charterhouse, Boys' School.—The boys of the upper class of this school have again this year achieved some very brilliant results in connection with the recent Science and Art Examinations of South Kensington. The success of these boys is remarkable when it is borne in mind that they had to compete with candidates who, in the majority of cases, were double their age. Some fifty-five boys were presented for examination. Of this number all except one succeeded in passing in one or more subjects, while some of the best passed in eight subjects. Thirty-five first class certificates were obtained. In mathematics twenty nine passed. Forty-five passed in acoustics. The results in magnetism and electricity were equally good considering the difficulty of the questions; only eight failed, and five obtained Advanced Certificates, two of them being of the first class. We may add that recently Dr. Gladstone, F.R.S., in giving evidence before a special committee of the London School Board, submitted the following statement:—"Prof. Silvanus Thompson told me that the only elementary school in London from which the Finsbury College could draw youths qualified for the technical classes was that of St. Thomas, Charterhouse, where a good deal of scientific instruction is given, and the boys are encouraged to make their own apparatus."

Electric Side Lights for Ships.—An excellent practical suggestion arising out of the discussion on the disastrous collision between the two Danish steamers has been made by Mr. J. Kenward, who in *The Times* of Tuesday recommends the use of incandescent lamps of high-candle power for the port and starboard lights. The power of these lamps could be proportioned, as no oil lamps can be, to the penetrating power of the white light overhead; and by this means the red and green lamps would be visible at as great a distance as the topmost light. At present, the statutory range is five miles for the white light, and two miles and a-half for the coloured lights. But owing to the absorption of the coloured lenses, the green light rarely reaches the lowest of these ranges, and the red seldom exceeds it. If all the three triangular lights were of equallised long range, the risk of collision would be reduced by about one-half. As there is no imperative rule of the road at sea for steam vessels approaching each other, and, as their safety rests on the discretion of the commanders, obviously the great object should be to increase the distance at which all three lights can be seen, and consequently the time for exercising this discretion. We are glad to learn from Mr. Kenward that at least one steam line company of high distinction is now preparing to give this plan a trial.

Proposed Electric Lighting at Richmond.—At the meeting of the Richmond Select Vestry, on the 14th inst., the clerk

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read a letter from the secretary of the Richmond Gas Company (Mr. E. B. Blott), acquainting the Vestry with the resolution come to by the company to reduce the charge for the public lamps from £3. 10s. to £3. 6s. 8d. per lamp per annum, as from the 24th of June last. Notwithstanding this concession, the Vestry on the same occasion referred to the Parliamentary Bills Committee an offer from Mr. R. F. Coles, on behalf of the proposed Richmond Electric Lighting Company (Limited), to the following effect:—"That in consideration of their transferring, or delegating to him, on behalf of the company, the Provisional Order and powers held by the Vestry from the Board of Trade for electric lighting within their area, and giving him any necessary assistance to have their order altered or substituted for similar powers under the new Act, and further guaranteeing him entire co-operation and support in the matter of electric lighting in their district, the company would either pay him a royalty of 1s. per light per annum (street lamps by special contract), or if preferred would undertake to give a fixed sum—say, £150 per annum—for consideration of the transfer. He undertook to satisfy the Vestry as to the *bona fides* of the undertaking; and mentioned that he had orders in hand for some 200 lights, and only desired the sanction of the Vestry before commencing the erection of a central station.

University College, London.—Gilchrist Engineering Scholarships.—An entrance scholarship will be offered at University College, London, in the present month. The value is £35 per annum, tenable during two years, and the competition is limited to those who have not previously been students of the College, and who will not complete their nineteenth year before October 1. Every candidate must declare his intention of taking, at least, the two first years of one of the engineering courses, and the second payments will depend upon his success during the first year and the arrangements he makes for the second year's study. The subject of the examination will be mathematics and any two or more of the following five subjects:—Mechanics, mechanical drawing, an essay on a given subject, French or German, and the use of tools. A senior scholarship of £80 will be awarded at the close of the session. Candidates must have attended college classes in the following subjects during the whole of the session; Applied Mathematics, Physics, Engineering, Engineering Drawing and Geology. The result of the class examinations will decide the obtainment of the scholarship, providing sufficient merit has been shown to justify the award. There are also entrance and other exhibitions and scholarships given at University College for Mathematics, Physics, Chemistry, Classics, German, French, Art, Greek, Hebrew, Jurisprudence and Political Economy, Philosophy of Mind and Logic, English Literature, Medicine, Surgery, Pathology and Physiology.

Lighting of Cowpen.—The action of the Cowpen Local Board in advertising for tenders for lighting the place by electricity does not meet with the approval of the *Blyth Examiner*, in which journal we find some rather interesting remarks, which we quote below. We may, however, first state that the population of Cowpen is a little over 10,000, that it consumes about 8,000,000 cubic feet of gas per annum, there are 130 street lamps, and 450 private consumers, and that the gas mains are 4½ miles in length. The *Blyth Examiner* says:—

"It certainly seems somewhat ridiculous that an unimportant place like Cowpen (part only of the town of Blyth) should place itself alongside of Barnet, Exeter, Southampton, and Taunton, and actually presume to teach all grades of corporations their duty as to electric lighting. If any electric lighting company contemplating tendering for the lighting of Cowpen district will first make a study of the facts and figures we have adduced, they will know more about the prospects of ultimate success with their speculation than they are likely to do from twenty interviews with that wonderful and loquacious individual, the 'Surveyor to the Board.' It is also interesting to notice how electric companies go about establishing themselves in a given locality. They are tolerably old birds now, and not likely to be caught with chaff. But Cowpen Local Board seem to think a company will come upon the ground, run all the risks incident to dealing with a fickle authority having no continuous policy, and forthwith transfer to the place a large amount of costly plant, without requiring a substantial guarantee that the speculation shall ultimately yield a profit to the company. They *may* do so, for nothing seems to be impossible; but if they do, all we can say is—their trifling with their shareholders' funds will be on a par with the Board's trifling with the funds of the ratepayers. We are much mistaken if it is not the general rule that electric companies have ceased to experimentalise merely with a view to payable business in the distant future. Their usual practice now is to require that a local company be formed on the spot. The electric company takes some shares, and the rest of the capital is subscribed locally. Cowpen Local Board has no power to invest in such shares, and we do not think 20 private individuals could be found to do so to any appreciable amount."

Municipal Lighting Statistics.—In a recent issue we gave a list of provincial towns in which the local authorities are at the present moment actively interested in electric lighting. The following tabular statement with regard to the population, ratable value and gas lighting in these places will be of interest to many of our readers:—

	Population.	Ratable Value. £	Gas Capital Invested. In £'s.	Gas consumed. In cubic feet.	Miles of Mains.	No. of Private Consumers.	Public Lamps.
Bath.....Municipal Borough	51,814	281,289	187,500	357,455,000	80	7,200	1,950
Blackpool ..... ,,	14,229	155,116	corporation.	102,519,000	28	3,704	946
Brighton..... ,,	107,546	681,023	437,000	717,633,000	128	14,640	2,895
Cheltenham ..... ,,	43,972	252,005	125,000	252,025,181	78½	5,817	1,695
Eastbourne..... ,,	21,510	203,000	87,490	129,985,400	35	2,350	780
Hastings..... ,,	42,258	320,151	131,250	232,836,400	79	5,349	1,114
Ilfracombe .....Local Board	6,043	37,088	13,760	16,982,500	8½	561	186
Leamington .....Municipal Borough	22,979	131,217	57,000	131,376,400	33	3,200	947
Weston-super-Mare .....Local Board	12,882	78,473	34,000	54,152,700	20	1,377	381
Barnet..... ,,	4,095	20,900	83,267	56,576,000	...	3,469	648
Bradford.....Municipal Borough	183,032	965,231	corporation	1,204,753,429	214	44,976	6,714
Dewsbury ..... ,,	29,637	113,139	corporation.	143,594,200	47	6,337	926
Dublin..... ,,	418,910	...	707,000	1,083,942,000	600	17,000	6,040
Edinburgh ..... ,,	250,000	...	231,100	1,066,918,284	162	20,049	1,975
Exeter..... ,,	37,665	195,648	103,500	167,855,400	34	3,600	1,083
Glasgow ..... ,,	680,000	...	corporation.	2 145,927,900	224	129,000	15,600
Leeds ..... ,,	309,119	1,190,989	corporation.	1,758,973,300	660	68,000	8,015
Southampton..... ,,	59,916	251,518	139,858	243,150,200	91	5,222	1,395
Taunton ..... ,,	16,614	70,448	35,000	52,838,400	14	1,200	366
Waterford ..... ,,	112,768	...	27,000	38,742,400	19	951	356

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THE SPRAGUE MOTORS AT RICHMOND, Va.

BY ALBION T. SNELL.

A Paper recently read before the American Institute of Electrical Engineers contained some interesting data of the Richmond motors. The undoubted success attained by the engineers of the Sprague Company justifies the writer in examining more closely the peculiarities attributed to these motors. Let it be clear, however, that it is not intended to criticise in a captious spirit what is really a very successful application of electricity to street-car driving. The object is rather by a close examination to see whether there be any marked difference between English and American practice in motor design, and further to appreciate the meaning of such differences if any be found.

Thanks to Mr. Sprague, we are enabled to see some of the points peculiar to the Richmond machines. This gentleman gave in his Paper a series of curves, which purport to illustrate their chief characteristics. These curves are reproduced with a few additions by the writer.

On first examining them the writer asked himself why they were ever published in their present form? As they stand, with the exception of the curve O A, they are purely theoretical. They refer to an imaginary motor of 3·65 ohms running at a constant potential of 400 volts, and having no losses other than that due to ohmic resistance with 10 per cent. increase allowed for heating. Such an assumption can make no proper allowance for material friction, hysteresis, or self-induction. The former cause of loss of energy might perhaps be included by a percentage. But the latter are variable, being both of them small at low outputs, and increasing somewhat irregularly with the load. It is the writer's experience that the losses resulting from hysteresis and self-induction are too large to be neglected, and, moreover, they vary so in different machines and with various loads, that the extent of the error can only be estimated by a brake test. If curves E D C, O F C, and O D G had been plotted from a series of brake tests, the writer believes that very different results would have been obtained.

It probably is Mr. Sprague's opinion that the effects of hysteresis, &c., are included in the curve O A. Let us examine this curve more closely. O A is the external characteristic of the machine, run as a series dynamo on a variable external resistance, at 856 revolutions per minute. This consequently includes the dynamo reactions of the armature, and also the effects of hysteresis; and the characteristic of the machine, run as a motor at the same speed and currents, would probably approximate closely to it. But its significance is lost in the deduced curves III., IV., and V., owing to the uncertainty attached to curve B C. This latter is assumed to be a linear function of the current, and is plotted from $e = E - C R$. This equation is, on the above assumption, only true if the value of R be constant. Since R is necessarily a variable, owing to induction and hysteresis being included in it (in Sprague calculations), an error creeps in, the magnitude of which is uncertain. Now, if brake tests had been made to determine the curves here deduced from I. and II., which are really the fundamental ones, this uncertainty of internal resistance would have been of no moment for practical purposes. Mr. Sprague, however, proceeds to combine I. and II., and thus plots the speed curve of the motor for different currents at a constant potential of 400 volts.

The work curve IV. is next obtained by multiplying the several currents by the corresponding value of e, and dividing by 746. It expresses the work as a function of the current. It will be noted that the effective horse-power of the motor is assumed to be $\frac{Ce}{746}$, and that the curve is quite symmetrical. If brake tests had been made to plot IV., the writer suspects that the dotted curve would more nearly approximate to the actual readings; in fact, the effective horse-power would not only be generally less than that shown, but the divergence from theory would be the more marked as the load increased. Also the maximum work would be given by a current considerably less than that determined by the condition $C = \frac{E}{2R}$, where E is the E.M.F. of supply.

The next important curve, V., expresses the work as a function of the speed. This should also have been plotted from brake tests. Its real form would then be somewhat like the dotted curve 5, in which the values of the ordinates (speed) are less for a given current than in the published curve. This is principally due to a certain quantity of energy being absorbed by hysteresis in the armature, and also by induction in both armature and field. The chief effect is seen in the increase of current required for a given output over that determined by the calculations used in the Sprague curves.

The remaining curves need no special reference. They are based on the effective horse-power being equal to $\frac{Ce}{746}$, and hence stand or fall by the others. The tractive effort expressed as a function of the speed in curve K L and in terms of the current in O H is instructive, and subject to the corrections indicated is of considerable use. The so-called car curves serve to give a rough idea of the efficiency of the motor at different speeds. The value of a (constant for each part of the work and speed curve) diminishes in value as the efficiency increases. The current required at each point can be read direct from the abscissæ by reference to the speed and current curve when the value of n is determined. There is one curve omitted. That is the efficiency curve or ratio of B.H.P. to E.H.P. The theoretical efficiency $\frac{Ce}{CE}$ can, of course, be obtained by inspection from the published curves.* But it would be more satisfactory to see a curve plotted from brake tests. It would be found to be somewhat as shown by the dotted lines in curve 6. The efficiency would be zero till a value of c was reached sufficiently large to overcome the static friction of the motor it would increase rapidly with the load, and attain a maximum somewhere about 25 amperes, and not with zero current as shown in the Sprague curve.

It is more convenient, however, to refer the efficiency to the speed of the motor. Brake tests are taken, and speeds plotted as abscissæ, and E.H.P. as ordinates. Curve E E then gives E.H.P. as a function of the speed. Taking B.H.P for ordinates, and using the same abscissæ, O e is traced. This expresses B.H.P. in terms of speed. The ordinates of O e are then divided by ordinates of E E, and plotted to any convenient scale. The resulting curve O F F gives us $\frac{\text{B.H.P.}}{\text{E.H.P.}}$ as the true commercial efficiency. It must be noted that the maximum of the B.H.P. curve and the efficiency curve do not coincide with the same speed. They do so, however, if the horse-power be taken as C e. Mr. Sprague has done this. Hence his output is a maximum with 50 per cent. efficiency, while really the output for 50 per cent. efficiency is less.

The following curves based on brake tests of various series-wound motors will serve to show some reasons for the writer's criticisms, and will support his objections to Mr. Sprague's treatment of the subject.

It will be noted that each diagram contains three curves, severally denoted by $\frac{E}{n}$, $\frac{e}{n}$ and $\frac{\text{B.H.P.}\ 746}{nc}$. In all of them the symbols have the same meaning. E = the terminal E.M.F.; e = the theoretical back E.M.F. found from equation $e = E - CR$, where R is the ohmic resistance of the motor measured hot; n = the number of revolutions per minute; and C = the current in amperes. The two first speak for themselves; they severally represent the number of volts required to perform certain work during one revolution. The last quantity $\frac{\text{B.H.P.}\ 746}{nc}$ is of the same order—viz., a definite number of volts absorbed per revolution in actual work on the brake. Note that the measured B.H.P. multiplied by 746 gives the available useful horse-power in watts—that is, a quantity that can be

* If the ordinates of II. be divided by four, the theoretical efficiency $\frac{e}{E}$ is given as a percentage for corresponding currents.

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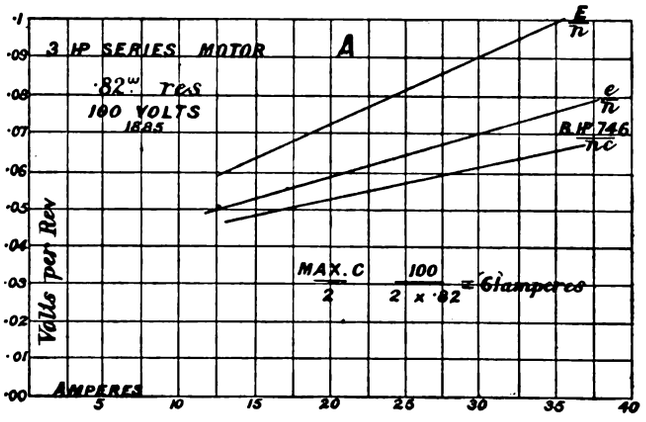
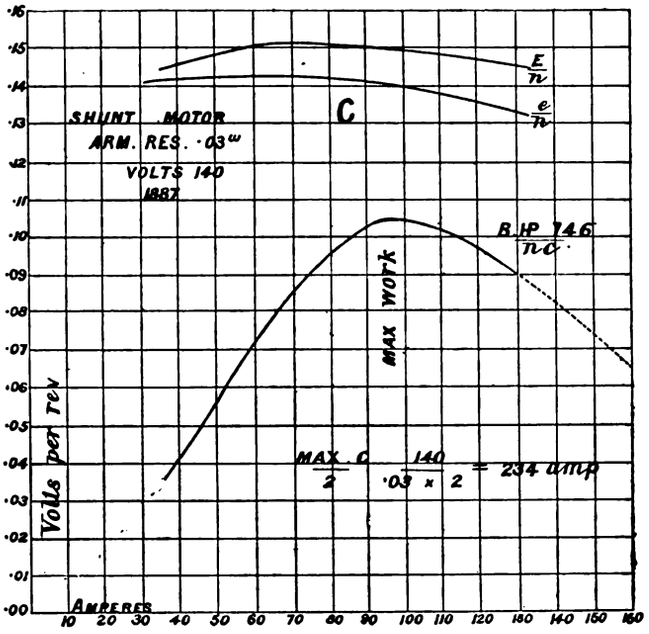
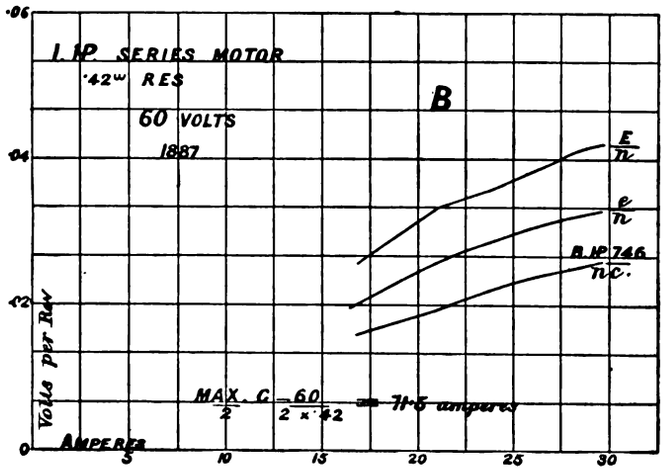
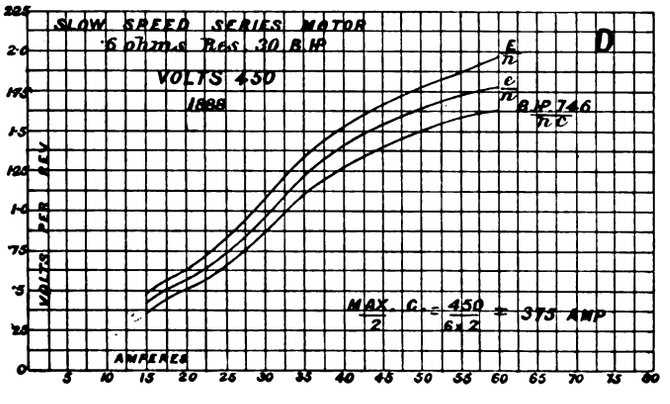
Diagrams A, B, C and D are traced from brake tests of motors by three of the principal English manufacturers. They show graphically the large amount of energy lost by causes other than simple ohmic resistance. And, further, it will be noticed that this *extra* loss increases with the load. This is shown by $\frac{e}{n}$ and $\frac{\text{B.H.-P.}\ 746}{nc}$ not being parallel. The motors have not been selected on account of their high efficiency, but rather to illustrate the progress of motor design between the years 1885 and 1888. Each machine is fairly representative of the year of its construction. The writer desires to draw particular attention to the gradual reduction of ohmic resistance, and the consequent decrease of current for maximum output.









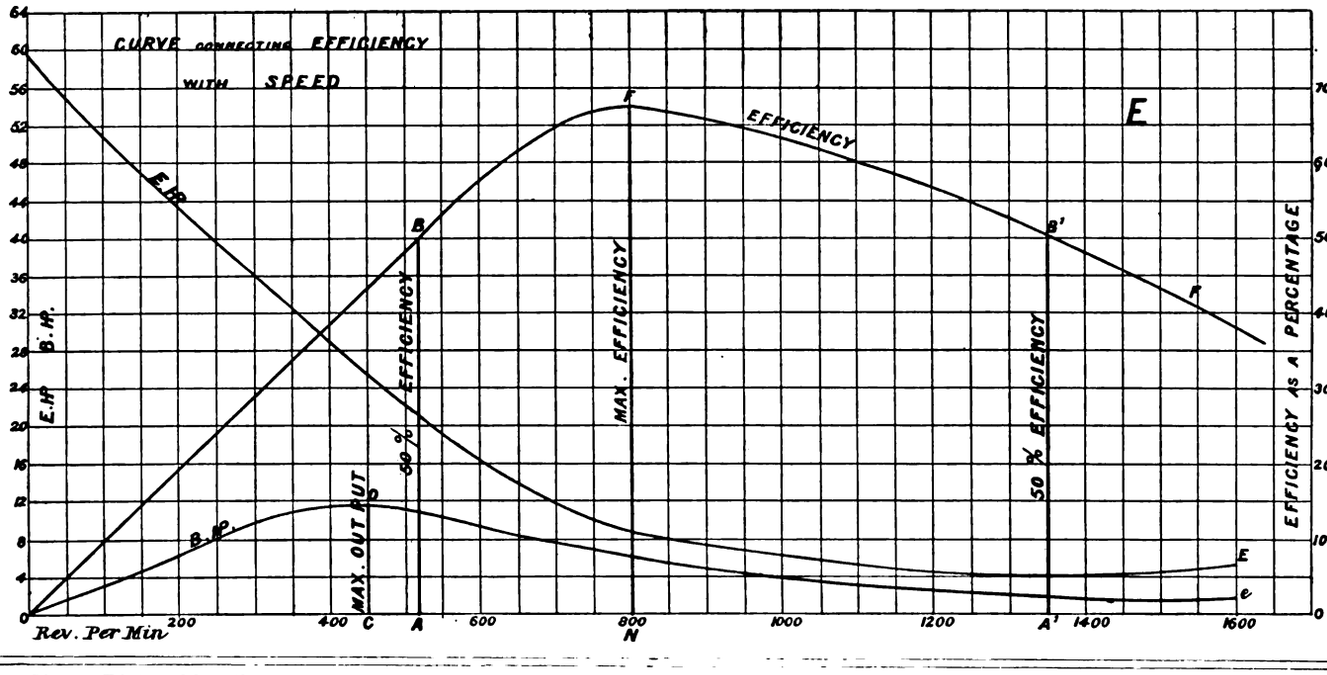


Diagram E is traced from the Sprague curves, with the B.H.-P. readings corrected as indicated by the writer. Curve E E is simply the values of the E.H.-P. for the different speeds. O e is an approximation to the corresponding B.H.-P, and O F F is the commercial efficiency. It will be noted that the efficiency increases at first with the speed, and, after attaining a maximum at 800 revolutions, slowly decreases, passing through two points of 50 per cent. efficiency. The first 50 per cent. is given at a speed of about 500 revolutions; the second at 1,350, approximately. Neither of these correspond with the maximum output, which is given at 450 revolutions. If the internal resistance were lower, the curve would reach its maximum more rapidly and approach the second 50 per cent. reading more slowly. That is, the distance between B and F would be less, and that between F and B' considerably increased. This would give a large range of work with a small variation of efficiency—one of the main considerations in motor design. On reference to the Sprague curves, it will be seen that the maximum output is assumed to be at 400 revolutions and 50 per cent. efficiency (the first one on Diagram E), and the efficiency to vary according to curve II.

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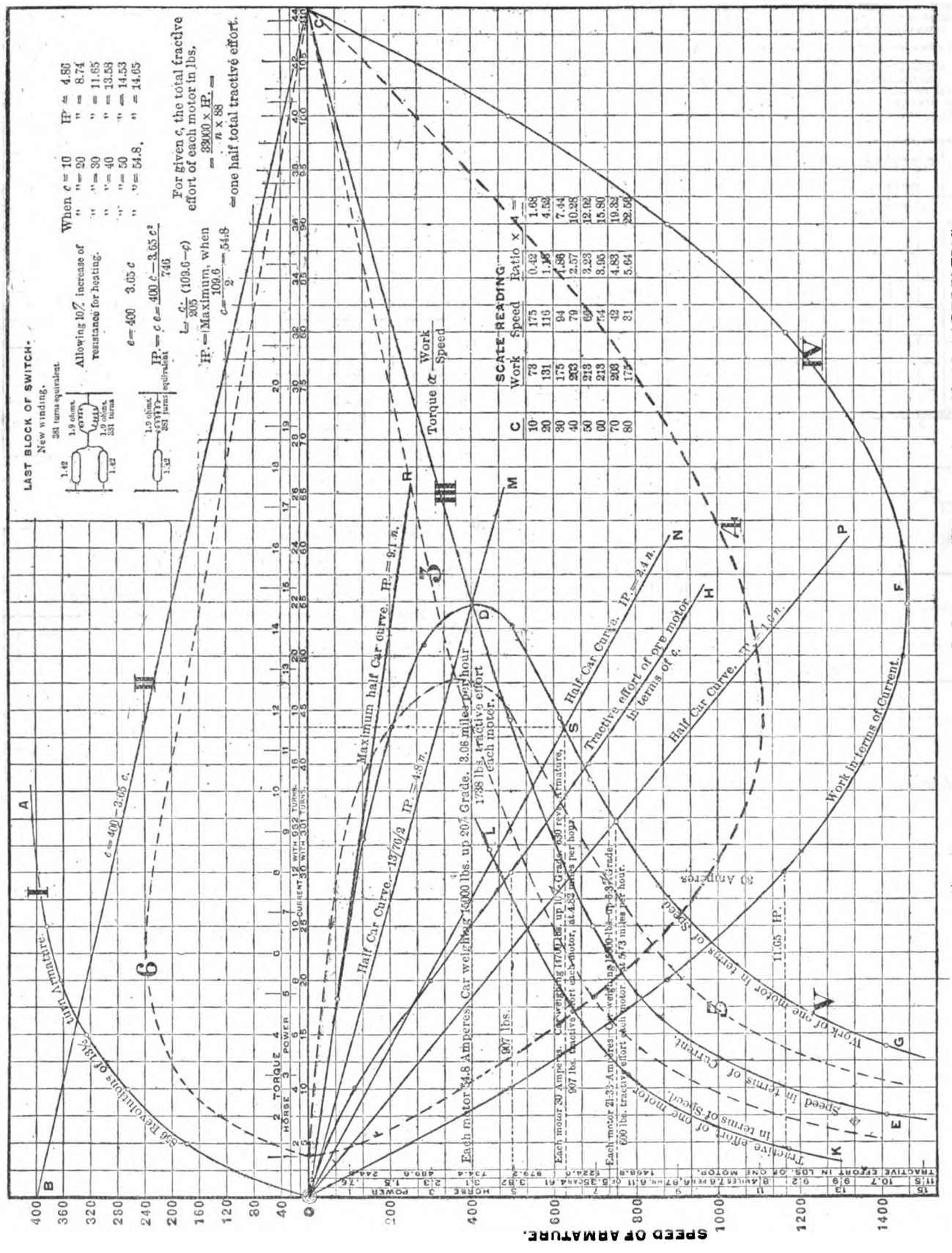
LAST BLOCK OF SWITCH.
New winding.
381 turns equivalent.
1·9 ohms.
331 turns
1·42
Allowing 10% increase of resistance for heating.
1·9 ohms.
331 turns
1·42
1·9 ohms.
381 turns
1·42
equivalent
e = 400 3·05 c
IP. = c e = 400 c − 3·65 c²
746
= c (109·6 − c)
205
IP. = Maximum, when c = 109·6 / 2 = 54·8
For given c, the total tractive effort of each motor in lbs. = 23000 × IP. / n × 88 = one half total tractive effort.
When c = 10 IP = 4·86
" " = 20 " = 8·74
" " = 30 " = 11·65
" " = 40 " = 13·53
" " = 50 " = 14·53
" = 54·8, " = 14·65
SCALE READING
C | Work | Speed | Ratio x / y
10 | 78 | 175 | 0·42 | 1·68
20 | 131 | 116 | 1·16 | 4·53
30 | 175 | 94 | 1·86 | 7·44
40 | 203 | 79 | 2·57 | 10·28
50 | 213 | 66 | 3·23 | 12·92
60 | 213 | 64 | 3·05 | 15·80
70 | 208 | 43 | 4·83 | 19·32
80 | 175 | 31 | 5·64 | 22·56
Torque = Work / Speed
Maximum half Car curve. IP. = 9·1 n.
Half Car Curve. 13·76/2 IP. = 4·8 n.
Each motor 34·8 Amperes. Car weighing 15000 lbs. up 2% Grade. 3·06 miles per hour 1738 lbs. tractive effort each motor.
Each motor 20 Amperes. Car weighing 17760 lbs. up 1% Grade. 6·30 revs. armature, 907 lbs. tractive effort each motor, at 4·82 miles per hour.
Each motor 21·33 Amperes. Car weighing 15000 lbs. up 0·3% Grade. 600 lbs. tractive effort each motor at 5·73 miles per hour.
Half Car Curve. IP. = 2·4 n.
Tractive effort of one motor in terms of c.
Half Car Curve. IP. = 1·6 n.
Work of one motor in terms of Current.
Work in terms of Current.
Speed in terms of Current.
Tractive effort of one motor in terms of Speed.
11·05 IP.
30 Amperes
907 lbs.
Turn Armature.
Sub Revolutions of Disc.
HORSE POWER
TORQUE
CURRENT
TRACTIVE EFFORT IN LBS. ON ONE MOTOR.
SPEED OF ARMATURE.

-CURVES ILLUSTRATING ELECTRIC RAILWAY MOTOR CHARACTERISTICS.

The dotted curves 3, 4, and 5 are rough approximations to what would be obtained by brake tests. They severally refer to the Sprague curves III., IV., and V. Curve 6 is intended to show the order of the efficiency curve plotted as a function of the current.

expressed by the symbol C E. We know the current flowing for any load, but do not know the exact fraction of the applied E.M.F. usefully employed in external work. But if we divide the B H.P. expressed in watts by the known currents, the value of the unknown volts, e, is given. This quantity divided by n is plotted in the lowest curve. The efficiency is given by dividing the lowest ordinates by the value $\frac{E}{n}$ for the same currents.

The quantities are divided by n simply because it is practically difficult to make a test with constant values of n. Since n is nearly proportional to e, and is the same for the three ordinates corresponding to each value of c, no error of importance is introduced.

Indeed, very regular curves can be plotted from a series of tests giving large variations of n.

These curves show on inspection two things of great importance when considering the design of a motor. The height of

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the ordinate between $\frac{E}{n}$ and $\frac{e}{n}$ shows the E.M.F. lost over the ohmic resistance of the machine; that between $\frac{e}{n}$ and the lowest curve shows the E.M.F. lost from all other causes, viz., material and magnetic friction, and by induction. These three curves give at a glance the value of the motor as a converter of energy, and they show not only where the losses occur, but they give the magnitudes.

Mr. Sprague has assumed that $\frac{e}{n} = \frac{\text{B.H.P. } 746}{n\,c}$ in his curves. In judging for himself of the value of such an assumption the reader is reminded that the difference in value between $\frac{e}{n}$ and $\frac{\text{B.H.P. } 746}{n\,c}$ will tend to increase largely as the current is raised (*see* diagrams A, B and D). This is due to the resulting intense magnetic field and the consequent errors from abnormal values of Foucault currents, hysteresis, induction, and variation of lead. The possible values of current in motors of English design are shown by the figures in the diagrams. The truth of these statements will be apparent to engineers accustomed to motor work.

It may be noted that in plotting these curves for shunt-wound motors it is necessary to run at a constant potential. This precaution is necessary since the field strength does not vary directly with that of the armature, but is simply proportional to the terminal E.M.F. A diagram, C, is given to show the order of these curves when plotted from a shunt-motor test. The large variation of efficiency for different loads and the point of maximum conversion are well marked.

Having thus given some general reasons for not accepting any but brake tests as criteria of the performance of an electric motor, it is proposed to examine some of the peculiarities of the Richmond type.

The writer first notes the high ohmic resistance. 3·65 ohms hot, for a series motor running with 400 volts and at speed varying between 400 and 1,400 revolutions per minute, is a very high resistance. English practice would reduce this to something like ·65 ohm. The gain would be obvious, the area enclosed between $\frac{e}{n}$ and $\frac{E}{n}$ would be reduced to about one-sixth; this means the heat-waste would be reduced by over 80 per cent. The self-induction of the armature would also probably be less. All of these mean a higher all round efficiency.

The evil effects of this high internal resistance are seen in the characteristic O A, which shows signs of drooping even with 25 amperes, or about one-half the current required to give the maximum work the motor is designed for. The writer believes that Mr. Sprague uses no external resistance for starting the motor. This may be the reason of the high ohmic value.

The English practice is to use a temporary resistance for starting and to run on a minimum motor resistance when under weigh. This economises power, for the loss is a maximum only when starting, and there is no continual heavy waste of power as must obtain with the Richmond motor if designed in this manner.

The writer is next astonished at finding the motor designed to give its greatest output at half the maximum current. One sees in all the text books the statement that a motor gives its maximum output with a value of $\frac{E}{2}$ for its back E.M.F. Now, as a mathematical illustration of an easy application of the calculus this is interesting; but even if it were true in practice the mere fact of the heat-waste being equal to the useful output should prevent one from designing a motor to work at this point. Take the Richmond motor, at half maximum current the speed is 400 revolutions, and the assumed effective horse-power is 14·65, and *the heat-waste is also 14·65 horse-power*. How long would the motor run with such a furnace at work inside it? And note the car speed for this current is about three miles per hour, and so this must occur frequently. Well, the writer cannot explain this, for the actual total losses would be far more, and the efficiency correspondingly less, if the value of $\frac{\text{B.H.P. } 746}{n\,c}$ were known.

In ordinary English practice a motor absorbing 50 amperes and say 100 volts, and running an eight-ton car at about three miles per hour, would have an internal resistance of some ·25 ohms. The waste heat would be some ·84 horse-power. The same motor would be designed to give a maximum output at about 200 volts and 100 amperes, the heat-waste then being approximately 3·35 horse-power, the speed about three miles per hour, and the efficiency some 60 per cent. But the makers would never think of running the motor at half the maximum current for the sake of getting maximum output. With this motor the $\frac{\text{max. C}}{2} = 400$ amperes. Indeed, the writer has made hundreds of brake tests of motors of all sizes between one-man power and 100 horse-power, but has never found it safe to push the load to this point. In fact, motors are so designed on this side of the Atlantic that at half the maximum current the safe working load would be far exceeded.

Exception must also be taken to the statement that "no matter how the field may be changed, the speed of the motor at 50 per cent. efficiency is a constant." This is true on the assumption that $\frac{e}{E}$ gives the efficiency; but a brake test would give very large variations of speed for a ratio of $\frac{\text{B.H.P.}}{\text{E.H.P.}} = ·5$ when the field windings are altered.

The writer is tempted to leave the simple question of motor design and consider the gearing of the Richmond cars. Here great ingenuity is displayed, and a sound mechanical method is employed which combines the advantages of a positive gear with the flexibility of a friction clutch or belt. In fact, the mechanical work seems to be better than the electrical.

If the Sprague motors, as exemplified by the Richmond curves, are fairly representative of the American machine, it would appear that the English electrical engineer has not much to fear in the matter of competition. The Richmond motor, indeed, seems to compare hardly favourably with the 1885 type of English manufacture, and it cannot be said to be on a level with the best home practice of the current year (judging from Mr. Sprague's Paper and curves). The writer, however, thinks that, in all probability, the success attained at Richmond is due to a better motor than the one selected for the curves.

However, be this as it may, it must be granted that commercially electrical engineering in America is far more advanced than in England. It will be profitable to ask why this is so, since in motor design we are apparently far ahead of the American engineer. The reasons are various, and not far to seek. England is an old-established country, with large vested interests, and necessarily a conservative spirit, not disposed to changes of any kind. Repressive legislation has also told its tale. Reckless speculation and often gross incompetency have further hindered the commercial progress of electricity. But practically great advances have been made in all departments. In America the case is very different. The general spirit is more liberal, and new things are readily tried, for novelty always tells. Moreover, success is judged on broad lines rather than details. There seems to be further a spirit of enterprise in America which is wanting in the old country. It is such a spirit that led to the Richmond tram line and gives America another *biggest thing*—this time in electric tramways.

CENTRAL INSTITUTE FOR TECHNICAL EDUCATION.—The Session of the Central Institution of the City and Guilds of London Institute will commence on October 2nd. The Clothworkers', Siemens', Mitchell, and Institutes' Scholarships will be competed for at an examination held on September 25th to 28th. We may remind our readers that the courses of instruction include lectures on Mathematics, Engineering, Chemistry, and Physics, and laboratory and workshop practice.

NOTICE OF REMOVAL.—Messrs. Thompson and Rew notify that on and after 1st Sept. their offices will be at 7, Westminster-chambers, Victoria-street, London, S.W.

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ELECTRIC TRANSMISSION OF POWER FOR A WIRE-ROPE RAILWAY.

A correspondent of the *Daily News*, writing from Lucerne, gives an interesting account of a wire-rope railway or tramway line on the side of the Burgenstock, for which electric plant is employed to transmit energy from a waterfall three miles away to the hauling station at the upper end of the line. We have taken the liberty of slightly editing the technical details, but the article runs substantially as follows :—

"An electric mountain railway—the first of its kind—has recently been opened to the public at the Burgenstock, near Lucerne. The fact is interesting to tourists, because it opens up a charming mountain resort hitherto somewhat inconveniently approached, and it is important to electricians and engineers because of the novelty and skill which have entered into its accomplishment, and because of the extraordinary difficulties which have been surmounted. Hitherto it has been considered impossible to construct a funicular mountain railway with a curve, but the new line up the Burgenstock has achieved that feat under the superintendence of Mr. Abt, the Swiss electrical engineer. The rails, in fact, describe one grand curve formed upon an angle of 112 degrees, and, by an arrangement of wheels for the cars known as the 'System Abt' the journey is made as steadily and smoothly as upon any of the straight funiculars previously constructed. The Burgenstock being almost perpendicular, it would have been impossible to construct a railway upon the old plan. A bed has been cut for the most part out of the solid rock in the mountain side from the shore of the Lake of Lucerne to the height of the Burgenstock—1,330 feet above its level, and 2,860 feet above the level of the sea. The total length of the line is 938 metres, and it commences with a gradient of 32 per cent., which is increased to 58 per cent. after the first 400 metres, and this is maintained for the rest of the journey. A single pair of rails is used throughout, with the exception of a few yards at half distance to permit the two cars to pass. Through the opposition of the Swiss Government each car is at the present time only allowed to run the half-distance, and they insist upon the passengers changing, in order, as they say, to avoid collision or accident. I have made a number of journeys up and down the mountain in company with an engineer, and the experience is sufficient to prove that the prohibition is altogether unnecessary. A committee of Swiss, German, and French engineers have also examined the line, and state that each car could run the whole length without fear of accident. With the safeguards and precautions employed it appears to be well nigh impossible for the cars to meet at the passing point of the double rails.

"The current is generated by two dynamos, each of 25 horse-power, which are worked by a water-wheel of 125 horse-power, erected upon the River Aar at its mouth at Buochs, three miles away. The current is conducted by means of insulated copper wires to a pair of electric motors, of the same power, which are placed at the head of the railway. The loss of energy in transmission is estimated at 25 per cent. The motors are connected by leather belting with two large pulleys on a countershaft, which is connected with a set of movable conical cogs, from which the big wheel over which the wire-rope passes is driven. To give the rope adhesion it is wrapped under and over two smaller pulleys, and then for a second time over the larger wheel. The arrangements for applying the power are of the simplest character. Only one man is required to manage the train, and the movement of the cars is completely under his control. One dynamo is sufficient to perform the work of hauling up and letting down the cars containing fifty or sixty persons. With a switch the conductor regulates the amount of current according to his requirements. He communicates by electric signals with the man at the water-wheel when the cars are about to commence their journey, and the latter in turn regulates the water-power applied. A finger moving along a figured disc before him by means of a millimetre screw at the rate of a millimetre to every metre of the railway, enables him to see the exact position of the cars on the line at any given moment of the journey, and he can increase or slacken speed accordingly. In addition to this the cars themselves give him a signal at stated points. For instance, at a distance of one metre and fifteen metres respectively after the car leaves either the upper or the lower station, the flanges of the wheels pass over an electric plate, and a bell is rung in the machine room. The same signs are given when they arrive within fifteen metres and one metre of the half distance, so that the cars are themselves their own signalmen, and the driver knows exactly when to shut off power. At the end of the journey, completed in about fifteen minutes, at an ordinary walking speed, the car moves gently against a spring buffer, and is locked by a lever, without noise and without jolting the passengers.

"The precautions for safety are complete. In the first place it is well nigh a physical impossibility for the cars to collide at the passing point. In that part where the double line is laid for this purpose the two outside rails are direct, the inner rails 'broken' and guarded. The wheels on one side of each car have a double flange fitting the rail closely ; on the other side they are merely broad drums, which pass easily over the crossing ; and as there are no facing or other points, it is impossible for either car to move forward to the wrong set of rails. Then suppose the wire rope were to break, the car would simply stop dead. A double set of teeth are fixed in the middle of the track, and over them moves a cog-wheel running beneath the car. As soon as the tension of the rope ceases, a pair of steel bands fall upon the outer rim of the wheel, and hold it firmly there. The guard has a break lever, which he can instantly drop with similar effect. At the same time a steel 'anchor' moves forward underneath the two sets of teeth, and as the levers drop, the two 'arms' spring up and clench the car firmly to the rails from below. In such a contingency the passengers could easily step down and regain either the summit or the lower level by a flight of 3,000 steps built up the inner side of the track.

"This interesting undertaking has been carried out at a cost of £25,000. The water wheel is also employed to light the whole of the hotel buildings and its grounds by electricity, and when the railway is not working, another dynamo pumps up spring water a thousand feet for use in the establishment. To tourists the new railway will be the means of opening up the delightful views from the summit of the Burgenstock, which can be reached in half an hour's walk from its upper station."

From a rather obscure sentence which we have omitted above we gather that the motors derive their current from a set of accumulators at the station and not directly from the dynamos. This arrangement would probably be adopted not only for the sake of economy in the mains but also to avoid the possibility of accident arising from an interruption of the charging circuit.

TELEPHONE SYSTEMS OF LONDON, MANCHESTER AND GLASGOW.

The following article appeared in the *Financial News* of the 27th instant :—

"Agreeably to your request I have examined the various systems of telephonic communication in use in England and Scotland. I have treated the three great representative centres, viz., London, Manchester and district, and Glasgow and district, separately, and compared them with each other. I have looked at the subject from a technical point of view ; but, as far as possible, treated it in popular language, the intention being that your readers should be enabled to judge of the relative merits of the companies concerned, viz., the United, the Lancashire and Cheshire, and the National, and of their management.

"Beginning in the north, I examined first the National Company's system. This company has now in Glasgow 1,570 subscribers. The wires converge into six central exchanges, which are connected with each other by means of from eight to 25 junction wires. The wires are entirely silicium bronze of No. 18 gauge. This wire weighs only 35lb. to the mile against 220lb. per mile in the case of the old Post Office wires and the telephone wires commonly seen in London. The wire has the peculiar quality of returning to its normal position immediately after the snow or frost has melted off, and it contracts or expands but slightly through the action of cold or heat. Being very thin, it collects little snow, and owing to its lightness can, if broken, do little or no damage in falling. The wires are carried over the housetops by means of iron poles which rest in sockets on the roofs, and are supported by stays of twisted galvanised wire. On the principal routes five iron poles, with arms stretching across, after the pattern of a gridiron, are used. Thirty-two wires are fixed on each cross-bar, so that the five iron poles carry nearly 1,000 wires. As the distance from the exchange increases, and the number of wires becomes less, the poles are reduced to two, with 30 cross-arms carrying 10 wires each. Further on still, a single pole with 20 cross-arms carries upwards of 100 wires. The wires are attached to the arms by means of single porcelain insulators, and every joint is soldered. The use of these insulators and the soldering of the joints is of much value in producing good talking. In this connection it may be mentioned that every earth connection is also taken, regardless of distance, to the nearest water pipe and there soldered. The intercommunication, or 'switching,' is accomplished in the central offices by means of the so-called 'multiple' board system.

"Your readers are no doubt aware that a certain number of subscribers in every telephonic exchange is allocated to each of the operators in the central offices. The wires of these subscribers are all collected upon 'table,' by which means they are grouped under the control of this operator. The advantage of the 'multiple' board system is that while under the old plan great difficulty was found in practice in joining wires from table to table—that is to say, connecting with each other the groups worked by the various

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operators—under the new plan each wire has a connecting wire to each other wire on each table. It is difficult to convey on paper a clear idea of how this is done. The plan, though effective, is very costly, a multiple board capable of carrying 2,000 subscribers' wires requiring 400,000ft. of these connecting wires. Great quickness in service results, however, as every operator has under direct control a branch wire to the wire of every other subscriber in the central exchange. All the ringing from the exchange is accomplished by means of magneto-electric generators worked by a small turbine, the power for which is got from the ordinary water mains. Each operator has a key or switch connected with this ringing apparatus, and can thus use the currents at will upon any line required. One operator is found to be able to attend in Glasgow to about 60 subscribers. As regards the subscribers' end of the wire, each subscriber is provided with a magneto ringing apparatus for the purpose of attracting the attention of the operator. The old and costly system of ringing by means of batteries has been entirely discarded.

"There is no special contrivance in Glasgow by which a subscriber can notify to the operator that his conversation is at an end. In Dundee the company has adopted a sytem which enables every subscriber to put himself at once—even, say, in the middle of a conversation with another subscriber—in communication with the central office. This system works well, and has been of great benefit in promoting quick service. The vexatious delays which occur when, as is too often the case, a conversation is interrupted by the central office under the impression that the interview is over, are impossible under this system. No telephonic system can be considered complete unless it embraces some contrivance for this purpose.

"Overhead cables are little used in Glasgow. In this respect Manchester, as will be seen later on, is ahead. The whole of the National Company's system, even down to the smallest exchange in a country town, is open all the year round, night and day. Glasgow is connected by means of trunk lines with all the neighbouring towns of any importance; indeed, all the principal towns in Scotland can either now or will be able very shortly to communicate by telephone with each other.

"The Manchester telephonic exchange system differs in many ways from that of Glasgow. There are 1,350 subscribers, and the whole of their wires have been concentrated in one central exchange. The wires, which are hard-drawn copper of No. 18 gauge, are carried over the housetops by means of wooden standards, with two poles and 10 cross-arms, each supporting 15 wires. On the routes requiring fewer wires single wooden poles, with 10 wooden arms carrying eight wires each, are used. Single and double shackles insulate the wires. Glover's anti-induction 20-wire cable plays an important part in the outside wiring, and is found to be very successful. Along one route there is one of these lead-covered 20-wire cables one mile in length, the induction on which is said to be imperceptible. Several hundred wires are carried in this manner in many directions from the central exchange. Your readers are no doubt aware that it is owing to 'induction' that one subscriber can overhear the conversations of another. Hence the importance of avoiding it in telephone work.

"The multiple board has been introduced in Manchester with good results. The ringing from the exchange is accomplished both by means of magneto-electric machines driven by water power and also by means of batteries. A most convenient test-board receives all the wires as they come in from the roof. It is arranged so that by inserting a small plug the wire is disconnected either on entering or leaving the test-board. By this means all the wires can be at once tested, and if not found to be in working order they can be repaired, it may be before the subscriber has discovered the fault. All the neighbouring towns of Lancashire and Cheshire are connected to Manchester by means of trunk lines. A special charge is made for each conversation on these trunk lines, and monthly accounts for these charges are rendered to each subscriber. In order to prevent disputes the particulars of these connections are written on a slip of paper, and this slip is placed in a small machine, which stamps on it the date and the time to a minute. Three operators attend to 200 subscribers.

"A special feature of the Cheshire Company's system is the use of what are called 'polarised indicators.' I can only hope to explain the effect of these to your readers, an idea of the mechanism not being easily conveyed. To attract the attention of the central office each subscriber has a battery of four cells, which is put in action by one of two push buttons—the one white and the other black. The white button sends a current which calls the attention of the operator in the usual way, thus notifying that the subscriber desires to be connected with some other subscriber. The operator having placed him in communication and his conversation being over, by means of the black button he is enabled to notify that the conversation is at an end, and in any case to make it clear in the central office that it is to them, if to anyone, he desires to speak. In other words, he has a similar advantage in this respect to the National Company's subscribers in Dundee. But this is gained at greater expense to the company, as the apparatus and accessories are costly and liable to get out of order.

"It now remains to consider the London system, where there are now upwards of 4,800 subscribers to the United Telephone Company's exchanges. The wires are concentrated into some 20 different centres, about half of which have between 100 to 600 subscribers each, the rest having a smaller number. The largest exchange is in Coleman-street, where there are about 500 wires. Hard-drawn copper wires are now being used on new work, but the bulk of the work has been done with steel wire of No. 8 gauge, and where the largest number of wires converge they are attached to massive angle-iron tower-shaped fixtures by means of single shackles. From each corner of these fixtures two sets of upwards of 50 wires each are led off in opposite directions. Thus each of these important fixtures is designed to carry only about 400 wires. The main routes are conducted over the housetops by means of single iron poles, each having twisted wire stays to support it. The wires are arranged in one row, say, of 20 to 30 wires, reaching in a line from top to bottom of the poles, and are attached by clips and double shackles. Overhead cables are very much used, upwards of 25 of these leading away from the central City exchange. In three or more of the principal centrals multiple boards have been introduced; but in all the rest the original single-wire system remains. This, of course, entails delay, and is the cause of many of the instances of bad service which occur. The exchanges have hitherto been closed at nights and on Sundays, and are now only open in part for a continuous service. The subscribers to the London system use the original form of electrical ringing apparatus, operated by a battery—there is no separate arrangement for ringing off or calling the central office, and, in fact, no improvement of any kind has been introduced in this connection since the beginning. There has hitherto been no system of public call offices, and, with the exception of Brighton and Tilbury, no towns are connected to London by telephone. The Tilbury wire is practically disused, and the Brighton wire has been so inefficient as to lead to no practical benefit. As regards trunk wires, in fact, London may be said to be quite isolated.

"Having thus described shortly the representative centres of British telephony, and stated the plain facts in each case, let me make a short comparison of the results obtained by the companies. The question first of all arises, is it wise to concentrate all your wires into one central, as in Mancheater, or to have many exchanges, as in Glasgow and London? Under existing circumstances, and unless some better system of interswitching between exchanges can be introduced, Manchester takes the lead. It must be admitted that the expense of concentrating is very great; but still, in telephony it is pre-eminently the case that the best service, although costly, is the one that will eventually pay the best. Then as to the wires; Glasgow and Manchester undoubtedly lead the way with silicium bronze and hard-drawn copper wires of a small gauge, which are better conductors, last longer, aed exert only one-sixth of the strain resulting from the old-fashioned steel or iron wires so much in use in London. The next point is the fixtures on which the wires are carried. London again is found behindhand, for while Glasgow and Manchester carry from 100 to 300 wires on each main route, London, *with practically, as regards way-leaves, the same outlay, carries only 20 to 30.* The large angle-iron central standards in London are undoubtedly substantial, and even artistic in design, but quite unsuited for the purpose, while the only parts of the structures themselves which could conveniently and economically be used for carrying wires, viz., the flat sides, are not made use of at all!

"In the manner of the attachment of the wires to the fixtures Glasgow stands first. Single insulators, as there invariably used, have eight times the insulation resistance of the double shackle of Manchester and London, and correspondingly good talking power. In cables Glasgow is left behind.

"Descending to the switching rooms, Glasgow and Manchester are on a level footing, whilst London is just awakening to the fact that improvements upon original types exist. Manchester and Glasgow have long had an all-night and Sunday service, while London has only just begun to follow them in this. With regard to the ringing-up systems with which subscribers are provided, undoubtedly the magneto system of Glasgow is the cheapest and most efficient. Still Manchester, with the white and black buttons, has a great advantage. The London electrical ringing system is at once the most expensive and the least efficient, and has not even the redeeming feature of a special ring-off system as in Manchester. In the matter of trunk lines, Glasgow and Manchester have been at work in earnest, while London has done in effect nothing.

"With regard to the practical working it may be stated generally that London is not to be compared with the others. The causes of the delays, the induction or leakage, and the continual disconnection during conversation, which render the telephone in London comparatively useless, are to be found in the defects of the system, which, as I have shown, is in every point inferior to that in other centres."

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	3 months.	6 months.	12 months.
For Foreign Parts and Colonies :—	s. d.	s. d.	s. d.
Within Postal Union	6 6	... 12 6	... 24 0
„ Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	... 14 6	... 28 0
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THE BRITISH ASSOCIATION AT BATH: 1864 and 1888.

Although the British Association is now in its fifty-eighth year, only one of the annual gatherings has previously been held in the city which will give it a welcome reception next week. This circumstance is perhaps not surprising, for notwithstanding the claims which the ancient City of Bath may have on account of its antiquity, its historic interest, its famous though somewhat faded renown as a health resort, and its pretensions to the title of the English Florence, its attractions appeal to the fashionable rather than to the scientific world. Nevertheless, the forthcoming meeting promises to be one of some importance; and certainly there will be no shortcomings on the part of the local authorities and principal inhabitants to make it an interesting and enjoyable one; whilst the proximity of such places as Bristol, Cardiff, Chepstow, the Severn Tunnel, representing industry and mechanical enterprise; and of Tintern, Salisbury and Glastonbury, to say nothing of the Abbey Church at Bath itself, as examples of architectural splendour, will provide ample food for the miscellaneous excursionists.

We have already informed our readers as to the probable features of interest in the scientific Papers to be read at the meeting. But these Papers will derive some of their importance, over and above their intrinsic merits, from the evidence they will disclose of the progress which has been made in the

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subjects of which they treat since the Association last visited Bath, twenty-four years ago. At the meeting of 1864, Sir CHARLES LYELL was the President, his address being appropriately occupied with the "Origin of Hot Springs and the Metamorphism of Sedimentary Rocks." But amongst the Papers in Section A we find several relating to matters of more immediate interest to our readers. Prof. FLEEMING JENKIN read a Paper "On the Retardation of Electrical Signals on Land Lines," a subject which was then little understood, and which has quite recently received much attention both from the theoretical and the practical sides. Submarine telegraphy being then in its infancy, several Papers were devoted directly or indirectly to that subject, amongst which we notice one by Captain SELWYN and another by WILLIAM FAIRBAIRN. Prof. JENKIN described an Electrical Resistance Balance of Prof. W. THOMSON, who a year later was knighted for his services in connection with the first wholly successful Atlantic cable. This is the instrument now well known under the name of the Thomson Bridge, and which is of such great value for the measurement of small resistances. Mr. J. B. THOMPSON submitted a contribution to the Mechanical Theory and Application of the Laws of Magnetic Induction and Electricity. A description of a Cheap Form of Automatic Regulator for the Electric Light was given by Mr. SAMUEL HIGHLEY; and Prof. W. B. ROGERS explained an invention by Mr. CORNELIUS, of Philadelphia, for Lighting Gas by Electricity.

Meagre as is the above list compared with what we are now accustomed to, some of the items are worth recalling even to-day. Mr. J. B. THOMPSON'S induction machine, which he exhibited at the meeting, was one of this kind. It was described briefly as follows:—"The chief points of novelty appear to be that it is self-acting; the current of voltaic electricity which produces the induced current also drives the machine; the machine can be so adjusted that the quantity and intensity of the induced current shall range from that of ten Daniell cells to that of 1,000, and this without employing more than three or four cells. . . . . In this machine it [the current] is apparently a continuous flow, and no spark will jump from one electrode to the other, unless first brought in contact, as in batteries. The construction of the machine is simple, and will not easily be worn out. When modified for electro-plating it is much more efficient than the ordinary battery; for although it deposits the metal more slowly on any one article, yet it deposits it much more firmly and with a better surface than the ordinary battery does, and it will deposit the same quantity on a thousand articles at once, which enables it to deposit ten times more metal in the same time than its own exciting battery would do."

It is perhaps a little doubtful whether the machine was ever actually employed for electro-deposition on so large a scale as is here indicated, or whether it would in that case have answered all the expectations of the inventor. The machine apparently belonged to the class now known as "motor-generators" or "dynamotors," and it would be very interesting to know the details of its construction and whether it is still in existence.

Prof. FLEEMING JENKIN'S Paper is also of great interest. He gives a curve showing the logarithmic growth of the current in a circuit; but he puts the equation to the curve in terms of the capacity of the circuit, whilst we should now use the inductance. Prof. JENKIN employs some experimental results of M. GUILLEMIN to determine the electro-static capacity per foot of the wire on which the experiments were made, and found it to be nearly three times greater than that indicated by theory, neglecting leakage and induction. He finally arrives at the conclusion that the speed of WHEATSTONE'S automatic transmitter will be limited to 120 words per minute at a distance of 530 miles; but that the limit may be extended by employing larger wires, fewer posts, and a better form of insulator. Everyone now knows that this speed has been greatly surpassed, not, however, by increasing the size of the wire nor even so much by improved insulation, but by the substitution of a non-magnetic metal for the iron wire which was at that time solely employed.

The only other feature at the Bath meeting in 1864 deserving mention here is a Report of the Committee on Standards of Electrical Resistance, confirming some of the conclusions submitted in their report of the previous year. The absolute electro-magnetic system of measurement had been adopted and expounded the year previous, and the committee were at this time engaged in settling the practical standards of measurement. But although the work was not yet complete, they had arrived at the conclusion that the principal standard of resistance should be made of platinum-silver alloy. The best metal for reproducing practical standards was still under discussion. Dr. MATTHIESSEN recommended lead as the most suitable material "when great care is used," but thought it should be checked by comparison with some other metal, preferably mercury. Dr. MATTHIESSEN'S preference for lead was apparently based upon the ease with which that metal can be obtained in the pure state. The value of the mercury unit was unsettled; the resistance of a column of mercury one metre in length and one square millimetre in section in B.A. units was thought to lie between 0·9564 (SIEMENS) and 0·9619 (MATTHIESSEN). Later observations have almost invariably yielded values somewhat lower than these. A determination which has just been made by Messrs. GLAZEBROOK and FITZPATRICK gives the value 0·95352.

Our space will not admit of more detailed account of the other electrical Papers to which we have adverted; but we have said enough to mark the vast difference which has arisen in the treatment of electrical science, and the attention it has commanded in the years intervening since the British Association last visited the City of Bath.

IMPROVEMENTS IN THE TELEPHONE SYSTEM OF GLASGOW AND THE WEST OF SCOTLAND.

By D. SINCLAIR, Engineer, National Telephone Company.

In the following Paper I propose to deal with some particular features of telephone engineering as practised by the National Telephone Company in the West of Scotland, with regard both to the different kinds of material employed and also to the system of our exchanges.

The telephone has brought with it many new things when compared with the older telegraph engineering, but in none has the change been greater or more radical than in the wire now used. Iron wire, which did service for so long, we have entirely given up, unless under special circumstances. For trunk lines, *i.e.*, lines connecting towns, we use hard-drawn copper. At first we tried No. 16 B.W.G. = ·065 inch, with a resistance of 13ω per mile and a breaking strain of 200lb., but we found it was not strong enough to stand the effects of the winter, and gave it up in favour of No. 14 B.W.G. = ·083 of an inch, weighing 110lb., and having a resistance of 8·25ω per mile and a breaking strain of about 350lb. This wire we find to be the best for long lines; its relatively low resistance, apart from the other considerations of capacity and self-induction, is of great value when dealing with such lines. Its lightness, as compared with iron wire, enables a better line to be

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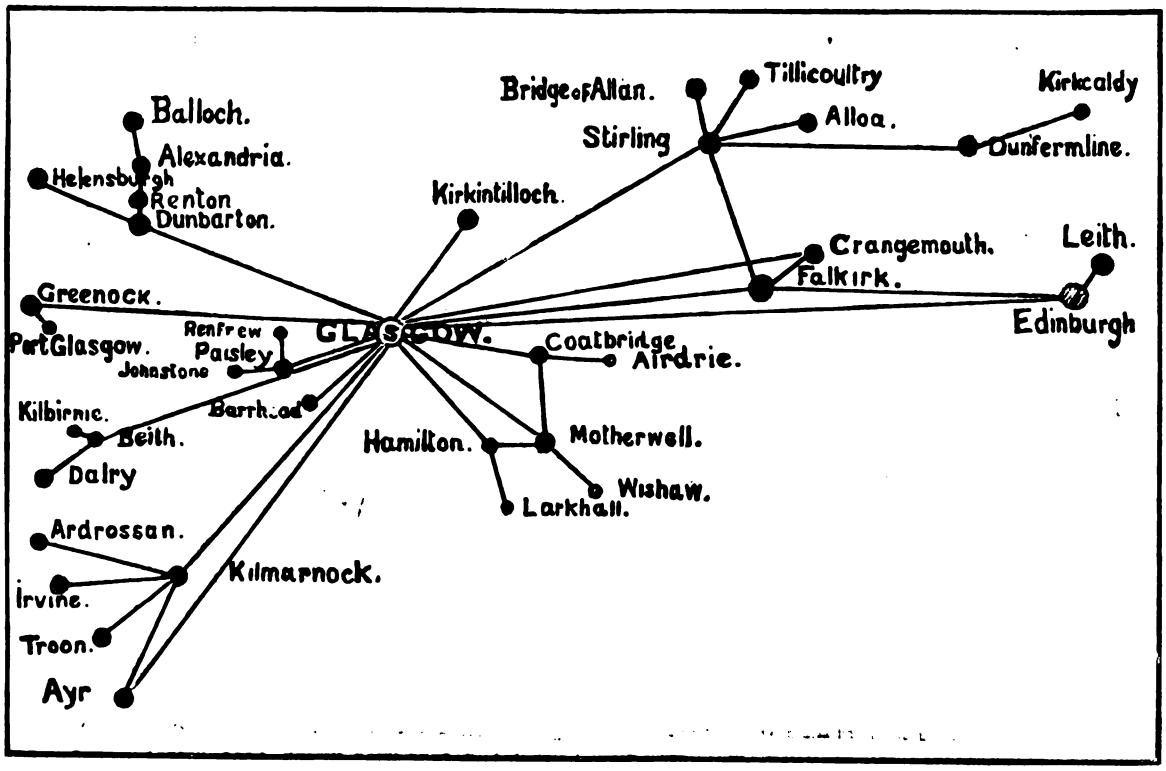
FIG. 1.—TELEPHONE TRUNK LINES IN THE GLASGOW DISTRICT.



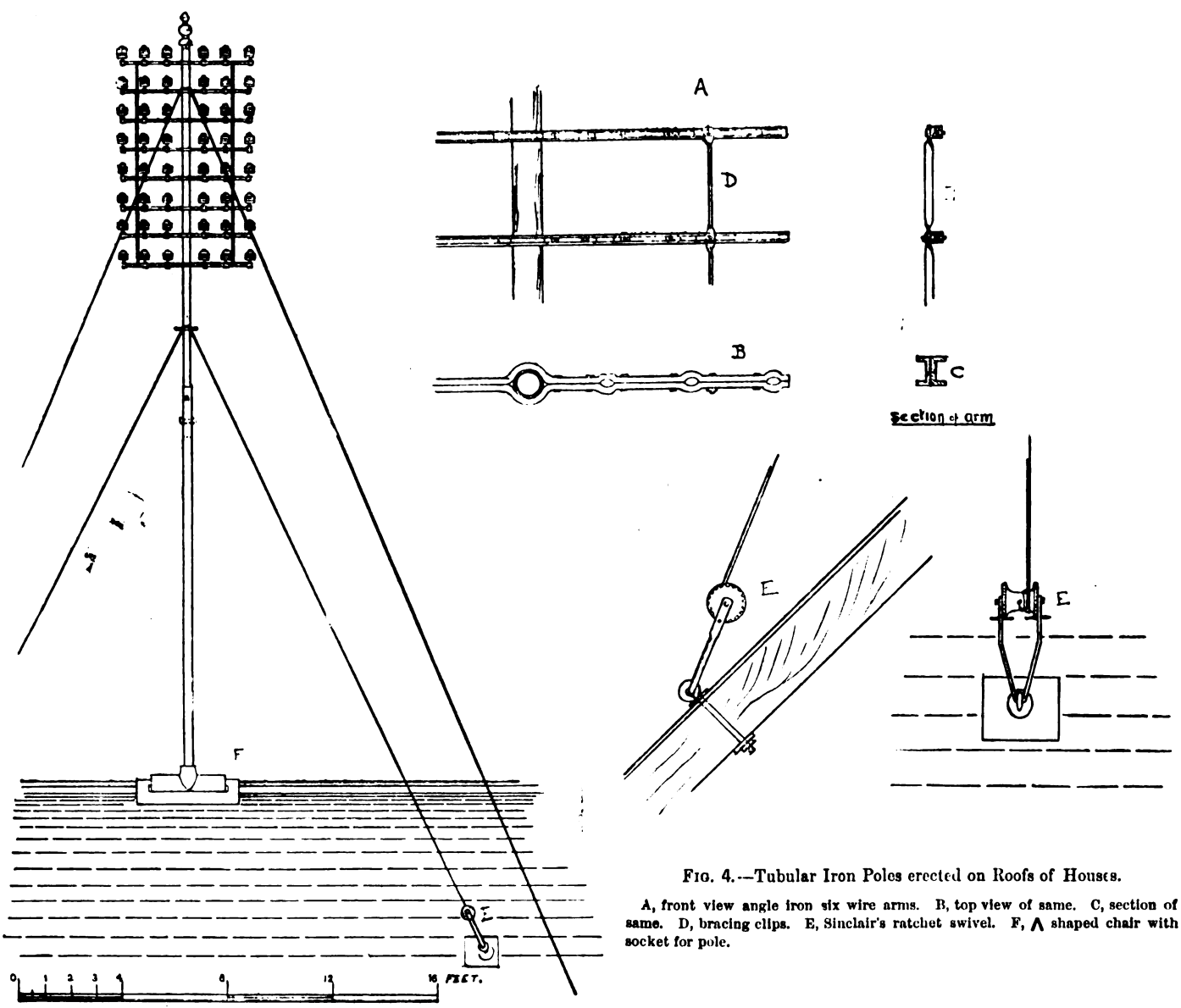


FIG. 4.—Tubular Iron Poles erected on Roofs of Houses.

A, front view angle iron six wire arms. B, top view of same. C, section of same. D, bracing clips. E, Sinclair's ratchet swivel. F, Λ shaped chair with socket for pole.

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built where staying facilities for the poles are difficult to procure, and, of course, everything else being the same, the poles can carry a greater number of these than of iron wires. Fig. 1 is a sketch map, showing the towns in the West of Scotland joined up, and between any and all of which the telephone communication is a complete business success, working from week to week with pleasure and profit to all concerned.

These trunk lines are erected with the ordinary creosoted poles and best white Cordeaux insulators. On each line we have one single wire; the others are all twisted metallic loops. I may mention that we did not approve of the swan-necked insulators as used by the Post Office, preferring to use only the ordinary 24in. and 40in. arms and upright insulators. The other patterns are difficult to keep in their proper positions. Fig. 2 shows how we have done this work, and it will be seen that the long and short arm is used alternately on each pole, the twisted loop being formed by using the end of each arm on the same side of the pole. It is sometimes found necessary to put a greater number of wires on a line of poles than can be done on the above system, and our line between Glasgow and Paisley has been erected with four wires on each arm, which wires are four sides of twisted metallic loops, the second side of the loops being on the arm immediately below; thus two arms carry four loop circuits, as shown on Fig. 3. For clearness I have only shown two loops, the one plain and the other in dotted lines. These wires have been working for the last three years with the utmost satisfaction.

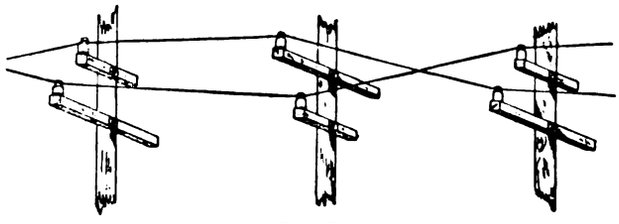

FIG. 2.

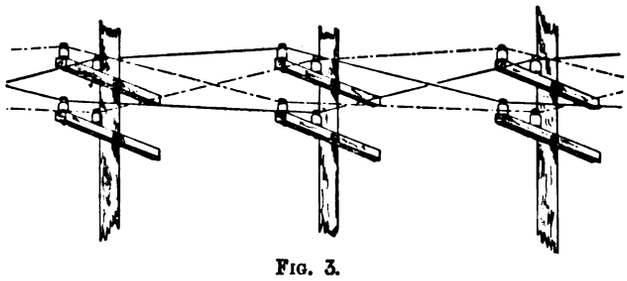

FIG. 3.

Method of Running Wires to Neutralise Induction.

Fig. 2 shows two loops on two arms (used on light lines). Fig. 3 shows four loops on two arms (used on heavy lines).

For our general exchange line purposes in towns and cities we use only silicium bronze wire, and leaving trunk lines for connecting towns out of consideration, silicium bronze wire has proved to be decidedly the best to use. We have adopted it of No. 18 B.W.G. = ·049 of an inch diameter, weighing about 39lb., and having a resistance of 75ω per mile and a breaking strain of about 200lb. The conductivity and breaking strain of this wire varies considerably, and as its breaking strain increases so does its resistance. The reasons for adopting this wire are:—

Firstly. Its great tensile strength when compared with other wires, a feature of vast importance in a city like Glasgow, where it is often imperatively necessary to have long spans of from 200 to 300 yards.

Secondly. The better appearance from the thinness of this wire causes it to be allowed by many proprietors who would certainly object to heavy iron wire.

Thirdly. The lightness of the wire permits with perfect safety the construction of standards on roofs on which can be put from 150 to 200 wires. On our ordinary single poles, as shown on Fig. 4, we consider that from 80 to 120 of these wires make a very safe and good line.

Fourthly. The most important consideration in using this silicium bronze wire is that it does not seem to deteriorate in any way. We have had it erected in Glasgow for four and a-half years. I examined samples of it lately and was not able to detect any rust or any difference in the size of the wire. This to me is very remarkable, and I wish much that the reason could be brought out. I can only say that the wire was coated with a mixture which, for want of a better name, I would call smoke and chemical impurities, which, however, are certainly successful in preventing oxidation. It may be that the compound of which the wire is made up is not affected by the Glasgow atmosphere, which has such a detrimental effect upon all kinds of iron material, and especially on iron wire.

The class of poles we use for carrying this bronze wire is shown on Fig. 4. They are made of the best rolled tube iron. The length in common use is 28ft., made up of two tubes, the lower half being 15ft. by 4in. by ¼ inch, and the upper half 15ft. by 3½in. by ¼ inch. They are jointed by the upper half being slipped into the lower two feet and secured with two strong bolts at right angles to each other, as shown on the figure. The pole is placed in a strong, cast-iron chair, made with a receptacle for it, and of such a shape as will fit the ridge of a house. When erected these poles are usually secured with eight stays, adding what more may be necessary for any special strain of wire. On these we fix channel iron arms, as shown at A on Fig. 4, using six-wire arms where pole space is of great value, and four-wire arms where there are not so many wires to be carried. This is the only class of poles we have used for the last five years for overhouse work, and we have about six hundred of them erected. They are easily converted into standards of any size required. We have some with ten-wire arms composed of two tubes in the form of the ordinary H-pole 40ft. high. These poles can be filled with arms and wires from top to bottom, and if well stayed are perfectly safe. In Glasgow they have stood the test of some very severe winters without one single mishap of any kind. Being easily erected and convenient they are doing the work required of them admirably. It is my decided and firm belief that if only these light poles and bronze wire had been universally adopted from the beginning, the principal cause for so many complaints against overhead wires would never have existed—viz., unsightliness.

(To be continued.)

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER IX.—*Magnetic Fields.*

(Continued from page 508.)

126. *The Nature of Magnetism.*—At the point now arrived at, it may be of interest to discuss briefly what is the difference in the internal condition of a piece of iron or steel before and after magnetisation. In the first place, it has long been admitted that magnetism is *molecular* in its nature, which is evident from the fact that, however we subdivide a magnetised steel rod, we have in every portion so subdivided a perfect magnet, with two poles of opposite name; and this is true, however far we carry the subdivision. So that if we conceive the subdivision carried out until the molecule itself is reached, we should expect to find it a perfect magnet.

It is only by the generalisation of experimental researches, and in the endeavour to assign reasons for, and explanations of, the effects and phenomena we observe in Nature, that her laws are discovered and real progress made in any branch of science. A consistent and logical explanation of a set of observed effects is known as a "theory" of those effects. For a theory to be a true one it must explain *all* the observed effects and phenomena, and hence it sometimes happens that a new experiment or fact observed modifies or even upsets a previously accepted theory. But a theory, though imperfect, answering all the phenomena then known is decidedly better

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than none at all, for some of our most reliable and adaptable theories at the present time have been the outcome of a long process of evolution from previously held theories.

In magnetism the observed effects to be explained might be summed up in the following questions :—

1. What is the condition of the molecules in a mass of iron or steel before the mass is magnetised ?
2. What is their condition after the mass is magnetised ?
3. On ceasing the process of magnetisation of the mass why is the polarity retained when the mass is of steel, and almost completely lost when it is of soft annealed iron ?
4. Why do blows from a hammer and mechanical strain or stress assist the process of magnetisation when the mass is in the presence of an inducing cause, and facilitate the disappearance of magnetisation when the inducing cause is removed ?
5. Why does heat produce the same effect ?
6. What is the cause of the elongation of iron when magnetised ?
7. What is the reason for the audible sounds emitted by iron during its magnetisation ?
8. If we take a magnet and de-magnetise it until there is no evident magnetism left in it, is the condition of the molecules the same as that previous to magnetisation ?

Those who were present at the Society of Telegraph-Engineers and Electricians on the 24th May, 1883, when Prof. D. E. Hughes, F.R.S., read a Paper on "The Cause of Evident Magnetism in Iron, Steel, and other Magnetic Metals," will not easily forget the enthusiasm with which the author's new theory of magnetism therein contained was received. Perhaps the greatest claim to general acceptance, and certainly the charm most attractive to his hearers, lay in the fact that Prof. Hughes completely demonstrated his theory experimentally. This, in itself, was a refreshing contrast to the necessity for imagination required in grasping the previous theories of Coulomb, Poisson, and Ampère ; the two former of whom supposed the molecule to be spherical, containing two opposite magnetic fluids, which were separated when magnetised, and mixed when demagnetised or neutral, and that a peculiar force, called coercive force, present in molecules of steel, retained the evident magnetism by preventing the involuntary mixing of the two fluids. Of this there was no experimental demonstration. Ampère supposed each molecule to be an electro-magnet; that is, an electric current was supposed to be constantly flowing round it, and that under magnetisation the molecules were symmetrically arranged, while in a neutral state they were arranged in haphazard directions. Besides other objections to this theory we have the anomaly of assuming a coercive force in soft iron to cause the rotation of at least half the molecules in order to bring about neutrality. De la Rive, Weber, and Maxwell made a step in advance by propounding the *inherent polarity or magnetism af the molecule*—that is, magnetism or polarity is a property with which the molecule is *originally endowed*, and that magnetisation of a mass of iron consists in arranging the molecules all in one direction, not developing magnetism in them. This theory also assumed that neutrality was brought about by a haphazard arrangement of the molecules.

Prof. Hughes' experiments confirm the theory of the inherent polarity of the molecule, and prove that in neutrality the arrangement of the magnetised molecules is not haphazard, but perfectly symmetrical. He also proves that simple molecular rigidity explains all the effects of the retention of magnetism previously assigned to the mystical coercive force, and sums up his theory in these remarkable words :—

"From numerous researches I have gradually formed a theory of magnetism entirely based on experimental results, and these have led me to the following conclusions :—

"1. That each molecule of a piece of iron, steel, or other magnetic metal is a separate and independent magnet, having its two poles and distribution of magnetic polarity exactly the same as its total evident magnetism when noticed upon a steel bar-magnet.

"2. That each molecule, or its polarity, can be rotated in either direction upon its axis by torsion, stress, or by physical forces such as magnetism and electricity.

"3. That the inherent polarity or magnetism of each molecule is a constant quantity like gravity ; that it can neither be augmented nor destroyed.

"4. That when we have external neutrality or no apparent magnetism the molecules or their polarities arrange themselves so as to satisfy their mutual attraction by the shortest path, and thus form a complete closed circuit of attraction.

"5. That when magnetism becomes evident, the molecules or their polarities have all rotated symmetrically in a given direction, producing a north pole if rotated in that direction as regards the piece of steel, or a south pole if rotated in the opposite direction. Also, that in evident magnetism, we have still a symmetrical arrangement, but one whose circles of attraction are not completed except through an external armature joining both poles.

"6. That we have permanent magnetism when the molecular rigidity, as in tempered steel, retains them in a given direction, and transient magnetism whenever the molecules rotate in comparative freedom, as in soft iron."

While referring the reader to the original Paper we may mention therefrom a few prominent points and experiments.

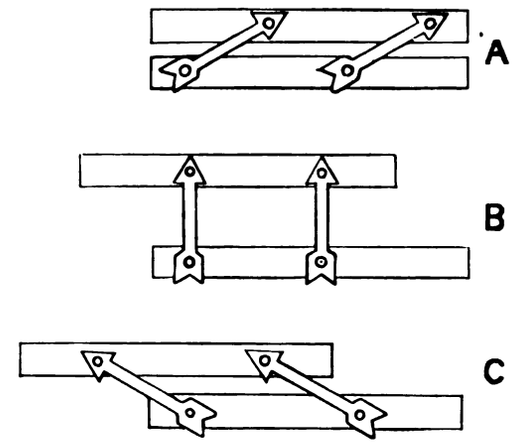

Fig. 98.

The rotation of the molecules under the action of an inducing field is rendered evident by taking a rod of soft iron and bending up the ends, by which a twist can be imparted to the rod while held vertically. The moment this is done the

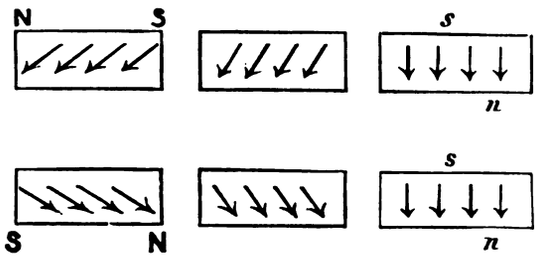

Fig. 99.

rod becomes magnetic, the field of the earth (assisted by the molecular freedom imparted by twisting) causing all the molecules to be attracted and rotated in one direction. The lower end of the rod will be found to be north. On reversing the rod and applying a twist the molecules will rotate right round, and the external polarity will be reversed, the north pole being at the end which is now the lower. With a strip of soft Swedish iron, 1ft. long by 4½ centimetres wide and ½ millimetre thick, the writer obtained by twisting while held vertically a strength of pole equal to 7·3 C.-G.-S. units, as measured on the magnetometer. A mechanical model exhibited by Prof. Hughes to illustrate the rotation of molecules is shown in Fig. 98. It is on the principle of the parallel ruler, and is shown in the three positions in which A represents the direction of the molecules when a mass of iron is magnetised one way, C their direction when the polarity is reversed, and B the immediate stage of transversal polarity. In Fig. 99, the

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molecules are shown as they exist in polarised iron or steel. The transversal polarity shown at *n s* has the external appearance of neutrality as far as the ends of the bar are concerned, but while there are external poles at all, although at the side, there is no neutrality. We have only perfect neutrality when all the mutual attractions of the molecules are satisfied *amongst each other* in the interior of the mass, and no external polarity is evident.

The inherent polarity of the molecules may be observed by drawing a rod of soft iron over the pole of a permanent magnet. This powerfully magnetises the rod and it retains sufficient magnetism when withdrawn to strongly deflect a directing needle. A few twists of the rod then completely discharges its magnetism. If the operation of magnetising,

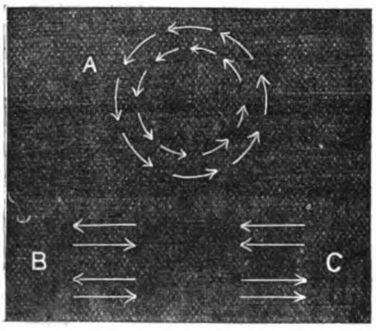

FIG. 100.

withdrawing and discharging were kept on we should expect to weaken the strength of the permanent magnet, and eventually draw all the magnetism out of it. But we do no such thing. The molecules are simply rotated each time, and the mechanical energy spent by the experimenter is proportional to the molecular rigidity of the metal.

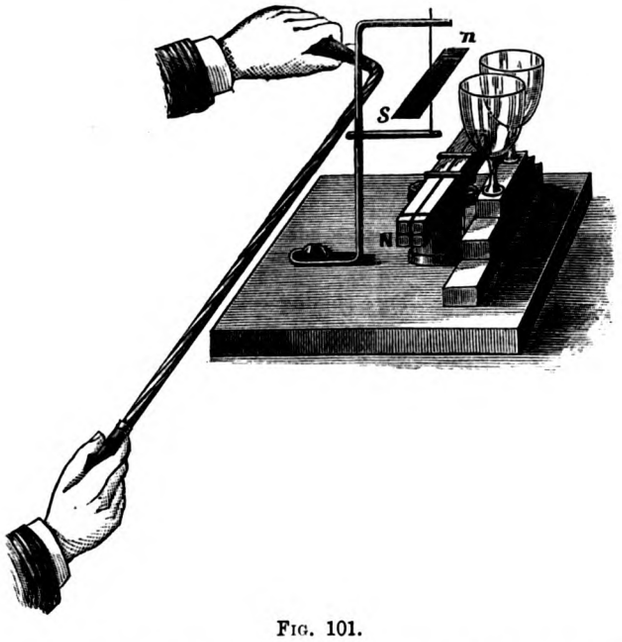

FIG. 101.

Prof. Hughes has shown that by magnetising a rod in a given direction, and then slowly demagnetising it, and again magnetising it in the opposite direction, that there is no haphazard arrangement ; every change takes place with perfect regularity and symmetry. In Fig. 100, at B and C is shown the neutral arrangement of the molecules, and at A a circular neutral arrangement effected by passing a current of electricity longitudinally through the rod.

To show the effect of torsion on the rotation of molecules, Prof. Hughes took a strand composed of about ten untempered cast-steel drill wires, each 1 millimetre in diameter, and about 1 foot long, of the kind in use by watchmakers, and fastened handles at the ends of the strand, as shown (Fig. 101). Holding one handle fast, he imparted two entire right-handed twists to the strand with the other, and strongly magnetised it on the north pole of a magnet while under this torsion. He then released the two right-handed twists, and gave it two entire twists to the left, and oppositely magnetised it on the south pole while under the torsion. On releasing the torsion the strand possessed the remarkable property of a double polarity—that is, either end could be made north at pleasure by simply twisting it one way or the other. In the figure is shown the simple bell apparatus constructed by Prof. Hughes to demonstrate the marvellous transformation of one kind of mechanical movement to another through the medium of molecular motion. The magnetic armature *n s* is held in its position by the directive force of the magnet beneath it, and when the doubly-polarised strand is held near to the armature and twisted consecutively in alternate directions, the pole of the strand near to the armature changes in name for every alternate twist and produces attraction and repulsion of the armature, which can be made to strike against the rims of the two small wine glasses some six times per second.

(To be continued.)

THE TAINTER-BELL GRAPHOPHONE.

In the account of Edison's new phonograph in a recent issue we reserved our remarks on the graphophone until we should have had the opportunity of examining and testing the instruments then on their way to England. This we have now been able to do, the machines being on view at Messrs. Glover and Co.'s office, 10, Hatton-garden, Mr. H. Edmunds, a member of that firm, having been appointed as English agent for the Volta-Graphophone Company, of Washington, U.S.A. On the day of our visit a phonogram had just been received from Mr. Chichester A. Bell, one of the patentees of the instrument, who is now in America. His voice is well known to us, and was instantly recognised as soon as the instrument was set in motion. Owing to rough treatment in the post the cylinder had been quite bent out of shape, and we were agreeably surprised to find that in spite of this only one or two words out of a long letter were slightly indistinct.

The writer has had many opportunities during the last eighteen months of experimenting with a graphophone of an earlier pattern, and though it articulated exceedingly well, the present instrument is a very great advance upon it, the improvements consisting chiefly in simplification of details of the mechanical construction, and representing the results of Mr. Tainter's ingenuity and perseverance during the last two years. The machine is driven by a treadle which runs very lightly, and it is only necessary to maintain a speed above a certain minimum, as a simple but very ingenious governor devised by Mr. Tainter causes the cylinder to rotate at the same definite speed independently of that at which the treadle is worked. The work required to drive it is much less than for a sewing machine, and a small electro-motor may of course be used if desired. The inventors, however, are of opinion that it is better dispensed with, so long as primary batteries have to be used as the source of energy, and we have no doubt that such of our readers as have used primary batteries to drive electro-motors will agree with us.

If, while dictating to the machine, the speaker wishes to pause for a moment, or if it is desired to reproduce the record sentence by sentence, for the purpose of writing it down from the dictation of the instrument, the rotation of the cylinder and the simultaneous advance of the recording or reproducing style respectively can be checked, and started again instantaneously by a slight pressure of the finger on the button of a small lever. The arrangement adopted is very much simpler than the one used for the same purpose in Edison's new phonograph.

Another great advantage of the graphophone is that when once properly adjusted by the makers no further adiustment has to be made by the user, while Edison's phonograph has to be adjusted every time a cylinder is put on, and can therefore only give satisfactory results in the hands of an expert. In Edison's instrument the wax of the cylinders is of considerable thickness, which allows each cylinder to be shaved to a perfectly cylindrical form as the record is being imprinted upon it. This has the advantage of obviating the possibility of bubbles in the surface occasionally interfering with the uniformity of the record ; but except for exhibition purposes, and possibly for the reproduction of music, the advantage is not an important one, and is more than counterbalanced by the largely increased cost of the cylinders.

It should be borne in mind that while Mr. Edison in one of his phonograph patent specifications had stated that cylinders of paper

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covered with wax, paraffin, or some such material might be used with advantage, he accompanied the statement by the explanation that the wax was only to serve as a base for a sheet of foil, of tin or other metal, on which the record, consisting of a series of indentations, was to be impressed.

The credit of replacing the imperfect indentation record by a record consisting of a continuous curve, actually representing the sound-waves, is therefore entirely due to Mr. Chichester A. Bell, who accomplished the purpose by making the record upon the surface of the wax directly. This improvement, simple though it may seem when once the idea has occurred to the inventor, was only accomplished practically by a series of careful and laborious experiments, as the heavier styles suitable for the tinfoil record were quite unsuited for use with the wax surface, and numerous difficulties had to be overcome before the present delicate and beautiful diaphragms and styles, used respectively for recording and reproducing, were perfected.

EXPERIMENTS ON CARBON AT HIGH TEMPERATURES AND UNDER GREAT PRESSURES, AND IN CONTACT WITH OTHER SUBSTANCES.*

BY THE HON. CHARLES A. PARSONS.

The primary object of these experiments was to obtain a dense form of carbon which should be more durable than the ordinary carbon when used in arc lamps, and at the same time to obtain a material better suited for the formation of the burners of incandescent lamps.

There were a considerable number of experiments made in which the conditions were somewhat alike, and many were almost repetitions with slightly varying pressures and temperatures. They may, however, be divided into two distinct classes: the first in which a carbon rod surrounded by a fluid under great pressure is electrically heated by passing a large current through it, the second in which the liquid is replaced by various substances such as alumina, silica, lime, &c.

The arrangement of the experiment was as follows:—A massive cylindrical steel mould of about 3in. internal diameter and 6in. high was placed under a hydraulic press; the bottom of the mould was closed by a spigot and asbestos-rubber packing—similar to the gas check in guns; the top was closed by a plunger similarly packed; this packing was perfectly tight at all pressures. In the spigot was a centrally bored hole into which the bottom end of the carbon rod to be treated fitted, the top end of the carbon rod was connected electrically to the mould by a copper cap which also helped to support the carbon rod in a central position. The bottom block and spigot were insulated electrically from the mould by asbestos, and the leading wires from the dynamo being connected to the block and mould respectively, the current passed along the carbon rod in the interior of the mould.

The fluid was run in so as to cover the rod completely. The plunger was then free to exert its pressure on the liquid without injuring the carbon. The pressure in the mould was indicated by the gauge on the press.

Experiments.—Class I.

Among the liquids tested were benzene, paraffin, treacle, chloride and bisulphide of carbon.

The pressures in the mould during the several experiments were maintained at from 5 to 15 tons per square inch; the initial size of the rod was in all cases ¼in., and the current from 100 to 300 amperes.

Results.—In some of these experiments a considerable quantity of gas was generated, and the press had to be slightly slacked back during the experiment to accommodate it and maintain the pressure constant.

In all cases there was a soft friable black deposit of considerable thickness on the carbon.

In no case was the specific gravity of the carbon rod increased by this process. There was no change in appearance of the fracture, excepting when chloride of carbon had been the fluid; it was greyer in this case.

The rate of burning of samples placed in arc lamps was not diminished by the process. Various rates of deposition were tried, but with the same result, and the conclusion seems to be that under very high pressures, such as from 5 to 15 tons per square inch, the deposit of carbon by heat from hydrocarbons, chloride of carbon, bisulphide of carbon, treacle, &c., is of a sooty nature, and unlike the hard steel-grey deposit from the same liquids or their vapours at atmospheric or lower pressures.

Experiments.—Class II.

In these experiments the asbestos-rubber packing was omitted, the plunger and spigot being an easy fit in the mould. A layer of coke powder under the plunger formed the top electrical connection with the rod.

No. 1. Silver sand or silica was run around the carbon rod, and pressures of from 5 to 30 tons per square inch applied; the rod was usually about ¼in. diameter, and currents up to 300 amperes passed.

Results.—The silica was melted to the form of a small hen's egg around the rod. When the current was increased to about 250 amperes the rod became altered to graphite; the greater the heat apparently the softer the graphite. There was no action between the silica and the carbon, the surface of the carbon remained black, and there were no hard particles in or on the carbon rod.

Other substances, such as a hydrated alumina and mixtures of alumina and silica, gave the same results.

The density of the carbon was considerably increased, in some cases from normal at 1·6 to 2·2 and 2·4; in these cases the carbon appeared very dense, much harder than the original carbon, and about as hard as the densest gas-retort carbon. No crystalline structure was visible.

The specimens were treated with solvents, and there appeared no indication of the surrounding substance having penetrated the rod; the carbon was undoubtedly consolidated by 30 per cent.

In some cases, when the material surrounding the rod was alumina saturated with oil, soft crystals of graphite exuded from specimens that had been kept for some weeks.

No. 2. Pure hydrated alumina, carbonate and oxide of magnesia and lime all rapidly destroyed the carbon rod, by combining with it, the hydrated alumina forming large volumes of gas, of which it appeared to be a constituent. On account of the great diminution of bulk no analysis was made; the gas issued from the mould explosively at from 10 to 12 tons per square inch. The alumina was found in a crystalline crust, like sugar, around where the rod had been. Hardness that of corundum, almost translucent.

No. 3. The following is the most interesting experiment of the series:—

On the bottom of the mould was a layer of slaked lime about ¼in. thick, over this silver sand 2in., then another layer of lime of the same thickness as the former, finally a layer of coke dust, and then the plunger. With a pressure of from 5 to 30 tons per square inch in the mould, and the carbon of from ¼in. to $\frac{5}{16}$in. diameter, currents from 200 to 300 amperes were passed.

In from 10 to 30 minutes the current was generally interrupted by the breaking or fusing of the rod, or by the action of the lime in dissolving it at the top or bottom. On opening the mould when it had cooled a little, the silica usually appeared to have melted to an egg-shaped mass, and mixed somewhat at the ends with the lime; the surface of the carbon appeared acted on, and sometimes pitted and crystalline in places; silica adhered to the surface, and beneath, when viewed under the microscope, appeared a globular cauliflower-like formation of a yellowish colour, resembling some specimens of "bort."*

After several days' immersion in concentrated hydrofluoric acid, this formation remained partly adherent to the carbon; on the surface of the carbon was a layer or skin about $\frac{1}{64}$th of an inch thick of great hardness, on the outside grey, the fracture greyer than the carbon, but having a shining coke-like appearance under the microscope.

What part the lime and silica play, whether the former only supplies moisture and oxygen which combine with the carbon, or whether the presence of lime is necessary to the action, is not clear.

We may, however, observe that so far it seems as if the lime and moisture combining with the carbon form a gas or liquid at great pressure, which, combining with the silica, forms some compound of lime, silica, and carbon, or perhaps pure carbon only, of great hardness.

* *Proc.* Roy. Soc., Vol. XLIV., No. 270.

* The bort-like powder is not acted on by hydrofluoric and nitric acids mixed.

ON AN EXPLANATION OF THE ACTION OF A MAGNET ON CHEMICAL ACTION.†

BY PROFS. HENRY A. ROWLAND AND LOUIS BELL.

In the year 1881 Prof. Remsen discovered that magnetism had a very remarkable action on the deposition of copper from one of its solutions on an iron plate, and he published an account in the *American Chemical Journal* for the year 1881. There were two distinct phenomena then described—the deposit of the copper in lines approximating to the equipotential lines of the magnet, and the protection of the iron from chemical action in lines around the edge of the poles. It seemed probable that the first effect was due to currents in the liquid produced by the action of the magnet on the electric currents set

† Paper read at the Manchester Meeting of the British Association, Sept., 1887. (Now first published in the *Phil. Mag.* for August.)

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up in the liquid by the deposited copper in contact with the iron plate. The theory of the second kind of action was given by one of us, the action being ascribed to the actual attraction of the magnet for the iron, and not to the magnetic state of the latter. It is well known since the time of Faraday that a particle of magnetic material in a magnetic field tends to pass from the weaker to the stronger portions of the field; and this is expressed mathematically by stating that the force acting on the particle in any direction is proportional to the rate of variation of the square of the magnetic force in that direction. This rate of variation is greatest near the edges and points of a magnetic pole, and more work will be required to tear away a particle of iron or steel from such an edge or point than from a hollow. This follows whether the tearing away is done mechanically or chemically. Hence the points and edges of a magnetic pole, either of a permanent or induced magnet, are protected from chemical action.

One of Prof. Remsen's experiments illustrates this most beautifully. He places pieces of iron wire in a strong magnetic field, with their axes along the lines of force. On attacking them with dilute nitric acid they are eaten away until they assume an hour-glass form, and are furthermore pitted on the ends in a most remarkable manner. On Professor Remsen's signifying that he had abandoned the field for the present, we set to work to illustrate the matter in another manner, by means of the electric currents produced from the change in the electro-chemical nature of the points and hollows of the iron.

The first experiments were conducted as follows:—Two bits of iron or steel wire, about 1 millim. in diameter and 10 millim. long, were embedded side by side in insulating material, and each was attached to an insulated wire. One of them was filed to a sharp point, which was exposed by cutting away a little of the insulation, while the other was laid bare on a portion of the side. The connecting wires were laid to a reflecting-galvanometer, and the whole arrangement was placed in a small beaker, held closely between the poles of a large electro-magnet, the iron wires being in the direction of the lines of force. When there was acid or any other substance acting upon iron in the beaker, there was always a deflection of the galvanometer due to the slightly different action on the two poles. When the magnet was excited the phenomena were various. When dilute nitric acid was placed in the beaker and the magnet excited, there was always a strong throw of the needle at the moment of making circuit, in the same direction as if the sharp-pointed pole had been replaced by copper and the other by zinc. This throw did not usually result in a permanent deflection, but the needle slowly returned towards its starting point, and nearly always passed it and produced a reversed deflection. This latter effect was disregarded for the time being, and attention was directed to the laws that governed the apparent "protective throw," since the reversal was so long delayed as to be quite evidently due to after effects and not to the immediate action of the magnet.

With nitric acid this throw was always present in greater or less degree, and sometimes remained for some minutes as a temporary deflection, the time varying from this down to a few seconds. The throw was independent of direction of current through the magnet, and apparently varied in amount with the strength of acid and with the amount of deflection due to the original difference between the poles. This latter fact simply means that the effect produced by the magnet is more noticeable as the action on the iron becomes freer.

When a pair of little plates exposed in the middle were substituted for the wires, or when the exposed point of the latter was filed to a flat surface, the protective throw disappeared, though it is to be noted that the deflection often gradually reversed in direction when the current was sent through the magnet—*i.e.*, only the latter part of the previous phenomenon appeared under these circumstances.

When the poles, instead of being placed in the field along the lines of force, were held firmly perpendicular to them, the protective throw disappeared completely, though as before there was a slight reverse after-effect.

Some of Prof. Remsen's experiments on the corrosion of a wire in strong nitric acid were repeated with the same results as he obtained, viz., the wire was eaten away to the general dumbbell form, though the protected ends instead of being club-shaped had the ends perceptibly hollowed. When the wire thus exposed was filed to a sharp point the extreme point was very perfectly protected, while there was a slight tendency to hollow the sides of the cone, and the remainder of the wire was as in the previous experiments. In both cases the bars were steel, and showed near the ends curious corrugations, the metal being left here and there in sharp ridges and points. In one case the cylinder was eaten away on sides and ends, so that a ridge of almost knife-like sharpness was left projecting from the periphery of the ends.

These were the principal phenomena observed with nitric acid. Since this acid is the only one which attacks iron freely in the cold, in Prof. Remsen's investigations this was the one to which experiments were in the main confined. With the present method, however, it was possible to trace the effect of the magnet whenever there was the slightest action on the iron, and consequently a large number of substances, some of which hardly produced any action, could be used with not a little facility.

In thus extending the experiments some difficulties had to be encountered. In many cases the action on the iron was so irregular that it was only after numerous experiments under widely-varying conditions that the effect of the magnet could be definitely determined. Frequently the direction of the original action would be reversed in the course of a series of experiments without any apparent cause, but in such case the direction of the effect due to the magnet always remained unchanged, uniformly showing protection of the point so long as the wires remained parallel to the lines of force. When, however, the original action and the magnetic effect coincided in direction, the repetition of the latter showed a decided tendency to increase the former.

When using solutions of various salts more or less freely precipitated by the iron, it frequently happened that the normal protective throw was nearly or quite absent, but showed itself when the magnetic circuit was broken as a violent throw in the reverse direction, showing that the combination had been acting like a miniature storage battery which promptly discharged itself when the charging was discontinued by breaking the current through the magnet. The gradual reversal of the current some little time after exciting the magnet was noted frequently in these cases, as before. Owing to this peculiarity and their generally very irregular action, the various salts were disagreeable substances to experiment with, though as a rule they gave positive results.

Unless the poles were kept clean experimenting became difficult from the accumulation of decomposition products about them and oxidation of their surfaces. A few experiments showed how easily the original deflection could be modified, nearly annulled, or even reversed in direction by slight differences in the condition of the poles. These difficulties of the method are, however, more than counterbalanced by its rapidity and delicacy when proper precautions are taken.

Nearly thirty substances were tested in the manner previously described, but comparatively few of them gave very decided effects with the magnet, though, as later experiments have shown, the protective action is a general one. The substances first tried were as follows. The table shows the various acids and salts tried, and their effects as shown by the original apparatus.

Several things are worthy of note in this list. In the first place, those solutions of metallic salts which are precipitated by iron all show distinct signs of protective action when the current is passed through the magnet. Of the various acids this is not generally true, only those showing the magnetic effect which act on iron without the evolution of hydrogen, and are powerful oxidising agents. In general substances which acted without the evolution of hydrogen gave an effect with the magnet.

Substances.	Effect due to magnet.	Notes.
Nitric acid	Strong	Always powerful protective throw.
Sulphuric acid	Little or none	Does not act very readily on the iron.
Hydrochloric acid	,, ,,	
Acetic ,, ...	None	
Formic ,, ...	,,	
Oxalic ,, ...	,,	
Tartaric ,, ...	,,	
Chromic ,, ...	Some effect	Sometimes quite distict throw, irregular.
Perchloric ,, ...	,,	Much less marked than with chromic.
Chloric ,, ...	None	
Bromic ,, ...	,,	
Phosphoric ,, ...	,,	Hardly any effect on iron.
Permanganic ,, ...	Slight effect	More than with perchloric.
Chlorine water.....	Decided effect	
Bromine ,, ...	,,	
Iodine ,, ...	,,	
Copper sulphate	,,	Mainly showing as throw, on breaking.
,, nitrate.....	Some	,, ,, ,,
,, acetate.....	,,	,, ,, ,,
,, chloride	,,	,, ,, ,,
,, tartrate	Slight	
Mercuric bromide	Some	Throw, on breaking.
,, chloride	,,	Very slight solution, weak.
Mercurous nitrate	,,	Mainly as throw on breaking.
Ferric chloride.....	Decided	Both protective throw, and sometimes on breaking.
Silver nitrate	Some	Action very irregular.
Platinum tetrachloride.	,,	,, ,,

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From these experiments it was quite evident that the protective action, whatever its cause, was more general than at first appeared, and steps were next taken to extend it to the other magnetic metals. Small bars were made of nickel and cobalt, and tried in the same manner as before. These metals are acted on but very slightly by most acids, and the range of substances which could be used was therefore very small, but all the substances which gave the magnetic effect with iron poles gave a precisely similar, though much smaller effect, whenever they were capable of acting at all on the nickel and cobalt. This was notably the case with nitric acid, bromine water, chlorine water and platinum tetrachloride, which were the substances acting most readily on the metals in question. Even with these powerful agents, however, the magnetic action was very much less than with iron, and experimentation on metals even more weakly magnetic was evidently hopeless.

As a preliminary step towards ascertaining the cause of the magnetic action, and its non-appearance where the active substance evolved hydrogen, it now became necessary to discover, and if possible eliminate, the cause of the reversal of the current which regularly followed the protective throw. Experiments soon showed that it could not be ascribed to accumulation of decomposition products around the electrodes, and polarisation, while it could readily neutralise the original deflection, could not reverse its direction. Whatever the cause, it was one which did not act with any great regularity, and it was soon found that stirring the liquid while the magnet was on uniformly produced the effect observed. Since one pole was simply exposed over a small portion of its side while the other had a sharp projecting point, it was the latter which was most freely attacked when there were currents in the liquid, whether these were stirred up artificially, or were produced by the change in galvanic action due to the presence of the magnet. When the poles were placed in fine sand, saturated with acid, this reversing action was much diminished, and, in fact, anything which tended to hinder free circulation of the liquid produced the same effect. Several materials were tried, and of these the most successful was an acidulated gelatine, which was allowed to harden around the poles. In this case the protective throw was not nearly as large as in the free acid, since the electrodes tended to become polarised while the gelatine was hardening, and only weakly acid gelatine would harden at all; but the reversing action completely disappeared, so that when the magnet was put on a permanent deflection was produced instead of a transitory throw.

This point being cleared up, attention was next turned to the negative results obtained with acids which attack iron with evolution of hydrogen. The galvanometer was made much more sensitive and removed from any possible disturbing action due to the magnet, and with these precautions the original experiments were repeated, it seeming probable that even if the magnetic effect were virtually annulled by the hydrogen evolved, some residual effect might be observed.

This residual effect was soon detected, first with hydrobromic acid, and then with hydrochloric, hydriodic, sulphuric, and others. The strongest observed effect was with hydriodic acid; but as this may possibly have contained traces of free iodine, it may be regarded as somewhat doubtful. The effect in all these cases was very small, and though now and then suspected in the previous work, could not have been definitely determined, much less measured.

Some rough measurements were made on the electromotive forces involved in this class of phenomena by getting the throw of the galvanometer for various small known values of the E.M.F. The values found varied greatly, ranging from less than 0·0001 volt in case of the acids evolving hydrogen, up to 0·02 or 0·03 volt with nitric acid and certain salts. These were the changes produced by the magnet, while the initial electromotive forces normally existing between the poles would be, roughly speaking, from 0·001 to nearly 0·005 volt, never disappearing and rarely reaching the latter figure.

From these experiments it therefore appears that the protective action of the magnetic field is general, extending to all substances which act chemically on the magnetic metals. While this is so, the strongest effect is obtained with those substances which act without the evolution of hydrogen. But the series is really quite continuous, perchloric acid, for instance, producing but little more effect than hydrobromic, while this in turn differs less from perchloric than from an acid like acetic. It seems probable that the action of the hydrogen evolved is partially to shield the pole at which it is evolved, and lessen the difference between the poles produced by the magnet. It probably acts merely mechanically, for it is to be noted that those acids which evolve a gas other than hydrogen (perchloric acid, for instance), which is not absorbed by the water, tend to produce little magnetic effect compared with those which act without the evolution of any gas.

As to the actual cause of the protective action exercised by the magnetic field, all these experiments go to show that it is quite independent of the substance acting, with the exception above noted, and is probably due to the attractive action of the magnet on the magnetic metals forming the poles subjected to chemical action, as we have before explained.

In the first place, whenever iron is acted upon chemically in a magnetic field, those portions of it about which the magnetic force varies most rapidly are very noticeably protected, and this protection, as nearly as can be judged, varies very nearly with the above quantity. Wherever there is a point there is almost complete protection, and wherever there is a flat surface, no matter in how strong a field, it is attacked freely. Whenever in the course of the action there is a point formed, the above condition is satisfied and protection at once appears. Thus, in the steel bars experimented on, whenever the acid reached a spot slightly harder than the surrounding portions, it produced a little elevation from which the lines of force diverged, and still further shielding it produced a ridge or point, sharp as if cut with a minute chisel. Nickel and cobalt tend to act like iron, though they are attacked with such difficulty that the phenomena are much less strongly marked. With the non-magnetic metals they are completely absent. Now, turning to the experiments with the wires connected with a galvanometer, the same facts appear in a slightly different form.

When the poles were placed perpendicular to the lines of force instead of parallel to them, the magnet produced no effect whatever: showing, firstly, that the effect previously observed depended not merely on the existence of magnetic force, but on its relation to the poles, and, secondly, that when the poles were so placed as to produce little deflection of the lines of force, the protective effect disappeared.

When the pointed pole was blunted the effect practically disappeared, the poles remaining parallel to the lines of force, and when plates were substituted for the wires no effect was produced in any position, showing that the phenomena were not due to the directions of magnetisation, but to the nature of the field at the exposed points. In short, whatever the shape or arrangement of the exposed surfaces, if at any point or points the rate of variation of the square of the magnetic force is greater than elsewhere, such points will be protected, while if the force is sensibly constant over the surfaces exposed, there will be no protection at any point. With all the forms of experimentation tried this law held without exception. It therefore appears that the particles of magnetic material on which the chemical action could take place are governed by the general law of magnetic attraction, and are held in place against chemical energy precisely as they would be held against purely mechanical force. To sum up:—

When the magnetic metals are exposed to chemical action in a magnetic field, such action is decreased or arrested at any points where the rate of variation of the square of the magnetic force tends towards a maximum.

It is quite clear that the above law expresses the facts thus far obtained, and while in any given case the action of the magnet is often complicated by subsidiary effects due to currents or bye-products, the mechanical laws of motion of particles in a magnetic field hold here as elsewhere, and cause the chemical action to be confined to those points where the magnetic force is comparatively uniform.

The effect of currents set up in the liquid during the action of the magnet cannot be disregarded, especially in such experiments as those of Nichols (*American Journal of Science*, Vol. III., pp. 131, 272), where the material acted on was powdered iron and the disturbances produced by the magnet would be particularly potent. The recent experiment of Colardeau (*Journal de Physique*, March, 1887), while perhaps neglecting the question of direct protection of the poles, have furnished additional proof of the purely mechanical action of the magnet by reproducing some of the characteristic phenomena where chemical action was eliminated, and the only forces acting were the ordinary magnetic attractions.

An attempt was made to reverse the magnetic action, *i.e.*, to deposit iron in a magnetic field, and increase its deposition where there was a sharp pole immediately behind the plate on which the iron was being deposited. This attempt failed. The action was very irregular and the results not decisive. The question of stirring-effect was also examined. Usually stirring the liquid about one pole increased the action on that pole, but sometimes produced little effect, or even decreased it. This, however, is in entire agreement with the irregular action sometimes observed in the case of the after-effect in the original experiments.

An excellent method of experiment is to imbed an iron point in wax, leaving the minute point exposed: imbed a flat plate also in wax and expose a point in its centre. Place the point opposite to the plate, but not too near, and place in the liquid between the poles of a magnet and attach to the galvanometer as before.

There is a wide field for experiment in the direction indicated above, for it is certainly very curious that the effect varies so much. If hydrogen were as magnetic as iron, of course acids which liberated it would have no action. But it is useless to theorise blindly without further experiment, and we are drawn off by other fields of research.

In the *American Journal of Science* for 1886, p. 372, Professor

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E. L. Nichols has investigated the action of acids on iron in a magnetic field. He remarks that the solution of iron in a magnetic field is the same as removing it to an infinite distance, and hence the amount of heat generated by the reaction should differ when this takes place within or without the magnetic field. Had he calculated this amount of heat due to the work of withdrawing it from the field, he would probably have found his method of experiment entirely too rough to show the difference, for it must be very small. He has not given the data, however, for us to make the calculation. The results of the experiments were very inconclusive as to whether there was greater or less heat generated in the field than without.

In the same journal for December, 1887, he describes experiments on the action of the magnet on the passive state of iron in the magnetic field. In a note to this Paper, and in another Paper in the *American Journal of Science* for April, 1888, he describes an experiment similar to the one in this Paper, but without our theory with regard to the action of points. Indeed, he states that the ends of his bars acted like zinc, while the middle was like platinum, *a conclusion directly the opposite of ours*. The reason of this difference has been shown in this Paper to be probably due to the currents set up in the liquid by the reaction of the magnet and the electric currents in the liquid.

In conclusion, we may remark that our results differ from those of Professor Nichols in this: firstly, we have given the exact mathematical theory of the action, and have confirmed it by our experiments, having studied and avoided many sources of error, while Professor Nichols gives no theory, and does not notice the action of points; secondly, our experiments give a protective action to the points and ends of bars, while Professor Nichols thinks the reverse holds, and that these are more easily dissolved than unmagnetised iron.

ON THE ELECTRICAL CONDUCTIVITY OF SUPER-SATURATED SALINE SOLUTIONS.*

BY C. HEIM.

The author points out that the only previous experiments of the same kind are those of Von Beetz† with zinc sulphate, and F. Kohlrausch‡ with ammonic-chloride and sodic-sulphate. Kohlrausch obtained continuous curves of conductivity right up to the point when crystallisation began, and according to Von Beetz the curves showed no sudden change, even when the solution became solid throughout.

The method employed was F. Kohlrausch's§ Wheatstone bridge method with alternating currents, but using a telephone in place of an electro-dynamometer. The solutions were contained in a V-tube (Fig. 1) furnished with platinum electrodes, which were re-

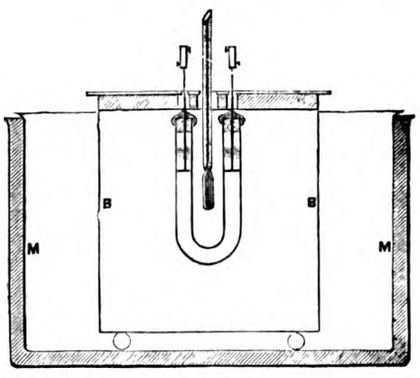

FIG. 1.

platinised before each experiment, and thick platinum conducting wires passing through corks sealed with shellac. The V-tube was fixed within a glass vessel, B, which was itself placed within a larger iron vessel, M. B was filled with a solution of salt, and had a felt cover, and M was filled with water, and connected with supply and waste pipes, by means of which a current of cold water, regulated at will by the experimenter, could be made to flow through it, and its sides and bottom were cased in felt. Both vessels were provided with apparatus for keeping the liquids in them in continuous circulation during the whole time of an experiment. To get rid of polarisation it was found necessary to have a very rapid make and break arrangement in the primary circuit, and a tuning-fork making 256 vibrations a second was used, which completely answered the purpose.

In making an experiment the whole apparatus was warmed up to a temperature some 10° higher than that at which it was desired to take the first readings, and very gradually cooled, the lower temperatures being attained by the use of ice, and finally of a freezing mixture of snow and salt in the outer vessel. In the first experiments the cooling was continued uniformly, and a great degree of uniformity could be attained after a little practice, at the rate of about 1° C. in four minutes; but the plan finally adopted was to regulate the rate of cooling so that it should be extremely slow in the neighbourhood of the readings, which were taken at every 5° and more rapid, in the intervals. The salts used were the sulphates of zinc sodium and magnesia, chloride of calcium, and carbonate of sodium. Fig. 2 shows the curves obtained from the means of a large number of very concordant experiments, and they exhibit the relation between the temperature and the observed resistance in Siemens mercury units. The figures attached to the symbols of the salts give the proportion of the salt to 100 parts of water, and the vertical dotted lines show the temperatures of saturation. It is evident from the figure that there are no sudden jumps in the curves at the points of saturation, but that they remain continuous as they pass through it. The author finds that

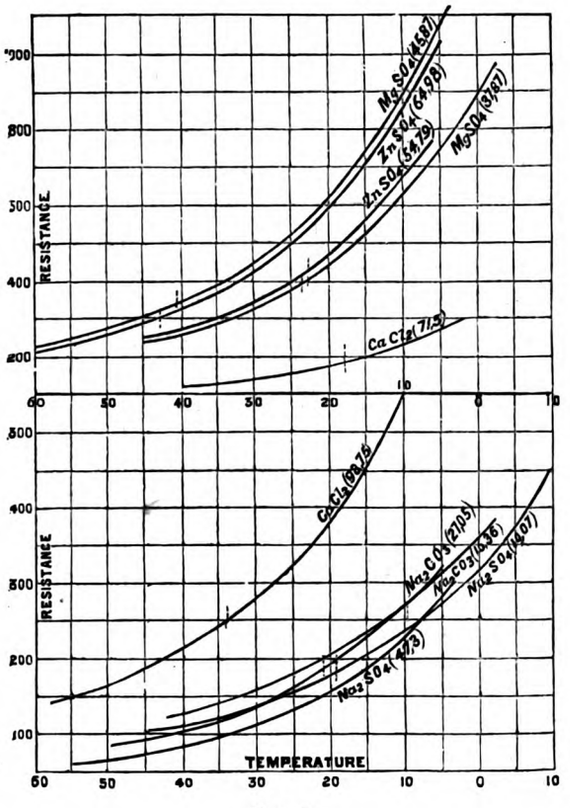

FIG. 2.

the relation between the conductivity k_t at temperature $t°$ and the conductivity k_0 at O° is given to a very close approximation by Kohlrausch's formula

$$k_t = k_0(1 + a\,t + b\,t^2)$$

where a and b are constants.

Owing to the small quantity of solution used, and its small amount of exposed surface, no difficulty was found in carrying the cooling far below the temperature of saturation without solidification taking place. When this happened a sudden increase in the resistance was observed in every case, the resistance in some cases becoming trebled within the space of half a minute, a result which does not agree with that obtained by Von Beetz in the case of sulphate of zinc.

The author's curve for this salt agrees well down to 1° with that obtained by Von Beetz, who cooled his solution down to O°, and the author conjectures that the solidification may have taken place immediately after his last reading, though, as he points out on the other hand, W. Kohlrausch* found no sudden increase in the resistance of fused iodide of silver when it became solid.

F. Kohlrausch also found in the case of chloride of ammonium and acetate of sodium that the curves were continuous up to the

* Wiedemann's *Annalen*, Vol. XXVII.
† Von Beetz, Pogg. *Ann*, Vol. CXVII., 1862.
‡ F. Kohlrausch, Wied. *Ann.*, Vol. VI., 1879.
§ Wied. *Ann.*, Vol. XI., 1880.

* Wied. *Ann.*, Vol. XVII., 1882.

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point of crystallisation, and his not having observed the sudden increase in the resistance at this point was probably due to the relatively small super-saturation attained in his experiments; for crystallisation always begins at some one point, and spreads thence throughout the solution, and therefore the increase in the resistance cannot be of the nature of an absolutely sudden jump, but it will be greatest when the solution is so highly super-saturated that the whole crystallisation takes place so rapidly that the temperature does not perceptibly fall during the process, but may even rise slightly in spite of the extreme cooling.

ON THE SPECIFIC RESISTANCE OF MERCURY.*

BY R. T. GLAZEBROOK, M.A., F.R.S., AND T. C. FITZPATRICK, B.A.

The Paper contains an account of experiments made to determine the value of the resistance of a column of mercury, 1 metre long and 1 sq. mm, in cross section, in terms of the B.A. unit. The method employed differed very slightly from that of Lord Rayleigh and Mrs. Sidgwick (*Phil. Trans.*, 1883). Tubes of about 1, 2, and 3 sq. mm. in cross section were calibrated and filled with mercury; they were then immersed in melting ice, and their resistance compared with that of the B.A. standards, using Carey Foster's method and the B.A. bridge. The length of the mercury column, occupying nearly the whole of the tube, was measured, and the mass of the same determined. From this the average cross section is obtained, and hence the value of r, the resistance of a column 1 metre long, 1 sq. mm. in cross section. The mercury used to find the cross section was with few exceptions that which had been employed in finding the resistance. The results of the measurements are given in Table I.

TABLE I.

No. of tube.	—	L.	a.	R.	r.	Mean value of r from each tube.
VI....	1.	113·134	0·0586	1·000010	0·95358	
	2.	,,	,,	0·999949	0·95364	
	3.	,,	,,	0·999949	0·95353	
	5.	,,	,,	0·999915	0·95351	0·95357
	6.	,,	,,	0·999982	0·95357	
	8.	,,	,,	0·999955	0·95360	
VIII....	1.	127·438	0·0622	1·000133	0·95351	
	2.	,,	,,	1·000103	0·95349	
	3.	,,	,,	0·999996	0·95353	0·95354
	5.	,,	,,	1·000040	0·95357	
	7.	,,	,,	1·000036	0·95361	
II. ...	1.	101·904	0·0553	1·011926	0·95353	
	2.	,,	,,	1·011805	0·95340	0·95349
	3.	,,	,,	1·011810	0·95356	
	4.	,,	,,	1·011803	0·95346	
V....	1.	112·950	0·0829	0·499233	0·95334	0·95338
	2.	,,	,,	0·499215	0·95342	
IX. ...	1.	110·913	0·0820	0·500388	0·95344	0·95344
	2.	,,	,,	0·500333	0·95343	
I....	1.	91·723	0·0915	0·332535	0·95343	0·95344
	3.	,,	,,	0·332574	0·95346	
III. ...	1.	101·765	0·0968	0·329854	0·95345	0·95351
	2.	,,	,,	0·329867	0·95357	

In the table, Column 1 gives the number of the tube, Column 2 the number of the observation. L is the length of the tube, and a the mean radius of the cross section, R the observed resistance in B.A. units. The mean value of r found from the three 1 mm. tubes is 0·95354 B.A. unit. The other four tubes of one-half and one-third unit respectively lead to the value $r = 0·95344$ B.A. unit. The difference between the two is considerable, and reasons are given for assigning more weight to the first value.

For an account of the experiments and of the small precautions necessary to secure accuracy, reference must be made to the Paper.

Table II. gives a list of the various values which have been found for r, with the lengths of the column of mercury which, according to the different observers, has a resistance of 1 ohm (10^9 C.-G.-S. units of resistance). In combining our own observations we have assigned weights to the various tubes inversely proportional to their diameters, and we find as our final value

$$r = 0·95352.$$

* Abstract from the *Proc.* Roy. Soc., Vol. XLIV., No. 270.

TABLE II.

Observer.	Date.	Value for r in B.A. units.	Value of ohm in centimetres of mercury at 0°.
Lord Rayleigh and Mrs. Sidgwick...	1883	0·95412	106·23
Mascart, Nerville, and Benoit	1884	0 95374	106·33
Strecker.....	1885	0·95334	...
L. Lorentz.....	1886	0·95388	105·93
Rowland	1887	0·95349	106·32
Kohlrausch	1888	0·95331	106·32
Glazebrook and Fitzpatrick	1888	0·95352	106·29

The Paper contains a discussion of the above results. It is shown that probably Lord Rayleigh's value of r may be too high by as much as 0·0002, in consequence of the fact that the mercury in his terminal cups was 5° or 6° C., but no complete explanation of the differences between his result and those of Rowland, Kohlrausch, and ourselves has been found. The difficulty of working with tubes such as those used by the Lorentz, 1—2 metres in length, and 1, 2, and 3 cm. in diameter, may perhaps account for his value for the ohm, viz., 105·93.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *August 18th*, 1888.

England having given us so many surprises lately in the way of decisions in electric lighting suits, turn about is fair play, and we can now contribute our share from this side. As some of your readers are perhaps, aware, an infringement suit has been pending in Boston by the Westinghouse Electric Company against the Sun Electric Company, seeking an injunction to prevent the latter company from operating its alternating system as devised by Mr. M. M. M. Slattery. A decision has now been rendered by Judge Colt, in the United States Circuit Court, dismissing the Bill. The main question considered was as to the scope of the patent, in view of a disclaimer which had been made by the plaintiffs. The Goulard-Gibbs patent, as originally drawn, was intended to cover all forms of converters for alternating-current service. The Patent Office, however, required the applicants to make their case conform to the arrangement of converters on the series system, as shown in an article in *Engineering* of March 2nd, 1883, which, it was said, contained a description of the invention. The plaintiffs having made this disclaimer, the Court holds that it is now too late for them to say that it means nothing; on the contrary, it limits the scope of the patent to the series system, and therefore the defendants who were using their converters in multiple arc did not infringe. It will be seen that this is a highly important decision, though it will, in all probability, be appealed. As far as the Sun Company is concerned, it might not mean much, that company being practically out of the business; but it happens that the Fort Wayne Jenney Company had taken up the work where the Sun Company had left off, and with the assistance of Mr. Slattery has lately been engaged putting its own converter system on the market with great activity, the converters being run in multiple arc. The decision is also regarded with pleasure by other concerns, such as the United States Company, who have lately entered the alternating field. Another decision of some importance has been rendered in the electric lighting business; it comes from the same judge, who, having in the first case upset a patent, proceeds in the next to support one. The suit was brought by the Thomson-Houston Company against the Citizens' Electric Light Company, using the American or Fuller-Wood system, for an infringement of one of the patents granted to Profs. Thomson and Houston in 1881, for improvements in current regulators for dynamos. Those familiar with the Thomson-Houston machine will remember that in it regulation is effected by a shifting of the brushes. In the American machine the same result is attained by analogous devices, and the Court now holds that there has been an infringement. This may prove a hard blow to the

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American Company, which had lately been struggling bravely through its financial difficulties.

It will probably surprise many of your readers to learn that we have more than one telegraph company in this country. The Postmaster-General has just issued his annual circular prescribing the rates to be paid by the Government for its telegraphing during the current year. In this circular he gives a list of no fewer than ninety-one telegraph companies which have accepted the conditions according to law, and are subject to the provisions of the order. Of course it goes without saying that most of these lines, though they may still keep up a separate organisation, are in alliance with, or owe allegiance to, the Western Union Company. Many of them, too, are railroad lines; but still the fact remains that even to-day, after all the consolidation and combination that has gone on, there are just upon one hundred telegraph corporations in the country. As regards the Western Union Company, it may be mentioned that its finances appear to be in better shape than ever. At the present time its business is averaging about £15,000 a week better than it was last year, and this handsome increase will undoubtedly enable it to pay a higher rate of dividend. The reports that have been current as to the proposed change in ownership or management have died away, but their renewal may be looked for at any minute. Graphic reports come from Saratoga to some of the papers with regard to the state of Mr. Gould's health, which, it will be remembered, is none too good, though decidedly on the mend. Quite a sensational story, by the way, got afloat last week with regard to Mr. Robert Garrett, who has been very ill. It was stated that the acquisition by Mr. Gould of the Baltimore and Ohio telegraph system had so preyed on Mr. Garrett's mind that at last it had given way under the strain, and he had practically become a monomaniac on the subject, believing that everybody whom he met had been in conspiracy to deprive him of that old family property. If one were to believe all that finds its way into print about these two magnates, they are as sick and wretched men as can be found all the conntry through, but then newspapers occasionally print something besides news.

Now that the phonograph and graphophone are before the public, attention is once more drawn to the problem of obtaining a record of telephonic conversation. Various efforts have been made in this line, none of which appear to have been at all successful, however ingenious. A new method is now announced to have been hit upon by a Mr. Paramore, of Philadelphia, in conjunction with Mr. Bonta, whose telephone was lately before the public as circumventing the Bell patent. Very few details about the new apparatus have been gained, but it is stated that while the receiver is in use any communication coming to it is committed to wax paper. This serves as a record, and also answers the purpose of registering the communications which may be sent in while the person whom it is desired to call up happens to be away from his office. On his return this person observes indications of the use of the instrument, and by passing the wax paper through the instrument, he can, it is said, hear the communication just as it was originally sent. The record sheets are said to be 8in. by 11in. They can at any time be replaced in the machine, and the record be heard, all of which is very interesting, if true. The man who brings out a good telephonic record system ought certainly to make money in America, if nowhere else.

The proceedings of the Board of Electrical Control continue to occupy public attention in various ways. The Board has now written to the Commissioner of Public Works, and to the aldermen of the city, describing its efforts in getting wires under ground, and inviting assistance and co-operation. It points to the fact that though 122 complaints have been made to the Department of Public Works as to wires and poles that should be removed, up to date nothing has been done to remove the obstructions. It also states that the United States Company, its pet offender, has never been duly authorised to stretch wires overhead, and that the extraordinary number of no fewer than 528 violations of the law and the rules have been reported against this flagrant sinner, upon whom, by the way, summons and complaint in the city suit, asking for $5,000 damages, have just been served by the Corporation council. As regards the alternating-current controversy, I hear that the Board has placed all the documents relating thereto in the hands of Dr. Wheeler, its electrical expert, requesting him to draw up such regulations as, in his opinion, will ensure public safety with the use of the alternating current.

I think I wrote you the other day to the effect that Mr. D. H. Craig, one of the pioneers of the Associated Press, had obtained permission to exhibit his machine telegraph system in the Senate wing of the Capitol at Washington. It is not every inventor that enjoys such an opportunity, and it is said that Mr. Craig has some hopes of inducing Congress to buy him out, and adopt his system as the basis of a Government telegraph service. Mr. Craig claims to be able to telegraph 2,000 words per minute from one end of his wire, and in order to get this amount of matter over the wire, he prepares his copy after the usual manner of perforation, with the addition that the machine which is perforating also prints in plain Roman letters a copy of the message which is sent. It is stated that the perforator experts prepare 50 words per minute in good shape, or 3,000 words per hour. Mr. Craig claims that the actual cost of transmitting 1,000 words 1,000 miles is not over 2 cents. The cost of paper to perforate 1,000 words is 1 cent, and for recording paper 2 cents. The perforating is done at the rate of 10 cents for 1,000 words, and the same for copying on the typewriter, making a total of 25 cents for completing 1,000 words. On this basis it would cost for labour and for paper less than £6 to telegraph and complete 48 columns of an ordinary newspaper from New York to Chicago. Some of these figures seem rather finely drawn. Ten cents per thousand words for perforation strikes one as rather a low rate of pay, and as for the typewriting, the average standard price at the present time is not 10 cents per thousand, but 5 cents per hundred. Mr. Craig, in addition to having a complete transmitting system, has also invented, it is said, a new silicon bronze wire, especially light, strong and conductive.

The newspapers print some queer stories occasionally as to the effects of electric currents on persons who happen to get an accidental shock. One of the funniest that has fallen under my observation is that with regard to an *employé* of the Electric Light Company at Hartford, Ct. This man appears to have been re-carboning some arc lamps, and while doing so to have placed himself in a live circuit. He got a pretty bad shock—so bad, indeed, that as the story reads it killed him. He fell, but in his downward course he struck against another wire, and the back of his neck touched it. When he reached the ground several people went to his assistance and carried him off. Since that time he has recovered, and the doctor in attendance, in commenting on this remarkable case, says "he was undoubtedly dead when he fell from his perilous position, but the lower wire touching his neck while falling restored him to life." It is to be hoped that the experts who have been experimenting on dogs at Columbia College will take note of this extraordinary episode. It might be suggested to them as a new experiment, that after killing the dog with one wire they should drop him on to another, bringing him to life again, and hence meeting some of the objections made by the Society for the Prevention of Cruelty to Animals. One obvious suggestion arising out of this is, that if a man were very ill, and on the point of death, it might be well to kill him with one wire and to bring him to life again with another, thus euchreing Nature; and if this were done once there is no reason why it should not be repeated indefinitely.

Considering the awe with which the Clark standard cell has been regarded up to the present, and the restrictions with which it seems to have been hedged about for practical work, your readers will undoubtedly be surprised to learn that a portable voltmeter has been brought out in this country in which the Clark cell is employed as the standard of reference. As is well known, the Clark cell, as heretofore employed, though admirable in all qualities relating to constancy, has been somewhat difficult to prepare, and, unfortunately, it has been constructed in such a form that it required great care in handling when moved from place to place. Hence its application in a portable instrument has been simply out of the

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question. Mr. John W. Howell, whose indicating instruments are well known, has heretofore employed as a standard of reference in his instrument a portable form of the Daniell cell, which, though it answered the purpose very well, still had some disadvantages in requiring the renewal of the cell at more or less frequent intervals. Recognising the value of the Clark cell, however, Mr. Howell has devised a portable form which he now embodies in his voltmeters, and which, after extended use, proves satisfactory in every way. In order to test the portability of the cell, Mr. Howell carried one around with him loosely in his pocket for several months, and frequent tests showed that it remained absolutely constant during all that time. In order to show, also, how long one of these cells would last when giving current, an engine room indicator was made in which this cell was employed. It has been in circuit eleven hours a day for ten weeks, the battery giving or receiving current under every variation of pressure on the line. During this time the indicator has always indicated correctly well within the limits of practical work, and, according to Mr. Howell, the cell is apparently as good in all respects as it was when first set up. In the voltmeter there are two cells. Each of these may be used independently as a check upon each other, or they may be both combined so as to increase the limits within which each indicator can be used, the scale readings then being multiplied by two. In order to take account of the temperature, Mr. Howell has added a thermometer to the instruments, which is not graduated in degrees, but is so arranged that the mercury points directly to the number of volts or fraction of a volt which has to be added or subtracted in order to make the reading correct. This instrument is evidently a great advance on the instruments previously in use for this purpose.

You will probably still bear vividly in mind the coulombmeter brought out last year by Prof. Forbes, and which commanded great attention on account of the ingenuity of the apparatus and the utilisation of the principle involved. Reasoning probably from the same premises as before, Prof. Forbes has just secured a patent in this country for a meter in which the principle of the heat generated by current is again utilised as a means of indication. In this instrument, however, instead of heat creating a motion which is registered, Prof. Forbes employs it to evaporate a liquid, such as alcohol, which is condensed, and thus affords a measure of the work done by the current. The apparatus consists of an inverted U tube. One of the legs of the tube is open, and is fixed in the stopper of a vessel containing the volatile liquid. From this open end there hangs an absorbent material, such as cotton, which sucks up the liquid for a short distance into the tube and around that portion of the leg which contains the cotton there is wound a few turns of wire placed in the circuit. The heating of this wire evaporates the liquid, which passes from it into the other leg, and is there condensed, falling to the bottom. Thus the scale attached to the closed leg measures the height of the condensed liquid, and affords a direct indication of the amount of electrical energy passed through the circuit.

NOTES FROM PARIS.

(FROM OUR OWN CORRESPONDENT.)

August 28th, 1888.

The Paris Municipal Council is not favourable to electric traction, and the plan proposed by M. Lartigne for a single-rail electric railway has been rejected, as well as the tubular one of M. Berlier. However, Messrs. Philippart Brothers say they are about to get permission for an experimental electric tramcar of their own invention. This car will run between the Arc de Triomphe and the Porte Maillott. It will have nearly the same external appearance as the large horse trams belonging to the Cie. des Omnibus. The total weight will be 9,440 kilos, or about 10 tons, viz. :—50 passengers, 3,400 kilos ; car, 3,500 ; accumulators, 1,800 ; electric motor, 350 ; sundries, 390. The battery will consist of 144 cells of the Faure-Sellon-Volckmar type, with a nominal output of 7 horse-power, and able to develop 20 horse-power on occasion. I hope that these experiments, which are of particular interest to the Parisian population, will soon begin, and if so I will send further details.

Electric lighting remains in the same dull state, and nothing new will come out before the beginning of October, when the Municipal Council will meet for its autumn session. The demands for concessions made by the Rothschild Company and the Edison Company will then be examined, but as it is said that their contents do not agree with the terms of the Cahier des Charges, they will certainly be rejected by the Council. Some other demands by the Compagnie d'Eclairage Electrique, M. Sencier, and others, are spoken of, but I doubt whether their proposals are likely to meet the views of the authorities. As has already been announced in your columns, the French patents of the Cruto lamps have been purchased by Messrs Rothschild on behalf of the "Société pour le Travail Électrique des Métaux." The factory is situated in the Rue Didot, and is well provided to meet all possible demands. Another lamp is, therefore, added to the many already in the market. The last arrival presents no remarkable features which should cause it to be preferred to any of its competitors. The makers guarantee a life of 1,000 hours and an efficiency of 3·5 watts per candle-power, in which there is nothing unusual. The lamps, however, are cheap, the price varying from 4fr. 50s. to 3fr. 75c., according to the number ordered. The Benardos process is apparently not very paying, since the company formed to work it has betaken itself to such a very different field. It may be interesting to some of your readers to hear that both M. Popp's private house and his station for compressing air, which are opposite one another in the Rue St. Fargeau, are lit by electricity. The plant comprises a 16-unit Gramme machine, driven by a 25 horse-power engine, and a 16-unit Thury compound dynamo, driven by a 40 horse-power engine. There are in all 400 incandescent lamps and 25 Mornat arc lamps, M. Popp's house being lit by 100 incandescents and 25 arcs. Attached to the station there is an electrical laboratory and lamp-testing room.

In my correspondence of the 10th July, I mentioned some experiments upon a new military microphone. I have since made the acquaintance of the inventor, who is at present at the Camp de Châlons, where he is engaged in some interesting experiments about which I hope soon to send you an account, and to give you the description of the microphone, which is an entirely new development.

As you probably know, the Prix Volta of 50,000fr. has been awarded by the Technical Commission to M. Z. Gramme, for his improvements in dynamo design. This decision, which has to be confirmed by a vote of the Chamber at its next meeting in October, has been cordially accepted by all the French electricians, who appreciate the qualities of this indefatigable worker.

I cannot conclude this letter without speaking of a new application of electrolysis, which, if introduced into general use, would open a rather large field to electricians in the undertaker line of business. A chemist of Brest, M. Kergovatz, seems to be the first who has pointed out the advantages we can get from electro-plating in lieu of the old fashions of embalming, burning, &c. The body, having been rendered a good conductor by a coating of plumbago or by immersion in a bath of nitrate of silver, is then placed in a galvanic bath, where it is coated with copper, brass, silver, or even with gold, according to taste and means. When so prepared, the body is entirely preserved from atmospheric action, and can be kept in this state probably for hundreds of years, if not for thousands. Although this application of electrolysis may not be very attractive, I thought it worth mentioning, as it is the first advance upon the Egyptian way of preserving the human body from decomposition.

NOTES FROM VIENNA.

(FROM OUR CORRESPONDENT.)

VIENNA, *Aug. 27th*, 1888.

Messrs. Siemens and Halske are inviting residents in the inner district of Vienna to apply to them to have their houses lit up by electric light, as they have completed, or are rather just completing, their large central station. They hope to be able to supply the light to any applicants before Christmas.

Considerable doubts, however, are expressed by those who have had experience in these matters in Austria of their ability to fulfil their promises, as municipal objections generally manage to postpone if not stop such enterprises.

If there is a firm that can succeed it is Messrs. Siemens and Halske, and the development of their new enterprise will be watched with much interest.

The same firm have also been negotiating the lighting of the small town of Purkersdorf, a favourite summer resort of the Viennese. The matter seems so far settled that the town may be lit up next spring with the electric light. An electric railway connecting Purkersdorf with Gabletz is also proposed. When all is completed the whole is to be handed to the Town Council (who buy it from Messrs. Siemens), who will carry it on on their own account.

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The Imperial Continental Gas Association have succeeded in lighting the Opera for nearly a year now without a hitch, and to the entire satisfaction of the Opera authorities. They have spared no trouble or expense to make their central station a model one, and have certainly succeeded so far, although they are continually carrying out improvements in detail.

CORRESPONDENCE.

MR. MOSELEY'S TELEPHONE SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The reply of Mr. W. Moseley to a letter of mine on the above subject leaves me still, I regret to say, somewhat sceptical as to the merits of several points in his article on "A Proposed Telephone System," and I should again like to draw attention to the subject.

Mr. Moseley refers us for information on this subject to a most valuable and interesting portion of your paper, viz., the "American Notes." I find those from which he quotes are in your issue of 13th January, 1888. and, having carefully read the paragraph in question, I would ask Mr. Moseley to do the same, as he appears to have somewhat misunderstood it. I should like to quote it in full, but as any of your readers who are interested in the subject can refer to it, it will be sufficient for me to say that the subject of the paragraph is the construction of the one large Telephone Exchange in New York—which is to take the place of several comparatively small existing ones—and the placing under ground of all the lines which rendered it necessary that they should be made complete metallic circuits. "This," the paragraph goes on to say, "involved many changes and much new work, and a total expense to date of £60,000." Thus, £60,000 covers a great deal more than the cost of an unfinished switch-board for 6,000 lines, as Mr. Moseley suggests—in fact, the cost of the switch-board was but a fraction of this amount; in addition to which, I may add, it is not merely a switch-board for 6,000 lines, but so constructed as to be capable of being extended to over 10,000. I would not deny for one moment that a switch-board after Mr. Moseley's design for 6,000 subscribers could not be made at a less cost than £60,000, but it would have to cost *very* much less than this if it is not to be expensive, and I am still of opinion that Mr. Moseley's switch-board would be a very costly apparatus both to erect and maintain as compared with the present form of multiple switch-board.

As regards the chains which he uses in his switch-board, I regret that I could only assume in my last letter that the description and drawings he himself gave of the board were correct. It now appears that this is not the case, for in Fig 8 of his drawings there is something so well representing the joints of pieces of wire to the last links of the chains that I have not yet found anybody with sufficient mechanical knowledge to say that it represents continuous chain as Mr. Moseley now tells us they represent. Steel chains would no doubt be less liable to break and stretch than a composite length of chain and wire, but they are objectionable on the score of extra expense, and on account of the chances of the chain twisting and becoming thereby shortened being increased—a probable event which I pointed out in my previous letter. Mr. Moseley tells us that the difficulty of repairing these chains is less than that of repairing overhead wires when broken down by a snow-storm. I am glad to hear it; but, although the latter is a known quantity of considerable dimensions, the comparison, I regret, does not give much information as to the method by which a chain may be repaired or replaced.

The fact that the contact between X and Z (Fig. 12 of his drawings) is not broken until the plug W is withdrawn for more than one-half of an inch, which Mr. Moseley now tells us is the case, only increases the chances of the faults which I pointed out, occurring in this part of the apparatus. The wire—I may here mention that again in this drawing a wire and not a chain is shown—has now only to stretch one inch in its whole length and the contact will not be broken by the placing of a plug in the plug hole, and similarly the chain will only have to get twisted sufficiently to shorten the whole length by one-half inch and the contact will not make. As Mr. Moseley compares this piece of his apparatus to the steering gear of a ship and a chronometer, perhaps there are some further intricacies which are also not "obviously shown." He considers that no difficulty exists in leading the wires for the electrical connections to the plug holes, except in my imagination. I must own that, until I had practical experience in the designing and erection of multiple switch-boards, I scarcely thought that this detail would present any trouble; but the difficulty has formidably presented itself not only to me but to all who have had similar experience. If Mr. Moseley has a method successfully overcoming this "self-inflicted" (?) difficulty, I feel sure that he will benefit not only very many telephone experts, but probably himself in addition by telling us how we are to rid ourselves of our self-imposed burden.

Next, as regards the dimensions of the switch-boards, we shall find that here again Mr. Moseley has gone wrong in his quotation from the "American Notes." It is a switch-board for 10,000 lines that is to occupy 300ft. in length, not one for 6,000, as he would have us believe. The New York switch-board is being constructed to operate 6,000 lines, and is divided into sections. Some of the sections will be arranged to attend to trunks only, the others to 200 subscribers each. The dimensions of these latter sections will be 6ft. in length, and the height from the top row of "spring jacks" to the floor will be between 4ft. 6in. and 5ft. We will now see how this compares with the dimensions that Mr. Moseley gives us of his board. First, as to the number of sections. On this point Mr. Moseley's statements are somewhat contradictory. He first tells us that he accepts my figure, viz., that 200 subscribers is the right number to be attended to on each section, and then he says that 26 sections will attend to 5,500 lines. If he intends to operate 200 lines on each section he will require 27½ sections occupying in length 137ft. 6in., instead of 130ft. for 26 sections. Now 27½ sections of the New York multiple board will occupy 165ft., and thus Mr. Moseley's board will take 27ft. 6in. less than this board, provided he can get it into the length he says he can. I am certain, however, that he cannot get a workable board for 5,500 lines on his principle into that length. This brings me to a second point of comparison, viz., the sizes of the sections in the two forms of multiple boards. We have seen that the space occupied by each section of the New York board was 6ft. in length by between 4ft. 6in., and 5ft. in height, which includes space for running gear for plugs and cords and keys, &c., for working the plugs, and also about 6in. between the adjacent "spring jacks" of each of the sections, which space is necessary for the leading of the electrical connection wires to and from the different sections. Now, as each plug hole of Mr. Moseley's board is ¾in. square, 5,500 of these will fill a space 4ft. 8½in. square—Mr. Moseley says 5ft. square; this allows room for a frame 1⅞in. all round the plug holes. He will find that it is not practicable to place the lowest row of plug holes lower than 2ft. 6in. above the floor, above which the upper plug holes will then be 7ft. 6in., rendering the placing of a plug in these holes, although a gymnastic performance, certainly not an easy or a rapid one. To reduce this height it will be necessary to increase the length of each section, and if the height is reduced to the same as the New York boards, the length will have to be exactly doubled; and his switch-board for 5,500 lines will occupy a space of 275ft. in length, whereas the New York board for 6,000 will only be 180ft. long.

I now come to the portion of the paragraph in the "American Notes" on which Mr. Moseley has pinned his faith. It states, at a second conference of telephone experts connected with the American Bell Telephone Company, "one result arrived at, *it is said*, is the decision that . . . it is desirable in large cities to combine all the wires and connections as much as possible under one roof up to the number of at least 5,000 subscribers. Beyond that point the conclusion *seems to be* it is better for the present to relieve the central office by a system of minor exchanges." The fact that your correspondent has expressed himself in this somewhat cautious manner with reference to the opinions of the experts on this

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point, would rather lead one to believe that they were by no means agreed on the subject, which I have heard is the case. However, there are but few towns in the world in which one exchange with a capacity of 5,000 would not be sufficient to meet all demands for some time to come, and as there is at present, as far as I know, no exchange working with as many as 3,000 lines but little is at present known as to how a very large centre would work. In New York, at all events, the experts appear to be of the opinion that an exchange for 6,000 lines will succeed.

In conclusion, I may add for Mr. Moseley's information that though the heading to his letter has an imposing appearance, it unfortunately is not correct. I am unable to say whether the opinion of the United Telephone Company as regards *the new* public telephone system agrees with mine owing to the fact that I left that company's service some time prior to the date when I wrote my former letter. While mentioning this company, I would like to draw attention to another slight inaccuracy of Mr. Moseley's when, in the first of his articles, he states that the telephone master patents expire in three years from the date he wrote. One master patent, no doubt, does expire about that time, but the most important one does not run out until some three years after that.—Yours, &c.,

F. B. O. HAWES.

East Ferry-road Engineering Works, London,
August 22nd, 1888.

UNIPOLAR INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I think I have shown that the evidence upon which Mr. Tunzelmann based the theory put forward in his articles on this subject is quite incompatible with Faraday's theory, or even with that stated in the concluding paragraph of my last letter.

I have also shown that the results of Exner and Czermak's experiments, upon which most reliance has been placed, were not deserving of credit, and therefore not evidence at all. So we are left no nearer a solution of the fundamental problem attacked.

The "incontestable fact," which Mr. Tunzelmann characterises as my "bare assertion," that the number of lines within the circuit in any case of strictly unipolar induction does not vary, was accompanied by a demonstration, and I fail to see anything in it inconformable with the views of Faraday; but at the same time, the accepted *statement* of Faraday's law of electro-magnetic induction does not fit the case of unipolar induction with sliding contacts. This, however, is a mere matter of language.—Yours, &c.,

R. SNOWDON.

Thirlmere Aqueduct, Staveley, Chesterfield,
August 24th, 1888.

FLASHED FILAMENTS AND LAMP VOLTAGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the leader in your issue of July 27th, one or two points appear to require comment, as they seem likely to be misunderstood. You seem to point out that the process of flashing is principally of importance for "making lamps all alike as regards resistance," and therefore that the difficulty of making unflashed lamps arises out of the variation of resistance in such lamps.

Now, a recent publication of experiments with flashed lamps shows that equality of resistance will not necessarily produce lamps of equal E.M.F. This was shown to be due to variations in the method of flashing, coupled with the inevitable variation of dimensions caused by the process itself. A contractor of experience, who tests a few sample lamps before he settles upon using a certain class of lamp, ought to prefer to use unflashed lamps, for the carbons must be really good if free from spots, &c., as only a first-rate unflashed carbon will be free from obvious defects, such as spots or bright points, whereas a really poor carbon may be made to appear pretty even as regards brilliancy by its "veneer" of flashed carbon, which cannot stand for long the strain to which it is put, but is torn off, and the lamp then rapidly becomes worthless. The reason for which small makers have failed with unflashed lamps is simply because they have always attempted to work with worthless carbons. If cheap lamps would be the result of competition by such makers, I do not consider that electric lighting would gain much by having such competition. You state that the Brush Company and Messrs. Woodhouse and Rawson may be able to overcome the difficulty of making, say, 1,000 lamps all alike as regards resistance. Since the Cheesborough patent was upheld Messrs. Woodhouse and Rawson have stated that for the last year or two they have made nothing but unflashed filaments. Perhaps this has been possible owing to the excellence of their carbon, and it shows that if one can only get a high enough quality of carbon one can do without the Cheesborough process. It is of course possible that Messrs. Woodhouse and Rawson have perfected some other method of reducing their lamps to a common resistance. It is well known, however, that they endeavour to get buyers of lamps to order a few volts on one side or the other of the standard E.M.F.'s, and this looks as though they had a certain number of lamps that did not come out exactly to a given E.M.F.

The transformer system will doubtless give a considerable impetus to the manufacture of the lower E.M.F. lamps, which have fallen out of use to some extent, and if some of the transformer makers were to wind their transformers to give slightly different E.M.F.'s from the normal 100 volts now generally adopted they would find that they got on an average better lamps. If this were done there is little doubt that the price of lamps might be reduced; but whether the millenium of good lamps at 1s. 6d. each is likely shortly to be reached depends partly upon the adoption of some method such as the above for immediately utilising *all lamps* made. Contractors would also gain by not having to wait so long for lamps, the delay generally arising from the fact that there is such a demand for lamps of one or two E.M.F.'s.—Yours, &c.,

EXPERIENTIA.

REPORT OF MR. GISBERT KAPP ON THE LINEFF SYSTEM OF ELECTRIC TRACTION.

A copy of the following report came into our hands several months ago, but at Mr. Lineff's request we have withheld its publication until now. The report is as follows:—

To the Chairman of the West Metropolitan Tramway Company.

Dear Sir: I have examined and tested the electric tramway line on the Lineff system, which has been laid down for experimental purposes at the Chiswick depot of your company. The car is a small open car, fitted with a 4 horse-power (nominal) Immisch motor. The transmission of power from the motor to the car wheels is by means of a countershaft and two Renold's chains, and, in this respect, does not differ from that used on other electric cars. There are, however, two special appliances peculiar to the Lineff car. The one is a movable dash-board at each end of the car, which upon striking an obstacle automatically reverses the direction of rotation of the motor, and causes the car to run back; and the other is a magnetic brake.

The object of the dash-board and automatic reversing gear is to more quickly stop the car, if through the negligence of the driver it should run into an obstacle. In this case the dash-board causes the brake to go on, and the motor to be reversed. The putting on of the brake is a good feature, but I do not consider the advantages of automatically reversing the motor sufficiently great to compensate for the complication which the arrangement entails.

The magnetic brake can also be put on by hand, being actuated by the same switch lever by which the driver controls the speed of the car. I consider this brake an extremely valuable feature of the Lineff car. When the car was fully loaded and running at full speed, the distance traversed after cutting off the current and putting on the brake was only 9ft. It is needless to say that no hand-brake could effect a stop in so short a distance. As it is, however, not always necessary to stop so quickly, the switch controlling the brake-magnet should be provided with intermediate contacts and resistance coils, to enable the driver to stop more slowly if desired.

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The experimental line is about one-tenth of a mile in length, and is provided at one end with a crossing point, having the usual automatic switches, so that the car runs out on one side and home on the other side. The curves are very sharp—one having only 21ft. 6in. radius—and the line is rather in a bad condition throughout, being built mostly with old and discarded rails, so that the power required to propel the car is much greater than would be the case on a good line. Although a car of that size would usually be drawn by one horse, on the experimental line one horse is hardly enough to move the car on the sharpest curve, where the pull as measured by a dynamometer reached 380lb. This is the reason why the power required to work the car as given in the appendix is rather greater than would generally have to be provided for a car of that size. I have nevertheless based my estimate for the plant required for the Kew Bridge-Hammersmith line upon the data obtained in my tests with the small car, in order to have ample margin of power. This estimate is given in the appendix.

The Lineff tramway system belongs to that class where the current is supplied to the car by means of a conductor placed under ground, but whereas in other systems the metallic surface of the conductor is exposed along its whole length, and a contact brush or slider rubs along it to take the current off, in the Lineff system nearly the whole length of the conductor is insulated, and the current is taken off at certain points, abouth three feet apart. At these points are fixed small saddle-shaped contact pieces, over which trails the bight of a metallic rope, suspended from shoes which pass through the slot of a channel, and are attached to a flexible beam under the car. The rope consists of a stranded wire cable protected with gunmetal ferrules, which can be easily renewed when worn. It is insulated from the shoes which pass through the slot, and the connection between it and the main controlling switches is also insulated. The rope in passing over the contacts collects the current, which is thus led to one of the main controlling switches, and from there to the motor, returning through the framework and wheels of the car to the rails. The great difficulty with all underground conductors for tramways is their insulation. A cable protected by insulation over its whole surface may be buried in the ground, and no escape of electricity can take place. If, however, the insulation is removed at certain points along the cable, so as to expose at intervals the metallic surface, electricity can escape at those points, and it is evident that the escape will be the greater the more the conductor is bared. A conductor only partially insulated cannot be simply buried in the ground, but must be supported on insulated brackets clear of the surrounding ground or masonry. Even if so supported, a certain amount of electricity is lost by leakage, and, generally speaking, the loss will be in proportion to the metallic surface exposed. Now, in other systems of underground conductors, the metallic surface is exposed from one end of the line to the other, and the leakage resulting therefrom must obviously be very much greater than with Mr. Lineff's arrangement, where nearly the whole of the conductors may be covered by insulation, and only a few inches of metallic surface are exposed at intervals. It is doubtless due to this arrangement that the insulation resistance, even after the very severe test described in the appendix, was yet found to be as high as 10,000 ohms, being at the rate of 1,000 ohms per mile. With this insulation resistance, the loss of current over a double line between Kew Bridge and Hammersmith would not reach two amperes, and the power wasted would amount to about three-quarters of a horse-power, or about 1 per cent. of the power required to work an eight minutes' traffic over this line. I know of no other underground system which comes anywhere near this in perfection of insulation.

Another advantage of the Lineff conductor is the facility with which crossings can be arranged. The conductor consists of iron piping, with a copper conductor inserted. The saddle-shaped contacts are screwed into the pipe, which is sub-divided into sections, each sufficiently short as not to be influenced by changes of temperature. Connection between adjacent sections is made by short pieces of insulated cable, and it is thus an easy matter to arrange for two conductors to cross each other without interference. Such crossings have been fitted at one end of the experimental line, as already stated; and I have found the car and its collectors to take these crossings easily, the working being facilitated by the ingenious manner in which the shoe beam is attached to the under side of the car.

The direction of motion is controlled by a reversing lever, and the speed by a switch lever. Ordinarily, during the journey, the driver has therefore to attend to one handle only, by which he controls the speed and puts on the brake.

Having carefully examined and tested the Lineff system, I have come to the conclusion that it is superior to other systems employing an underground conductor, and that it will be found suitable for suburban lines having a heavy traffic.

The results of my experiments and estimates of the Kew Bridge-Hammersmith lines are given in the appendix.

Appendix to Report on the Lineff Tramway.

Object of Experiments.—The object of my examination and experiments was, in the first place, to ascertain the electrical condition of the experimental line laid down on the Lineff system at the depot of the West Metropolitan Tramway Company; and, in the second place, to estimate what amount of steam and electrical plant would be required to work on the same system a given line adapted for a definite traffic.

Instruments Used.—All resistances were taken by a Wheatstone's bridge and mirror galvanometer, whilst current and pressure were measured by Miller's patent ampere and volt meters, newly calibrated.

Insulation Test.—This was made by measuring the resistance between the rails, which carry the return current, and the central conductor, which carries the outgoing current. During these tests the car was placed in the shed, and that portion of the conductor which is within the shed was disconnected, so that leakage by current through the switches and various connections in the car should not interfere with the test. The insulation resistance of the whole conductor was found 25,400 ohms. As this insulation resistance necessarily depends to a certain extent upon the state of the atmosphere, and must be lower in wet weather, I determined to test it under the most unfavourable conditions possible; and for this purpose I ordered an attendant to play into the central channel from a water hose, and another attendant to throw buckets of water over the slot all along the line. Under this treatment, which was intended to imitate a heavy shower, the insulation and resistance gradually diminished until it reached 10,000 ohms, after which point there was no further reduction.

Resistance of Conductor.—The resistance of 174 yards of conductor was found to be ·170 ohm. The calculated resistance of copper wire within the pipe is ·240 ohm, so that the resistance of the iron pipe must be about ·580 ohm.

Resistance of Earth Return.—The resistance of 174 yards of earth return circuit formed by the tram rails, the girders of central channel, and the earth, was found to be ·145 ohm. This, at the rate of 1·47 ohm per mile, was very much higher than I expected to find. The probable reason for this high resistance is that the material of the rails and girders has not been specially selected with regard to its electrical properties. The rails utilised in the experimental line were worn-out and discarded rails of various patterns. According to the chemical composition of steel, its resistance may vary from six times to about forty times that of copper, and it is quite possible that the high resistance of the return circuit is entirely due to the particular quality of which these old rails consist. Rails can now be obtained of steel having about seven and a-half times the resistance of copper, and if this steel be used the resistance to the return circuit need not exceed ·25 ohm per mile.

Power Test.—The car employed was an open summer car, carrying 20 passengers, besides driver and conductor. I estimate the weight of car, as fitted with a 4 horse-power Immisch motor and chain gear, magnetic brake, and other accessories, at 35cwt., without passengers. The line consists of a straight portion, a curve of fairly large radius, and a crossing point, over which occur very sharp curves, one of only 21ft. 6in. radius. Owing to the rails being worn, and originally of different patterns, the wheels ran at times on their flanges, which causes a greater resistance to the motion than would be the case on a properly-built line. To find the electrical energy required to propel the car, I observed the pressure and current whilst the car was travelling up and down the line, over the straight portion and the curve, but not over the crossing points, because when passing these the current underwent such rapid variation that it was impossible to obtain correct readings. In all there were made ten runs, with the car containing only three persons, and the average current for the straight and curved part of the line, and for the slight rise at either end, was 11 amperes, at a pressure of 231 volts on the motor terminals, when the car was travelling at full speed, or about seven miles per hour. The energy supplied to the car when running light was therefore 3·4 E.H.P. The car was then loaded with 40 cast-iron rail chairs, weighing 86lb. each, and in addition carrying two persons, the total load being 3½cwt., and ten runs were made. The average current required was now for full speed thirteen amperes, at a pressure of 230 volts on the motor terminals, corresponding to an electrical energy of 4 horse-power, for a total rolling load of 3·4 tons.

Power Required to Work a Full-Sized Car.—The average electrical energy which will have to be supplied to each of a number of cars running simultaneously can be compiled on the basis of these experiments. I make no allowance for the following considerations, viz.:—1. The tractive force per ton of rolling load will be less on a properly-constructed line, with rails in good condition. 2. The efficiency of the motor and gear in a large car must be greater than in a small one; and 3. The car does not always carry its full complement of passengers. All these points tend to reduce the power required, but I leave them out of consideration in order to have an ample margin of power. A full-sized car capable of

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accommodating 46 passengers, and fitted with electric gear, will weigh about three tons, and the passengers, with the driver and conductor, represent an additional 3·4 tons, so that the total rolling weight will amount to 6·4 tons. The electrical energy which has to be supplied to propel this car at a speed of seven miles per hour is, therefore, $4\frac{6\cdot4}{3\cdot4}=7\frac{1}{2}$ horse-power. This is represented by a current of 20 amperes and a pressure of 230 volts.

Plant required for working a double line between Kew Bridge and Hammersmith, with an eight minutes' service, six or seven cars being simultaneously in motion. The gradients are only trifling, and need not be taken into account where the current is divided between several cars. The maximum current required for seven cars will be 140 amperes, and the pressure 300 volts, allowing 20 volts loss along the line. The conductor will consist of a ¾in. gas tube, with a central No. O B.W.G. copper wire or bare cable of equivalent area. The resistance of the conductor and earth return formed by the rails and channel girders will be ·75 ohm per mile. At the depot there will be three dynamos, each having an output of 30 horse-power (electrical), and three steam engines, each of 45 horse-power. Two sets to work the traffic, and the third in reserve.

With a Four Minutes' Service, fourteen cars will be simultaneously in motion. The conductor will consist of 1in. gas pipe, with a 19 strand No. 11 bare copper cable. At the depot there will be three dynamos, each having an output of 60 horse-power (electrical), and three steam engines, each of 80 horse-power, two to work the traffic, the third being in reserve.

Capital Outlay.

In estimating the cost of plant required to operate this line, I leave out of account the cost of buildings and permanent way, as both items are approximately the same as for horse traction. The building for the machinery will be less costly than the equivalent stabling; but, on the other hand, the permanent way will be slightly more expensive for electrical traction on account of the greater care which will be required in making good electrical connection between adjacent rails and the side rails, and the central channel girders.

Thus, we may take it that the total expense will remain about the same. As regards the cost of the central channel, I take this to be £2,000 per mile, which I understood is the figure arrived at by Mr. Lineff, from his actual expenditure incurred on account of the central channel on experimental line.

Cost of plant and reserve gear, including foundations and labour for a service of

	8 min.	4 min.
Central channel	£12,000	£12,000
Conductor	2,280	3,060
Boilers, engines, belt, feed-heaters, &c.	2,200	3,500
Dynamos, switch-blocks, instruments, &c.	1,000	1,500
Cars fitted with motors and gear (£350 each)	2,450	4,900
Contingencies	1,070	1,540
	£21,000	£26,500

Annual Working Expenses.

Coal, water, oil, &c.	£660	£1,100
Wages, including drivers	1,200	2,000
Maintenance channel and conductor, 5 per cent.	715	755
Maintenance cars (£70 each)	490	980
Maintenance steam plant, 7½ per cent.	165	265
Maintenance electric plant, 10 per cent.	100	150
Stores	200	300
Supervision and general expenses	470	650
	£4,000	£6,200

LEGAL INTELLIGENCE.

Fyfe v. Gwynne.

In the Court of Chancery, on Friday last, a motion came before Mr. Justice Denman, in which the plaintiff, suing on behalf of himself and all other shareholders of the Pilsen-Joel Electric Light Company (Limited), asked that an alleged agreement for the sale of the undertaking of the company to the defendant Gwynne, stated to have been adopted at a meeting of the shareholders of the company held on August 16, 1888, might be declared fraudulent and *ultra vires*, and not binding upon the company, and for an injunction to restrain three of the directors of the company, Mr. Horace William Scriven, Mr. Wheatley, and Mr. Rawson, from carrying out or proceeding with the alleged agreement, and to restrain the defendant, Mr. James Eglington Gwynne, from entering into possession, dealing with, or disposing of the property of the company, and for the appointment of a receiver. The Pilsen-Joel Electric Light Company (Limited) was formed in 1882 for the purpose of working a number of patents connected with electric lighting, and there were 430 shareholders, holding 22,000 shares, and 12s. per share remained uncalled. The plaintiff was the holder of 665 shares in the company. The company held thirteen patents for electric lighting, and had three stations for installation—one at Holborn, one in Stanhope-street, and one at Bethnal Green Museum, and at each station the company had considerable engineering plant. Amongst other contracts the company had one for lighting the Bethnal-green Museum, for which they were paid £1,200 a year by the Government, and altogether the income of the company was not less than £5,000 a year. The plaintiff stated in his affidavit that no less than £87,000 had been placed in the hands of the directors, in addition to the income which they had received. Prior to June of the present year great dissatisfaction had been felt by the shareholders with regard to the management of the company, and on June 27 a committee, consisting of four shareholders—the plaintiff, Mr. Parish, Mr. Phillips, and the defendant Gwynne—and the directors, was appointed to see whether a sale of the undertaking of the company could not be effected. The committee advertised for tenders, and the only offer received was from Mr. Gwynne, to take over the assets and liabilities of the company for the price of £4,500. The plaintiff strongly objected to that offer being accepted, on the ground that it was an inadequate price; but the committee resolved to accept it, and called a meeting of shareholders for Aug. 16, at which the offer was accepted. The plaintiff alleged that the meeting was not a valid one, there being only 27 shareholders out of 430 present at the meeting, and of those 13 only voted in favour of the resolution and 12 against, two not voting. On behalf of the defendants it was alleged that Mr. Gwynne's offer was the only one received, and that it was a fair and reasonable one. It was admitted that the income of the company from its contracts was £5,400 per annum, but it was alleged that the expenses of carrying on the company came to more than that amount, and that a loss resulted.

Mr. Kennedy, Q.C., and Mr. Pochin appeared in support of the motion; Mr. Marten, Q.C., and Mr. M'Laren for Mr. Gwynne; and Mr. Millar Q.C., and Mr. Rawson for the directors and for the company.

His lordship granted the injunction in the terms asked.

PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

Note.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

11,766. F. James. London. An improved electro-ozone producing apparatus. August 15, 1888.

11,779. E. E. de Facien. London. Improvements in galvanometers. August 15, 1888.

11,782. E. Correns. London. Means for disengaging the regulating mechanism of electric arc lamps and clockworks which disengage by electricity. August 15, 1888.

11,793. W. Woodall (trading as J. Macintyre and Co.). London. Improvements in fittings for electric bells. August 16, 1888.

11,809. A. H. Maurice, L. Carr and D. Owen. Cardiff. Improvements in electromotors and apparatus for measuring the electric potential of the earth and of its atmosphere, and of any other body or gas. August 16, 1888.

11,817. J. C. Hobbs. United States. Improvements in electric furnaces. August 16, 1888.

11,858. O. C. D. Ross. London. Improvements in electric batteries. August 16, 1888.

11,897. O. B. Schallenberger (United States) or W. P. Thompson, as a communication from G. Westinghouse. Electrical indicators. (Date applied for under Section 103 of the Patents, &c., Act, 1883, January 21, 1888.) August 17, 1888.

11,898. O. B. Schallenberger (United States) or W. P. Thompson, as a communication from G. Westinghouse. Electrical indicators. (Date applied for under Section 103 of the Patents, &c., Act., 1883, January 21, 1888.) August 17, 1888.

11,917. J. G. Lorrain. London. Improvements in or connected with the transmission of electric energy. August 17, 1888.

11,925. H. W. Edlin. London. Improvements in electrical switches. August 17, 1888.

11,929. G. Binswanger. London. Improvements in electrical indicators. August 18, 1888.

11,937. F. C. Lynde. Manchester. Improvements in apparatus for driving dynamos and similar machines for electrical purposes. August 18, 1888.

11,963. M. H. Smith. London. Improvements in or connected with electric rail or tramway systems. August 18, 1888.

12,010. C. F. E. Berg. Berlin, Germany. Electric signal lantern (the firm of Keiser and Schmidt, Berlin). August 20, 1888.

12,063. A. J. Boult. London. Improvements in or relating to electrical type-writers (J. F. McLaughlin, United States). August 21, 1888.

12,064. A. J. Boult. London. Improvements in or relating to electrical type-writers (J. F. McLaughlin, United States). August 21, 1888.

12,065. A. J. Boult. London. Improvements in or relating to electrical type-writers (J. F. McLaughlin, United States). August 21, 1888.

12,126. R. R. Hutchinson. London. Improvements in and relating to merry-go-rounds and the like, and in apparatus and devices in

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connection therewith, propelled and operated by means of an electric current. August 22, 1888.

12,127. J. Feaveryear. London. Improvements in and relating to electric motors. August 22, 1888.

12,129. J. L. E. Daniel. London. Improvements in automatic electric signallings for railways. August 22, 1888.

12,149. J. Hargreaves and J. C. Sewell. Liverpool. An improved electric battery. August 23, 1888.

12,155. R. Scott and C. R. Held. Huddersfield. A new or improved application of electricity to the manufacture of soap. August 23, 1888.

12,157. J. S. Ross. London. Improvements in portable electric lamps with combinations. August 23, 1888.

12,158. C. E. Spagnoletti. London. Improvements in working railways by electricity. August 23, 1888.

12,163. H. G. C. Serrin. London. Improved cell or containing vessel for electric batteries. August 23, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

Note.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

August 25, 1888.

11,543. H. Tudor. Liverpool. Improvements in electrodes for electric accumulators or secondary batteries. August 24, 1887.

12,414. F. C. Phillips and H. E. Harrison. London. Improvements in electric arc lamps. September 13, 1887.

12,763. G. Forbes. London. Improvements in electric meters or apparatus for measuring electricity. September 20, 1887.

13,978. A. Noble. Newcastle-on-Tyne. Improvements in electric firing gear for rapid firing and other guns. October 14, 1887.

14,954. W. Terril. London. Improvements in apparatus to be used in the deposition or treatment of metals by the electrolytic process. November 2, 1887.

8,637. A. L. Parcelle. United States. Improvements in electric clocks. June 12, 1888.

PATENTS SEALED.

August 24, 1888.

8,796. W. E. Ayrton, London, and J. Perry, London. Improvements in galvanometers with suspended coils. June 18, 1887.

10,233. M. Maitland. London. A novel combined electrical vapour bath. July 21, 1887.

10,381. W. J. Woodward. London. Apparatus or means for preventing more than one electric shock being given after the insertion of a coin into automatic or other machines in which electricity is employed. July 26, 1887.

11,004. M. H. Smith. Halifax. Improvements in apparatus for the electrical propulsion of tramcars and other vehicles. August 11, 1887.

16,473. S. S. Bromhead. London. An electrical signalling device for railway purposes (S. T. Street, U.S.A.). November 30, 1887.

1,932. F. H. Royce. Manchester. Improved forms of electrical contacts for switches and similar fittings. February 9, 1888.

4,964. A. J. Boult. London. Improvements in apparatus for transforming electric currents (Dr. S. Doubrava, Austria). April 3, 1888.

SPECIFICATIONS PUBLISHED.

10,663, 1887. Boult, A. J. (McLaughlin). Electrical type-writers, &c. (Price 1s. 1d.)

10,836, 1887. McEvoy, C. A. Electrical firing mechanism for ordnance. (Price 8d.)

12,880, 1887. Reynolds, W. J. Producing solid metal sheets by electro-deposition. (Price 6d.)

13,709. 1887. Bozon, R. S. India-rubber compensator for telegraph, &c., wires. (Price 8d.)

4,659, 1888. Schmidt, F. S. Making and breaking electrical circuits in connection with call boxes, &c. (Price 8d.)

7,848, 1888. Thompson, W. P. (Westinghouse). Indicators for alternating electric currents. (Price 8d.)

7,849, 1888. Thompson, W. P. (Westinghouse). Detecting and locating faults in alternate-current electric circuits. (Price 8d.)

7,998, 1888. Holman, F. Shades, &c., for incandescent electric lamps. (Price 8d.)

9,206, 1888. Lutckie, C., and George, P. Galvanic elements. (Price 8d.)

9,660, 1888. Boult, A. J. (Lugo). Electric motors and dynamo machines. (Price 1s. 1d.)

9,661, 1888. Boult, A. J. (Emmner). Telephone transmitters. (Price 8d.)

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 24th, 1888, amounted to £5,229.

LANCASHIRE AND CHESHIRE TELEPHONIC EXCHANGE COMPANY.—The report of this company states that on the past year's working the profit is £32,466, which, with a credit balance of £1,497 remaining from previous account, makes a total fund of £33,963. After deducting from this sum bank interest, interest on reserve fund, and the interim dividend declared in February last, there remains a balance of £19,421. The directors now recommend a further dividend at the same rate as in February, making a complete dividend of 7 per cent. for the year ended June 30th, which will absorb £14,000, and leave a balance of £5,421. The directors propose that £3,000 of this shall be placed to the reserve fund (making a total reserve, including interest of £8,650), and that the remaining £2,421 be carried forward.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 24th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £4,367.

NOTICE OF REMOVAL.—We are informed that Mr. Alexander Bernstein, late of Commercial-road, Pimlico, has removed his works to Hamburg. His address in future will be—Electrische Fabrik, Mühlenkamp, Hamburg.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, August 29, 1888		Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending August 29, 1888.	
£						£. s. d.		Highest.	Lowest.
			TELEGRAPHS.						
1,770,360	Stock	5/0	Anglo-American	40½	41⅛	3 6 3	Jan., Apr., July, Oct.	41	40⅝
2,614,820	Stock	10/0	Do. Preferred	68	69	3 19 9	,, ,,	68½	67½
2,614,820	Stock	nil.	Do. Deferred	13⅜	14¼	...	February	14⅛	13¼
130,000	£10	3/0	Brazilian Submarine	12⅞	13⅛	5 6 8	Mar., June, Oct., Dec.	13⅛	13
16,000	10	9/0	Cuba Submarine	13½	13⅝	6 3 8	February and August	13½	...
6,000	10	10/0	Do. Preference	18⅛	19⅛	5 2 6	,, ,,	18⅛	18⅛
12,931	5	4% '87	Direct Spanish (£4 paid)	3¾	4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference	9⅛	10⅛	4 15 3	April and October	...	...
60,710	20	2/0	Direct United States	9⅛	9⅝	4 5 3	Jan., Apr., July, Oct.	...	...
880,000	10	4/0	Eastern	12⅛	12⅝	4 17 0	,, ,,	12⅝	12⅛
70,000	10	3/0	Do. 6 per Cent. Preference	14⅝	15¼	3 19 0	,, ,,	15⅛	15⅛
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107	110	4 10 11	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅞	13⅛	4 19 0	Jan., Apr., July, Oct.	13⅛	13
22,050	10	8/3	German Union Telegraph and Trust	9	9½	7 7 4	January and March	...	...
179,177	10	3/0	Globe Telegraph and Trust	6⅛	6⅝	5 3 8	Jan., Apr., July, Oct.	6⅛	6⅛
178,992	10	3/0	Do. 6 per Cent. Preference	13⅝	14	4 5 9	,, ,,	14⅛	13⅞
150,000	10	7½% '87	Great Northern	13¾	14¼	5 5 3	Jan., July, and April	14¼	13⅝
17,000	25	37/6	Indo-European	37	39	6 8 2	April and October	...	...
33,348	10	3/0	London Platino Brazilian	6	6⅛	...	May and November	...	...
9,000	8	4/0	Reuter's	7⅛	8	5 0 0	April and October	...	...
338,225	Stock	13½%	Submarine	130	140	10 7 1	February & August	132	131
30,000	10	6/0	West Coast of America	6½	7	7 3 0	January and July	...	...
150,000	Stock	8%	Do. Debentures	110	115	...	June and December	...	...
88,321	10	nil.	West India and Panama	1⅜	1⅝	...	...	1⅝	1⅛
34,563	10	10/0	Do. 1st Preference	11⅞	12½	...	April and October	12⅛	12
45,181	15	9/0	Western Brazilian	12	12½	5 4 4	March & September	12⅛	11⅝
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118	123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	103	105	5 14 3	March & September	...	...
			TELEPHONES.						
224,850	14/0	£5 7s. '87	Consolidated Telephone and Maintenance	1/16	1⅛	5 10 0	Yearly	...	...
220,000	£1	2½% '87	Oriental (11s. paid)	1/16	1/16	3 9 0	...	...	...
80,000	5	10/0	United	13	13⅛	5 11 0	June and December	13 1/16	13¼
50,000	5	2/6	United River Plate	5⅛	5⅜	...	April and October	5⅜	...
			ELECTRIC LIGHT.						
23,003	5	1/2	Anglo-American Brush (£4 paid)	3	3⅛	...	...	3¼	...
23,692	5	nil.	Do. (fully paid)	4	4⅛	...	February & August	..	...
79,984	5	nil.	Swan United (£3. 10s. paid)	2⅛	2⅛	...	...	...	...
312,000	½	5% '86	Maxim-Weston	1/16	1/16	...	February	...	...
			MISCELLANEOUS.						
37,350	12	36/0	Telegraph Construction and Maintenance	39	40	5 19 9	March and July	40	39½
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	17	18	5 14 3	February & August	17⅜	17½

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 538.—Vol. XXI. FRIDAY, SEPTEMBER 7, 1888. Price 4d.

NOTES.

From the opening sentences in his very admirable Presidential address in "Section G" we gather that Mr. Preece is not fully prepared to endorse the views of Dr. Oliver Lodge on lightning-flash phenomena. The nature and extent of his antagonism will doubtless be more fully disclosed in the discussion on the whole question which is about to take place. Mr. S. A. Varley also, who is writing an entertaining though somewhat *omnium gatherum* and decidedly dogmatic series of articles in a contemporary journal, finds much to dissent from in Modern Views of Electricity as expounded by Dr. Lodge. Without proposing to take upon ourselves the task of buttressing the theories of Dr. Lodge or Mr. Heaviside, we should like to offer a few remarks upon the present stage of the controversy. Mr. Varley goes so far as to avow his belief that "the surging of currents through lightning conductors, to which Prof. Lodge gives so much prominence, is more imaginary than real." Now, we take it that the discovery of the (sometimes) oscillatory character of the lightning flash is, *if true*, one of the most beautiful, and will prove to be one of the most pregnant, scientific discoveries of recent date. There is, therefore, all the more reason that it should sustain the closest scrutiny before it is allowed to take the place of an established canon of electrical science. At the present moment the history of the subject may be briefly summarised thus:—In 1847 Helmholtz (*Die Erhaltung der Kraft*) proved that, under certain conditions, a condenser discharge would assume an oscillatory character, and the theorem was extended by Sir William Thomson in 1855. In his Dr. Mann lectures before the Society of Arts early in the present year, Dr. Lodge showed some novel experimental results dependent upon this fact; and, moreover, he proved that some of the recorded phenomena of lightning—notably "side-flash" from earthed conductors—were of the same general character (see *Electrician*, June 22nd, 29th and July 6th, 1888). In August last Dr. Lodge showed further, in the *Phil. Mag.* (see also *Electrician*, August 10th), that under certain not unreasonable assumptions, the conditions of a discharge from a thundercloud would lie within the limits which determine the existence of oscillations. This is, in brief, the basis of the deduction which Mr. Varley has characterised as more imaginary than real, and which Mr. Preece scarcely thinks to be logically sound.

It should, however, be noted that the argument does not by any means rest wholly upon the mathematical treatment of quantities whose values are only assumed as reasonably probable—though the support which is furnished by such calculations is undeniably valid so far as it goes. On the contrary, we have striking experimental verification in the shape of the artificial reproduction of known and hitherto unaccountable phenomena which are sometimes attendant on the lightning flash. The exact nature and degree of the analogy between observation and experiment affords, of course, a legitimate ground for criticism; and we think it will be admitted that in a case like this, where the natural phenomenon necessarily takes place upon a scale of incomparable grandeur compared with the laboratory experiment, that the highest value attaches to the results of direct or indirect observation. It seems worth while, therefore, to draw attention to the fact that, other things being equal, an oscillatory discharge must have a greater total duration than a direct or continuous discharge. It is true that the numerous experiments carried out by Arago, and by others after him, have led to the conclusion that the duration of a lightning flash is not greater than one-thousandth of a of a second; but, on the other hand, Dr. Lodge finds that the period of oscillation in a special case which he investigated would have been of the order of one-millionth of a second; so that, although the theory does not by any means say that all flashes are oscillatory, yet some of those observed by Arago might still have consisted of many hundreds of such oscillations. Perhaps Dr. Lodge or Mr. Heaviside will be able to calculate the probable total duration of a visible oscillatory discharge under given conditions. The importance of the point is enhanced by the circumstance (which we recorded in our issue of the 17th ult., p. 458) that an observation recently made in France by M. Trouvelot furnishes ground for believing that a single flash on one occasion had a total duration of no less than three seconds at the least. We are glad to learn that M. Trouvelot intends to follow up the question of duration by aid of the camera, and it would seem certain that such observations would throw much additional light upon the whole question.

We are a little surprised to learn from Mr. Preece that "the engineer and the physicist are completely at variance" on the question of "What is Electricity?" If this be so we take it that the disagreement can only be on a point of nomenclature. Electricity to the physicist is a term which, when standing alone, refers to that entity which we measure quantitatively in coulombs or dynamically in amperes. (We must, respectfully but firmly, decline to adopt Mr. Preece's new-coined term "coulombism," which is indeed, to our ears, what Walt Whit-

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man calls a "barbaric yawp.") But Mr. PREECE says that "the engineer regards electricity, like heat, light and sound, as a definite form of energy." It would follow immediately that if electricity give rise (say in an incandescent lamp) to a definite amount of energy in another form, as heat or light, a definite amount of electricity must itself disappear in the process—for of course the conservation of energy is not called in question. But in reality no electricity disappears on passing through an incandescent lamp. The current on each side of the lamp is of identically the same value; *ergo*, electricity is not a form of energy. But Mr. PREECE is necessarily familiar with this reasoning, and we gather that he chooses to reserve the term electricity for the product "C E"—which we should call "electric energy." When, however, we remember that engineers are already perfectly familiar with "energy" as consisting of two factors, a "quantity" and a "pressure," it has always seemed to us an advantage rather than otherwise that electric energy should be capable of the same form of expression as that derived from air, or water, or steam. If, however, an engineer wants a working definition of electricity (in the more usual sense of the term) he may be well content to say that electricity is "a vehicle of energy." This is indisputably true, and does not commit one to any assertion as to the identity of electricity either with luminiferous ether or with any other form of matter. It even leaves the door open for the assumption that electricity is simply *sui generis*, although capable of interacting both with ether and with matter.

IN connection with this question, which, like all ultimate problems, is apt to become more and more unintelligible the more closely it is examined, it is worth while to recall a suggestion of Prof. CLIFFORD'S, made many years ago (we believe it will be found in the *Camb. Phil. Trans.* for 1870 or 1871). CLIFFORD suggested that if we assumed space to be of four dimensions, then it might be imagined that a flow of electricity involved or was determined by a local bending of our ordinary space of three dimensions. The equations which arise from such a proposition are, he tells us, precisely similar to those of electro-magnetic induction and its propagation. We commend this idea to the mathematicians to whom we are already so vastly indebted for the proof that in space of four dimensions a straight line is not necessarily the shortest distance between two points, that (as Prof. NEWCOME showed) a solid ball may be turned inside out without stretching or tearing, that no knot (as KLEIN showed) can there be tied in any string, but (as Prof. S. P. THOMPSON recently informed us) any amount of knots can be tied in a line of force.

PROFESSOR FITZGERALD, in Section A, presented a most valuable and profoundly interesting exposition of the recent work of HERTZ, who has detected the phenomena of interference in electro-magnetic waves. This is an *experimentum crucis* which is sufficient single-handed to overthrow for ever the advocates of the "action-at-a-distance" theory, if any such remain. Prof. FITZGERALD characteristically omits any reference to his own earlier work in this direction, but at the Southport meeting of the British Association in 1883 he read a Paper "On a Method of Producing Electro-Magnetic Disturbances of Comparatively Short Wave Lengths," wherein he showed how extremely small wave lengths might be obtained by the discharge of a condenser through a circuit possessing a suitable time-constant. He also pointed out that by this means we might fill up the whole existing gap between the rates of vibration of sound and light. It is upon this basis that HERTZ has been able to achieve his remarkable success.

PROFESSOR AYRTON'S lecture on the Transmission of Power at Bath this (Friday) evening will afford one of the most, if not the most, complete exemplifications of the conversion and transmission of power by electricity which has ever been given. Very elaborate preparations have been made for the running both of motors, alternators, transformers, motor-generators, and continuous-current dynamos on the platform of the hall. Amongst the types of apparatus to be exhibited may be mentioned the Thomson-Houston, Brush, Immisch, Paris and Scott, and others. If the good ship "Britannic" arrives in time we *may* see a Tesla motor. Power is supplied by a Thomson-Houston 18-lighter, driven by a portable engine in a temporary shed outside. From a technical point of view, the most interesting experiment that will be shown is the running of two Immisch constant-current motors on a Thomson-Houston circuit. These two motors are self-governed, and the loads can be independently varied without affecting the speed.

THE reduced tariff for inland telegrams having been in operation during two complete years, the POSTMASTER-GENERAL, in his Annual Report for the year ended 31st March, 1888, is able to make a comparison showing the progress of telegraph business with popular prices. During 1887-8 the number of messages affected by the new tariff—that is to say, inland messages exclusive of press messages—increased by 7·45 per cent. over the previous year's total, while the receipts increased by 6 per cent. The annual deficit, which last year was larger, we believe, than it had ever been has this year fallen considerably, being rather lower than it was five years ago, before preparations were made for introducing sixpenny telegrams. This year's deficit is, in fact, a little less than the annual interest on the original purchase money; in other words, were it not for the interest still charged to it the telegraph service would now show a balance on the right side.

IT has often been suggested that this charge for interest ought to be discontinued, and we certainly cannot see the good of debiting the Postal Telegraph Department with it year after year. Should business go on improving at the present rate for another four or five years, the net receipts will about cover the interest on capital, but not the arrears, which now amount to such a very large sum that not even the Treasury can ever hope to get it paid back again out of profits on telegraph business.

IN this issue we bring to a conclusion the very interesting Paper by Mr. SIDNEY EVERSHED on "Electric Traction on the Inner Circle." Putting aside the question of accumulators,

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which (with one singular and to us unaccountable exception) no competent electrical engineer has seriously contemplated, two conclusions at least have, we think, been made perfectly clear. First, that electric traction is a practical and an economic possibility on the metropolitan railways. Secondly, that it will demand the fullest consideration on the part of the most able and best-informed engineers before such a project can be carried to a successful issue. As in so many other engineering problems, we have to face the difficulty of adapting new proposals to existing conditions; but that this difficulty can be successfully grappled with we make no doubt whatever. And provided a well-considered scheme be adopted, we are equally confident that the financial results will be such as to fully justify the necessary addition to the capital account of the railway companies. It is most unfortunate that the Circle line should belong to two separate companies, whose mutual hostility is apparently irreconcileable. We fear that in reality nothing whatever will be done (at least, on the main line) until either the concerns are amalgamated or their long-standing feud has been extinguished. The Metropolitan Company possesses an unchallenged right to run its trains over the District line by means of any motive power whatever; but of course it has no power to interfere with the permanent structure of that portion of the line. This fact no doubt accounts for the circumstance of Sir EDWARD WATKIN being bitten by the accumulator idea, but it does not account for a responsible firm of electrical engineers being found to back him up. Meanwhile we learn that the District Company is thinking of trying a conductor system on the branch line from Earl's Court to Putney Bridge. There are some heavy gradients on this line, but there is no reason why electric traction should not be completely successful.

IF Mr. WILLIAM WEBSTER's present anticipation that over a million gallons of sewage can be dealt with in twenty-four hours by an expenditure of 25 horse-power and one grain of iron per gallon (say six or eight shillings' worth of iron per million gallons) be capable of actual realisation, then we think that the electrolytic treatment of sewage will very soon become an important branch of electro-technics. Mr. WEBSTER has such faith in the efficacy and economy of his process that not only is he erecting works at Crossness, at his own expense, to deal with one million gallons per diem, but he has also publicly expressed his willingness to make experiment with the effluent fluid in his own proper person (*experimenta in corpore vili*) as a table water. For our own part, without undue scepticism, we shall prefer to base our judgment upon the results of six months at Crossness.

Turin.—The Turin authorities have just issued an order directing that no theatre is to be allowed to remain open after the 1st November unless lit by electricity.

The Acme Electric Works.—The Acme Electric Works, of Finsbury, have been so successful that they have been compelled to remove to more commodious premises at Ferdinand-street, Chalk Farm-road.

Personal.—Mr. James Swinburne has severed his connection with the firm of Crompton and Co. (owing to the expiration of agreement). Mr. Swinburne, whose address will still be at Chelmsford, intends to practise as a consulting electrical engineer.

City Office Lighting.—We hear that Messrs. Drake and Gorham have recently been entrusted with the lighting of Messrs. Johnson, Budd and Johnson's new city offices. The plant will consist of a set of Drake and Gorham accumulators, together with an Elwell-Parker dynamo and Otto gas engine.

The London Electric Supply Corporation.—This corporation is about to remove to 3, Adelphi-terrace, Strand. The new central generating station of the corporation at Deptford is rapidly approaching completion.

Theatre Lighting.—The proprietors of the Zarzuela Theatre, Madrid, have contracted with the firm of Bloss for the lighting of that building with the electric light. The installation is to cost $24,000 (£4,800), and the machinery will include two engines of 150 to 200 horse-power. The installation is to be complete early in October, and to begin working by the 15th of that month.

New South American Telephone Company.—A "Telephone Construction Company" has been formed in the United States, the object of which is stated to be the establishment of telegraphic and telephonic communication between the town of Valdivia, in Chili, at one extremity, and New York at the other, the line running through Bolivia, Ecuador, and Columbia.

The C. and C. Electric Motor.—The *Electrical World* gives a list of users who have adopted this motor in New York, where over 300 have been installed on the Edison, Brush and other circuits. The motors are used for driving sewing machines, boot and knife-cleaning machinery, small coffee mills, ventilating fans and other small electric-power purposes. Messrs. Shippey Bros. (Limited) are the agents for the system in this country.

Barnet.—The street lighting installation at Barnet, put in by Messrs. F. Joel and Co., commenced operations on Saturday last. There are at present 71 lamps of 32 candle-power. The wires are partly overhead and partly under ground. It is intended to provide for a private-house supply on a large scale on a separate system of mains. We understand that a considerable number of applications have already been received.

Mr. Blakesley's "Wandering Spark" Experiment.—A reference to this remarkable experiment occurred in our recent review of M. Planté's work on "Atmospheric Electricity." Mr. Blakesley now writes to correct an error in detail as follows:—"On looking at the Aug. 3rd *Electrician* I see you mention my experiment with the wandering spark as having been made on a photographic plate *after development*. For after read *before*."

Chinese Telegraph Convention.—Advices from China announce the signature of the Telegraph Convention between the Chinese Government and the two companies having cables to China. The text of the convention is the same as that which appeared recently in *The Times*. The only change is said to be that the Chinese may withdraw from the arrangement at any time in case they find it injuriously affects their own telegraph system.

Telephones for the King and Queen of Portugal.—We have recently had an opportunity of inspecting a special pair of telephones made by the Consolidated Telephone Construction and Maintenance Company for the King and Queen of Portugal. They are of the Gower-Bell pattern, into which several

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important improvements have been introduced. The instruments are mounted on very handsome West India rosewood panels, and are altogether a very creditable piece of work.

Sewage Purification by Electricity.—Mr. Webster, whose system of sewage treatment by electricity has been already referred to in this paper, has found, since filing the specification of his patent, that the employment of positive electrodes of any other material than iron is of little or no practical value in treating sewage and similar impure liquids. He has therefore filed an amendment limiting the patent to the use of positive electrodes of iron, except in the case of the filtering process.

The Thomson-Houston Litigation.—It will be remembered that last week our New York correspondent informed us that the Thomson-Houston Company had been successful in establishing an action for infringement against the Citizen's Electric Light Company, using the American system, in regard to their use of the Thomson-Houston method of current regulation. We now learn by cablegram that the judge has granted an order restricting the American company from selling or shipping goods infringing this patent.

The Telegraph Manufacturing Company.—The Telegraph Manufacturing Company of Helsby have just completed another large addition to their already extensive factory. This is for the special work attached to vulcanised electric light leads, which the company can now supply to any possible specification. Extra lighting plant has also been added, making an installation of over 500 incandescent lamps for the lighting of the shops alone. The company are full up with orders, and in one department are running night and day.

Woodhouse and Rawson's Catalogue.—We have received from the Woodhouse and Rawson Electric Supply Company a copy of a new edition of their catalogue and price list of switches and cut-outs. The articles made by this company are doubtless already familiar to the majority of our readers. The new catalogue, however, still shows signs of the care and attention which is being devoted to the perfection of minor details. The various switch-boards which are described and illustrated for installations of various types and sizes will be found of special interest.

Otley Local Board.—At the ordinary meeting of the Otley Local Board, held on Monday night, Mr. Johnston suggested that the water of the Ellar Gill would be ample to supply power for the generation of electric light for the whole of Otley.—The chairman said he was perfectly willing for the Board's property to be put to any useful purpose, and he had no objection to inquiring into the practicability of the proposal. After further discussion a sub-committee was appointed to obtain information on the subject, and to report to the Board at its next meeting.

Electric Lighting at North Shields.—At a quarterly meeting of the Tynemouth Town Council, held in the Town Hall, North Shields, last Friday, Ald. Joseph Green moved that the Council make application for a provisional order for lighting the public buildings and streets of the borough with the electric light. Councillor A. N. Dodds moved as an amendment that the question be referred back to the committee for further consideration. After a lengthy discussion, voting on the subject resulted in five votes for the amendment and ten for the resolution, which was declared carried.

Copper.—Messrs. Merton and Co.'s copper statistics for August put the deliveries in France and England during the month at only 3,270 tons, being the lowest for at least three years past. They, moreover, remark that 3,875 tons were taken as delivered in July, whereas this quantity was merely transferred to Continental stock, and the net deliveries in July were only 5,891 tons. This explains the continued increase of visible supplies. In England, France, and afloat the stock is now altogether 86,701 tons, being probably the highest on record, and more than half as much again as the average stocks last year.

The Rouen-Havre Telephone Line.—The telephone service between Rouen and Havre has not hitherto proved a financial success. It was carried out by the Government at the solicitation of the Chambers of Commerce in those towns, who guaranteed a minimum revenue of 6,000fr. That sum has never yet been earned, and the Chambers of Commerce have always had to make up the deficit. They now wish to terminate the arrangement, and refuse to pay the loss in 1887, on the ground that the service does not give satisfaction. The Government has commenced proceedings to compel them to carry out their engagement.

Brussels.—During a violent storm on the 25th July last a fire broke out at the Hôtel de Ville. A strict investigation as to its origin was made by Professor Courtois, and it was discovered that the fire arose from the sparking which took place between a lightning rod and a piece of iron underneath the roof. This sparking set light to some woodwork and caused the fire. Professor Courtois does not attribute this occurrence to any defect in the Melsens conductor, but simply to the fact that M. Melsens' instructions were not carried out in their entirety, a few of the iron supports of the roof being left unconnected to the lightning conductor.

Electric Light for Railway Signalling.—According to the *Railway World*, electric lamps are now used in place of oil lamps in the railway yard at Oakland, Cal., with every appearance of economy and improved service. Sixteen candle-power lamps, run at only 12 candle-power, are employed, the reduced candle-power insuring a long life for the lamp. These lamps, without any difficulty or attention other than occasionally cleaning the glass lens on the outside of the lantern, have been burning over 2,600 hours up to date; and, according to Mr. Slater, they are probably good for another year. The current is furnished from arc machines, and the lamps placed in multiple series.

The Manchester Multiple Switchboard.—After the annual meeting of the Lancashire and Cheshire Telephonic Exchange Company at Manchester, on Tuesday last, a number of gentlemen accepted the invitation of the directors to inspect the new switch room arrangements. All the wires are now brought to the one central office at the Royal Exchange, where a fine multiple switch-board, capable of accomodating, if necessary, 4,200 subscribers, has been erected. Upwards of 100 miles of wire is used in joining up the various sections, and some 65,000 soldered connections have been made. The switch room is 120ft. long by 24ft. wide, and is thoroughly well ventilated, warmed, and lighted.

Vienna.—The electric lighting of the Court Theatre at Vienna has now been completed. All parts of the building—stage, auditorium, and corridors—is brilliantly illuminated. Every precaution has been taken against accident, and arrangements of the most elaborate character are provided for switching the light on and off in particular parts of the building. The total display includes over 5,000 lamps of from 10 to 40 candle-power each. Arrangements are also made for tinted lamps, by means of which coloured effects will be produced, instead of by the old clumsy use of chemical compositions. This splendid building has now cost about £2,400,000, and it is one of the finest theatres in the world.

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The Postmaster-General's Report.—According to the recently published report of the Postmaster-General, the total number of telegrams forwarded during the year ended 31st March last was 53,403,425, being an increase of 3,159,786 over the year 1886-87. The total for 1870 was 9,850,000. The London local messages show an increase of 13·8 per cent., the total number being 4,337,907. The total number of telegraph offices in the United Kingdom is now 6,810, 257 new ones having been opened during the year at post offices and 39 at railway stations. Of the 1,745 lines of wire entering the General Post Office not one is overhead. The use of copper wire has been prevented for the present by the abnormal rise in the price of copper.

Dublin.—Last week Major Marindin, C.E., C.M.G., attended at the City Hall, Dublin, on the part of the Board of Trade, with reference to the local inquiry which had been sought for by the Alliance Gas Company, regarding an application made by the Corporation for powers to light the streets with electricity, utilising for the purpose the water power, the property of the Corporation, at Island Bridge Mills. The inquiry became purely formal, as the gas company had decided not to persevere in its opposition to the scheme, and the tramway company, which had also raised objections to the granting of the license, finally determined not to proceed any further in the matter. The inquiry was therefore limited to a clause sought for by the Port and Docks Board for the protection of bridges and other works under its care. It is anticipated that the license will be issued without further delay.

Dumfries.—Last Friday afternoon the introduction of the telephone into Dumfries was formally inaugurated. A luncheon took place in the ball room of the King's Arms Hotel, to which a number of gentlemen, including subscribers and the leading tradesmen and merchants of the town, were invited by the manager of the National Telephone Company. Mr. Bennett, general manager for Scotland, made a very telling speech, and the proceedings were brought to a close by a practical demonstration of the powers of the telephone. A violinist at Maxwelltown was asked to play a selection of Scotch airs, and the music could be distinctly heard in the ball room by means of the receivers. All the subscribers, numbering some 34, are now in connection with each other, and the exchange has already been frequently in use. Dumfries is not at present in connection with any other town, but it is intended before long to connect it southward to Carlisle and northward to Ayr and Glasgow.

A New Soft Solder.—According to an American paper, a soft alloy which adheres so firmly to metallic, glass and porcelain surfaces that it can be used as a solder, and which is invaluable when the articles to be soldered are of such a nature that they cannot bear a high degree of temperature, consists of finely pulverised copper dust, which is obtained by shaking a solution of sulphate of copper with granulated zinc. The temperature of the solution rises considerably, and the metallic copper is precipitated in the form of a brownish powder; 20, 30, or 36 parts of this copper dust, according to the hardness desired, are placed in a cast-iron or porcelain-lined mortar and well mixed with some sulphuric acid having a specific gravity of 1·85. To the paste thus formed are added 70 parts (by weight) of mercury, constantly stirring. When thoroughly mixed, the amalgam must be carefully rinsed in warm water to remove the acid and then set aside to cool. In ten or twelve hours it will be hard enough to scratch tin. When it is to be used, it should be heated to a temperature of 700° F., when it becomes as soft as wax by kneading it in an iron mortar. In this ductile state it can be spread upon any surface, to which, as it cools and hardens, it adheres very tenaciously.

The Lighting of Eastbourne.—At the recent Lighting and General Purposes Committee meeting of the Eastbourne Town Council, the following letter was read from Mr. Henry Towner, secretary of the Eastbourne Electric Light Company (Limited): —"Aug. 20.—My directors have to-day considered your letter of the 14th August, and have come to the conclusion that they cannot supply the Parade arc lamps at less than £35 (thirty-five pounds) per lamp per annum. My directors desire me to add they are fully sensible of the support the company has always received from the Corporation, but they feel the Council would not wish them to enter into a contract which would be a source of loss to the company. The price of £35 per lamp gives but a narrow margin of profit. The directors are quite prepared to prove the accuracy of the figures they have quoted as to the cost of production of the light to each lamp, and when I point out to you that the works are open and the machinery running up to one o'clock each night, it will at once be seen that the difference of half an hour proposed by you is of very little practical account to the company.—Yours faithfully, Hy. Towner, Sec." It was resolved "That this committee cannot see their way to recommend the Council to renew the contract for lighting the Parades by the electric light at the rate of £35 per lamp per annum, at the expiration of the present contract, the Electric Light Company having definitively refused the compromise proposed by the Council."

Norwich.—At the last meeting of the Norwich Town Council Mr. Squirrell moved "That a committee be formed, to be called the Lighting Committee, and that it should forthwith inquire into the cost and method of electric lighting in Brighton, Taunton, Eastbourne, Poole, Bradford, and any other towns in which electric lighting is in use, and report to the Council at its next meeting." His object in bringing this question before the Council was that they might be posted up with the fullest information as to the improvements and progress of electric lighting. Since they tried the experiment of the electric light in Norwich he believed great improvements had been made in the methods of lighting, and the Council ought to have ample information on this subject. In twenty towns in England electric lighting had been established. He moved that the committee should consist of the Mayor, Sir Harry Bullard—who had recently had some experience of the electric light—Mr. Hackblock, Mr. Saul, Mr. Cunnell, Mr. Holmes, and himself.—Sir H. Bullard, in seconding, said this committee would be very useful, and he thoroughly agreed with the resolution. Material improvements in electric lighting had been made since the experiment was tried in Norwich; and the failure of that experiment was due to the fact that it was only directed to public lighting. The point to be aimed at was to have the light so that it could be supplied to shops.—Mr. Hackblock said at present the Corporation had no powers, for their provisional order had expired; but Sir H. Bullard thought the Corporation could apply for such powers under Mr. Chamberlain's Bill.—After a few remarks from Mr. Watson the motion was adopted.

Collisions at Sea.—Mr. J. H. A. Macdonald, of North Berwick, writes to *The Times* of September 5th as follows: —In thinking the matter over I fell upon an idea which, as it has received four awards in electrical and life-saving exhibitions, and was the means of obtaining for me the membership of the Society of Telegraph-Engineers, may be thought worthy of publication in the present correspondence. An

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electric light with holophote reflector, similar to what are known as search lights, is placed on the bridge, under the control of the officer in command. The handle by which this light can be moved is regulated absolutely by the position of the helm. If the helm is amidships it is held firmly in its place and cannot be moved. If the helm is put to port, the detent which locks the handle on the starboard side is removed, and the light can be swept over the water from amidships to starboard, the pencil of light and its reflection on the water giving the same signal to the other vessel as the driver of one vehicle meeting another can do with his hand. When the light has completed its sweep to starboard it is automatically shut out, and is not again exposed till the handle is brought amidships, when it can again be swept to starboard, and this can be repeated as long as the helm is to port. *Vice versâ*, if the helm is put to starboard, the light can be swept from amidships to port. The light thus sweeps the water over which the vessel will go in paying off. It is thus obvious that the pencil of light distinctly informs the other vessel of the direction in which the coming ship is heading at the moment, and of the fact that she is paying off either to port or starboard.

Cheltenham.—At a meeting of the Cheltenham Town Council, held on Monday last, the Electric Lighting Committee reported that they had held two meetings. At the first, which took place on the 13th ult., it was resolved "That it is desirable that the lighting of the streets by electricity be carried out by the Corporation rather than by contract with a company or private individuals, if this course can be adopted at no large increase of cost, it being the opinion of the committee that the creation of another private monopoly to be hereafter purchased by the town should, if possible, be avoided, and that the retention of the supply under the control of the town will secure greater efficiency; that the Town Clerk be requested to report on the legal position of the Town Council in the matter, and as to what powers it will be necessary to obtain to enable the Corporation to lay down the proposed service and supply private individuals with the light, and what steps it will be necessary to take to obtain such powers; and that he be asked to make inquiries with the view of obtaining the professional services of a competent expert to advise the committee as to the installation; that the Borough Surveyor be requested to report what sites now belonging to the Corporation are available for generating stations."—Meeting again on August 31st, the committee received a report from the Town Clerk, prepared in accordance with the terms of their instruction. The Borough Surveyor also reported, suggesting sites that might be utilised for the erection of the necessary buildings and apparatus for the proposed installation. The Town Clerk laid before the committee the draft of a letter to the gas company, which was approved and ordered to be sent to the clerk of the company; and the further consideration of the matter was then adjourned. Mr. G. Norman proposed the adoption of the proceedings of the committee, and Alderman Simms Bull seconded. Alderman Parsonage thought that the Council and ratepayers were entitled to know what expense the scheme would involve, and after a lengthy discussion an amendment of Alderman Parsonage's was embodied in the resolution. As finally drafted, Alderman Parsonage's addendum was as follows: "That, except for the purposes of inquiry, the Electric Lighting Committee do, before any further step is taken, bring up an approximate estimate of the cost of their proposal." With this addition the minutes were unanimously agreed to.

Whitworth Scholarships for 1888.—The engineering scholarships founded twenty-one years ago by Sir Joseph Whitworth have undoubtedly been of the utmost value to this country in enabling young men of more than average ability to complete a course of practical and theoretical engineering which would else have been beyond their means. Sir Joseph Whitworth's munificent endowment permits an outlay of no less than £3,000 a-year for this purpose. From 1869, when the first competition was held, until 1879, the Whitworth scholarships were of the value of £100 a year, and tenable for three years. At first ten were awarded annually, but in 1873, in order to show the devotion of the scholars to the studies and practice necessary for mechanical engineering, the number of scholarships was reduced to six, and a system of extra payments was instituted on the results of examinations held during the tenure of the scholarships, so that the best scholar of the year's batch could obtain as much as £800 in all, and the others in proportion. From 1880 to 1887 the scholarships were awarded for one year only, and without bonus, there being usually one of £200, eight of £150, and sixteen of £100. The experience of past competitions led the Science and Art Department last year to again revise the rules for the administration of the Whitworth endowment. As before, candidates must be under twenty-six years of age, and have been engaged at handicraft for at least three years in the workshop of a mechanical engineer; but henceforth some of the awards are to be known as exhibitions tenable for one year, and others as scholarships tenable for three years. Both exhibitioners and scholars require to follow out a course of work or study satisfactory to the department. While doing so exhibitioners are permitted to hold posts of profit or emolument as well as the Royal exhibitions and national scholarships of the Science and Art Department, but scholars will be required to devote their time *entirely* to the prosecution of their education as mechanical engineers, and cannot hold Royal exhibitions or national scholarships. Exhibitioners and holders of one year scholarships are eligible for the three-year scholarships. An immediate effect of these changes has been to render the competition for Whitworth scholarships this year excessively keen. The awards have just been issued, and include four scholarships of £125 a year for three years, twenty exhibitions of £100, and ten of £50 for one year. We are glad to see that the Glasgow and West of Scotland Technical College, which, in racing phraseology, holds the record for Whitworth scolarships, has once again distinguished itself by carrying off no less than nine out of the 30 events. This year's successes comprise two scholarships of £125 a-year each for three years—the 2nd and 4th; six exhibitions of £100—the 3rd, 4th, 10th, 12th, 17th, and 20th; and one exhibition of £50—the seventh; total value £1,400. The 8th £100 exhibitioner was for several sessions a student here, so that the college deserves some credit for his success also. As showing the severity of the competition this year, we note that the first and third men were first in the Whitworth lists for 1887 and 1886 respectively, and the fourth man second in 1887; the second man does not appear to have been present at any previous competition. This makes the 32nd Whitworth gained by the students of this college at the last *five* competitions, making a total value of £4,250. For 1889 four scholarships of £125 a year, ten £100 exhibitions, and twenty £50 exhibitions will be open for competition in the following subjects:—Practical geometry, machine drawing or building construction or naval architecture, mathematics, theoretical and applied mechanics; sound, light, and heat; magnetism and electricity, inorganic chemistry, metallurgy, steam, and free-hand. Of these, practical geometry, mathematics, and theoretical mechanics are compulsory subjects, in which a certain pass must be obtained.

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ELECTRIC TRACTION ON THE INNER CIRCLE.

BY S. EVERSHED.

(Concluded from page 501.)

The large difference between the maximum and average power required by each train, and the still larger variation in the current taken by the motors, is perhaps the most serious difficulty in applying electric traction on a large scale, and will therefore be dealt with first.

The necessity for this great variation in power is due simply to the fact that the motors have been assumed to work under the same conditions as are imposed on the present locomotives; indeed, had a different cycle of operations been proposed the variation in power or in current might not have been apparent, and no pains were therefore taken to conceal the difficulty by assuming the motors to work either at constant power or with constant current. The power used by a train is given by the equation

$$p = \mathrm{M}v\frac{dv}{dt} + kv,$$

in which k is the total tractive force necessary, and if the power is constant this equation integrated gives the relation between velocity and time thus :—

$$t = \frac{\mathrm{M}}{k}\left\{\frac{p}{k} - v - \frac{p}{k}\log_e\left(\frac{p}{k} - v\right)\right\}.$$

If this expression is expanded, we have

$$t = \frac{\mathrm{M}v^2}{2p}\left(1 + \frac{2}{3}\frac{k}{p}v + \frac{2}{4}\frac{k^2}{p^2}v^2 + \ldots\right),$$

from which it is clear that the curve between v and t is parabolic in form, becoming, of course, a true parabola when the friction is nothing. It need not be pointed out that no locomotive is worked under such conditions. On the other hand, if constant current is made a condition, the power is proportional to the speed, and the integral of the above equation becomes simply

$$v = \frac{h - k}{\mathrm{M}}t,$$

where h is the ratio of power to speed. This relation nearly represents the way in which a locomotive starts a train, but would only be true with electric motors for a few seconds after starting, as it would then be more economical to increase the power at a much greater rate until maximum speed was reached.

The times allowed for starting, running and stopping, have been obtained from observations on the present underground trains, and are only true for the lighter ones among them. In particular, it should be noted that the time allowed for stopping (10 seconds) is shorter than the average obtained from the writer's observations. Most of the engines are, however, able to reach full speed in 20 seconds. It is at least doubful whether motors will ever be made capable of working under these conditions, and it may be better to increase the time allowed for reaching full speed, and consequently diminish the power during the interval; this necessitates an increase in the maximum velocity, and since the time interval between stations is constant the total work done is increased, as also is the work done in stopping the train. For example, if we increase the time of acceleration from 20sec. to 40sec. while still maintaining the same average velocity, the maximum speed must be increased from 23 to 25·4ft. per second, or 17¼ miles per hour, and the time allowed for stopping must be increased, in proportion with the increase in v^2, to 12sec. It will be found on working out that the power required during acceleration is now only 146 W.H.P., as against 200 W.H.P. in the estimate made in the last article; but the power required during the remainder of the run from station to station is increased from 56·5 to 67·2, and the average power from 80 to 108 W.H.P., an increase of 35 per cent., necessitating a corresponding increase in the fixed plant; the difference would be even greater than this since the friction would be somewhat increased at the higher speed. It would evidently be more economical to increase the size of the motors, even at some sacrifice of average efficiency, in order to secure the great advantage of a rapid start and low speed, for it should be clearly understood that when a train of given weight has to be moved from one station to another in a given time the least total work is done when the train acquires its full speed in the shortest time, the variation in power being, however, a minimum when the total work done is a maximum, and it will certainly be easier to overcome a few difficulties with the starting mains and the motors than to obtain capital for additional fixed plant.

When one looks at descriptions of early railway sand locomotives one is amazed to find what clumsy expedients were sometimes employed for want of a really ingenious idea. Look at Stephenson's original reversing gear, for instance—what a terribly unmechanical affair it was, yet it served its purpose until someone thought of link motion. Or the old spring buffers, three or four feet long, to avoid shocks in starting and stopping, yet when Booth brought out his screw-coupling with right and left-handed threads everyone said, "Oh! of course." Again, what a nightmare of bellows and fans the old engineers suffered to get a draught until they turned the exhaust into the chimney! The present want of a mechanical variable gearing has only to become acute as electric traction develops, and the right thing will, no doubt, be forthcoming as perfect in its way as link motion, as simple as Booth's coupling, and as obvious, after it has been done, as the steam blast.

The different forms of gearing at present known, including Mr. Beaumont's exceedingly ingenious idea, are either too crude or too complex for everyday work; they correspond with the early locomotives, which pushed themselves along with legs, or laid down a short railway and then ran over it, or painfully hauled their clumsiness over the rough road by means of a rack and cog-wheels. Such ideas are generally laughed at; but, in reality, they are extremely useful, indeed invaluable, as the right way of doing anything is not often discovered until ten wrong ways have been investigated. On the whole, we may look forward confidently to a happy solution of this problem rendering a near approach to the theoretically best method of running trains with frequent stoppages not only possible but economical both in first cost and working expenses.

Since the total amount of plant required varies directly with the weight of the trains, it will be well to reduce the dead load as much as possible. In the case of the present locomotives, there is not the same inducement to reduce the train weight, as the engines themselves form a very large proportion of the total load. The weight of the carriages or cars might be very considerably reduced if the companies concerned only realised that their lines are more akin to tramways than railways. There seems no good reason for adhering to three classes on the Inner Circle at all events; it is very difficult to understand why a system of caste which has disappeared from the streets should still linger in what is, after all, only an underground street. The abolition of first-class coaches would alone effect a large reduction in dead weight, for taking the weight of the lightest rolling stock of which the writer has any knowledge, namely, that used on the South London lines of the Brighton Railway Company, we find third-class coaches weigh ·135 ton per passenger, second – ·151, and first – ·247. Now, if the Circle trains are made up to carry 300 second and third class passengers, with a dead weight of ·143 ton per passenger, the total dead weight is only 43 tons, plus, let us say, 8 tons for motors and 18 tons for passengers, we have a total load of only 69 tons, thus saving over 20 per cent. in the weight of the trains, and therefore in the first cost of the fixed plant, besides effecting a considerable reduction in working expenses and maintenance of permanent way; the rails, having no longer to bear the pounding of a 40-ton locomotive every two or three minutes, may weigh less than 90lbs. per yard; half that weight would be sufficient, one would think.

No sooner are the trains satisfactorily started than they have to be stopped. There is not much difficulty in doing this by friction brakes, as at present, the only change being in working them by air pressure maintained by a pump worked from one of the axles in place of the steam pump or ejector. But, of course, a train driven by electricity ought to have

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electric brakes, or even stop itself by converting the motors into dynamos and restoring some of the energy of the train to the mains. That is in everyone's mind who has ever given a moment's thought to electrical railways, but when we have devoted two moments to the question, the answer seems less obvious. How much power can be saved by a dynamical brake, and how much is wasted in working a friction brake? We will endeavour to find answers to these questions. Still keeping to the arbitrary units of 90 tons for the weight of a train, and 15·6 miles per hour as its maximum velocity, the work the train is able to perform in stopping is 1,650,000 foot-pounds; as 10 seconds are allowed for this, the distance run before coming to rest will be 115ft., assuming, as before, that the average speed at this time is equal to half the maximum. Taking 15lb. per ton as the retarding force due to train friction, 155,250 foot-pounds will be spent in overcoming it, leaving nearly 1,495,000 foot-pounds available for reconversion. Now, if the gearing efficiency is ·85 and that of the motors working as dynamos under unfavourable conditions as to speed, load, &c., is ·6, the whole efficiency is only 51 per cent., so that about 760,000 foot-pounds for each stop made is all the return to the mains which can be reasonably expected. Even if the stop is made more slowly—in 20 seconds, for instance—the motors will have to work as dynamos under a heavy strain, and, considering that the distance run would increase nearly in proportion to the time, the energy available would be still less were it not for the fact that the maximum speed must be increased in these circumstances, the net result being that possibly 900,000 foot-pounds might be coaxed back into the mains during a stop. Now, the total energy supplied to the mains by the power stations to carry a train from one station to the next is over 9,000,000 foot-pounds, so that the electro-dynamical method of braking will only enable an economy of about 10 per cent. in power to be effected, under present conditions with known appliances be it observed, for, of course, the gearing which has been prophesied would put the matter on a different footing. Further, when we consider that a dynamical brake does not and never can fulfil all the requirements of railway working, a statical (friction) brake being absolutely necessary to keep a train standing on an incline, it really seems as though the play would never be worth the candle.

The energy wasted by a mechanical friction brake, though, of course, considerable, is not of much importance. The writer has roughly calculated the work to be done by a pump driven from an axle, in compressing air sufficient for one application of a continuous brake on a 90-ton train, and allowing ample margin for leakage, waste of power in friction, &c., not more than 50,000 foot-pounds will be necessary. But it may be said, and indeed Mr. F. Sprague, in his Paper on the Richmond tram line, has said it, we must use the surplus power in running down gradients to help trains up. This may be possible on a tram line with 5 per cent. gradients; but on the Inner Circle, where the ruling gradients are not more than one-tenth of this amount, and the maximum gradient only 1·43 per cent., there will be very few places where trains can become sources of power, since a gradient of ·5 per cent. is only equivalent to a tractive force of 11·2lb. per ton.

Although it would perhaps be unwise to abandon friction brakes, there is no reason why they should not be worked electrically. Considering the immense advantages any electric brake must possess over even a high-pressure air brake, it is not a little surprising that so little has yet been done in this direction. So far as the writer is aware, the Achard electric brake is the only one ever put to the test of experience on a practical scale. The simplest frictional brake would consist of an electro-magnet, with jointed pole-pieces embracing an iron drum on the axle, and serving as brake blocks. The magnet might be made to act directly on the wheel tyres, but this would require additional power to be spent in excitation to obtain sufficient induction through the wheels. An electric brake has one superlative advantage in that its action is absolutely simultaneous throughout the longest train, thus obviating all the shocks and strains on drawbars, and other serious evils attending the use of most air and vacuum brakes. An electric brake would not be quite instantaneous in its action, as anyone knows who has watched the slow increase of the current through the coils of a massive electro-magnet after closing the circuit.

It is perhaps premature to enter into the *pros* and *cons* of automatic blocking, but it should be noticed that no visual signals will be wanted in any case. Accidents from drivers misinterpreting or not seeing signals will become things of the past, for the most reckless driver will be unable to move his train over a blocked section where the power is cut off and the conductors short-circuited. There is a refinement of block-working for a line where trains are run at regular intervals, which, though impracticable under present conditions, is quite feasible with electric traction by conductors. The writer has only sufficient space at his disposal to briefly indicate the nature of it. To preserve the proper interval between the trains, it might be arranged that each train should vary, instead of cutting off, the power from the following train whenever it approaches within the prescribed distance; the following train would thus have its speed diminished until it equalled that of the train in front. Now, provided this can be done without wasting power in resistance, it is obvious that the slowest train on the line would find the conductors at the highest potential difference, and consequently its speed would be increased until it ran at the average rate. This system would obviate the present absurdity of trains starting and having, perhaps, just reached full speed, they are stopped either at an advanced starting signal or an intermediate block cabin, resulting in considerable waste of time and power. It would not necessarily interfere with the method described for preventing more than a certain number of trains from starting at the same time, nor would it prevent the adoption of a dead section behind each train as an additional security against accident.

In conclusion, whatever may be the precise details of the scheme eventually adopted, electrical traction must sooner or later displace steam on the Underground Railway, and the writer trusts he has succeeded in giving readers of *The Electrician* some idea of the magnitude of the undertaking.

REPLY TO PROF. ARMSTRONG'S CRITICISMS REGARDING THE DISSOCIATION THEORY OF ELECTROLYSIS.

BY SVANTE ARRHENIUS.

In his communication to the Electrolysis Committee of the British Association (printed in *The Electrician* for August 26th, 1887), Prof. Armstrong has honoured my views on electrolysis with a critical analysis from a chemist's point of view. In the following lines I will attempt to show how the chief objections that he has made can be removed, and also that his views present difficulties which greatly militate against their acceptance.

1 and 2.* Prof. Armstrong finds it difficult to explain why some single bodies, *e.g.*, silver iodide, conduct electrolytically, whereas other pure bodies, *e.g.*, water or hydrogen chloride, are non-conductors. We certainly are bound to assume that fused silver iodide is to a sensible degree dissociated into its ions, and that the dissociated parts of the non-conductor escape our observation. But it may be remarked that no exact comparison can be made between the two cases, silver iodide being examined at temperatures above 530° (the melting point of AgI), H_2O and HCl at ordinary temperatures, it being very probable that dissociation increases rapidly with the temperature. Also too much stress must not be laid on the behaviour of pure bodies or of concentrated solutions, as experience shows that dilute solutions are characterised by very remarkable regularities, analogous to those which obtain in the case of gases, and that these regularities vanish as the solutions attain a greater degree of concentration; indeed, there seems to be no connection between the facility with which compounds are electrolytically dissociated in dilute solutions, and the stability of

* The numbers correspond with same numbers in Prof. Armstrong's Paper above referred to, "Comparison Between the Views of Dr. Arrhenius and Prof. Armstrong on Electrolysis."

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the same compounds in the pure state, as Faraday has already remarked. Because of the regularities which characterise dilute solutions, the dissociation hypothesis has reference almost exclusively to matter in this state, and has, in my opinion, very successfully explained a great many of its properties.

3. Prof. Armstrong asserts that solutions in absolute alcohol oppose a practically infinite resistance. This view is not supported by the recent investigations of Fitzpatrick and Hartwig, from which it seems to follow that "any neutral solvent renders electrolysis possible," in accordance with the demands of the dissociation electrolytic hypothesis.

4. According to Prof. Armstrong, on the dissociation hypothesis, both water and salt are be regarded as dissociated; nevertheless the dissociation hypothesis assumes that conduction takes place only through the agency of the atoms of the dissociated salt, and not at all through that of the water. From chemical facts, *e.g.*, the partial decomposition of certain salts into base and acid by large quantities of water, it is very probable that water is to a very slight degree dissociated into H and OH.* But experiments show also that this occurs to an extent so extremely small that it will perhaps for ever be impossible to detect it by measuring the conductivity of water. Also I have essayed to show that the only fact cited in favour of a sensible conductivity of water can be satisfactorily explained without this assumption. In the same manner, different electrolytes, *e.g.*, HCl and $C_2H_3O_2H$, are very differently electrolytically dissociated by the same quantity of water, so that the one conducts very well, the other hardly sensibly, but we know representatives of all intermediate stages between these two extremes, so that there is no ground for assuming anything but a quantitative difference. Experiments on the conductivity of pure water, or of dilute salt solutions, lead to the assumption that water is not dissociated to any perceptible degree. If, therefore, as Prof. Armstrong asserts, the opinion is common among chemists, that in the case of the electrolysation of ammoniacal solutions water is (sensibly) electrolysed, then is this opinion a remnant of old views now abandoned through force of incontestable arguments?

6. In his article Prof. Armstrong makes no objection to the dissociation electrolytic hypothesis, but says: "I do not mean for one moment to assert that anything which we know of the conditions on which chemical change depends negatives beyond question the dissociation hypothesis."

7. Prof. Armstrong interprets the figures of Lenz concerning the parallelism between diffusivity and conductivity of alcoholic aqueous solutions as an "almost conclusive argument in favour of his theory." It must be remarked that there are many exceptions to this rule. Thus, *e.g.*, $MgSO_4$ and cane sugar diffuse nearly at the same rate (Graham), although in aqueous solutions $MgSO_4$ is a good conductor, while cane sugar seems not to conduct at all; consequently, the two phenomena are not of the same order, as they should be according to Prof. Armstrong's hypothesis. "The diminution in conductivity and also in diffusivity, as the amount of alcohol is increased, is most striking. If the solvent be neutral, the substitution of alcohol for water should have little influence; but if, as I suppose, the solvent be active, alcohol being far less active than water, the effect to be expected is precisely of the nature of that observed." In coming to this conclusion a very important thing is lost sight of. The conductivity depends on two circumstances, viz., the degree of electrolytic dissociation and the friction which the ions must overcome in their passage through the solution. The first circumstance must, as Prof. Armstrong asserts, have but little altered in Lenz's experiments with diluted KI and NaI; the diminution in conductivity must consequently have chiefly depended on the increase of the friction with the quantity of alcohol, which is *à priori* very probable. Evidently one must expect that the diffusivity also diminishes as the internal friction increases, and in this manner the parallelism between conductivity and diffusivity in Lenz's figures is quite explicable by means of the electrolytic dissociation hypothesis.

8. "Why, then, should it (the electromotive force) not give direction to the moving molecules, if these are still possessed of 'residual affinity,' *i.e.*, if some portion of the original charge of the atom be still unneutralised?" According to this passage I cannot understand Prof. Armstrong to mean otherwise than that the molecules will be directed by the electromotive forces, and consequently themselves move along the lines of flow. This way of viewing the question would lead one to expect the molecules to separate at the electrodes; but it is found experimentally that not molecules but ions are transported to the electrodes.

9. Prof. Armstrong finds it difficult to explain why phenylpropiolic acid $C_6H_5.C\equiv C.CO_2H$ conducts better—*i.e.*, is more dissociated, than hydrocinnamic acid, $C_6H_5.CH_2-CH_2.CO_2H$. But there are other peculiarities, which, perhaps, are very nearly connected with this circumstance, viz., the physical properties (heat of combustion, refraction of light), which indicate that the triple union in $C_6H_5.C\equiv C.CO_2H$ is less firm than the simple union in $C_6H_5.CH_2-CH_2.CO_2H$.

10. The formula proposed by Prof. Armstrong—

$$C = E/R,$$

"C being the amount of change, E the intensity of the total chemical effect," and R the resistance of the solution in which the interaction takes place, is not verified by experience. Thus, in the case of the hydrolysis of ethylic acetate by means of bases, "the intensity of the total chemical effect" (E) must be but very little influenced by the presence of neutral salts; R, on the contrary, very much. But experience shows that "the amount of change" (the velocity of interaction C) alters but very little (for strong bases) if R be increased by addition of neutral salt from 1 to about 20. In the case of ammonia C decreases extremely rapidly, when R decreases in consequence of added neutral salt. These phenomena are easily explained by the electrolytic dissociation hypothesis, the velocity of interaction being proportional to the quantity of OH in the form of ion.

The arguments brought forward by Mr. Crompton on the conductivity of sulphuric acid seem to me not very convincing in favour of the view that hydration of H_2SO_4 should condition the electrolytic conductivity.* There is no reason mentioned why the second derivative d^2k/dp^2 (where k is conductivity and p concentration of the acid in per cents) should have angular points at the places mentioned; on the contrary, the author says that he had expected to find such angular points in the dk/dp curve, but when he did not find them there he proceeded to the examination of d^2k/dp^2. The author does not take heed of the errors of experiment; a search would probably have shown that these errors in many cases are of the same magnitude as d^2k/dp^2 itself. Further, the author does not find the same hydrates as Mendelejeff ($H_2SO_4 + 24\ H_2O$ not appearing in Mendelejeff's curve, $H_2SO_4 + 6\ H_2O$ not being marked by Crompton's curve). The part of Crompton's curve between H_2SO_4 and $H_2SO_4 + 2\ H_2O$ can hardly be considered as consisting of two straight lines, as the author asserts. The artificial nature of the proposed formula is manifested by the circumstance that they give very different values of k at the limiting points where two formulæ should be applicable. Moreover, there is a very important difference between the views of Mendelejeff and of Crompton. Mendelejeff says, "Ich habe schon lange die schwachen Lösungen als die interessantesten angesehen und dieselben dem zerstreuten oder verteilten Zustande der Materie in Dampfform an die Seite gestellt. Die bemerkenswerten Untersuchungen von van 't Hoff haben gegenwärtig dafür einen vollständigen Beweis erbracht," whereas, according to Mr. Crompton, dilute solutions are characterised by their irregularities.

The above observations will, I believe, suffice to show that the objections urged against the dissociation electrolytic hypothesis are unsatisfactory, and that the arguments in favour of the residual affinity hypothesis need a more convincing corroboration than hitherto given. On the other hand, the dissociation electrolytic hypothesis has latterly acquired a

* Wied. *Annalen*, XXXIII., p. 58, and *Phil. Mag.* (5), XXIV., p. 377.

* In saying this I wish not to deny that some (but very few) hydrates (*e.g.*, $H_2SO_4 + H_2O$, as Kohlrausch has stated) exert an influence on the conductivity, but only to say that the assertions of Mr. Crompton are to a very high degree exaggerated.

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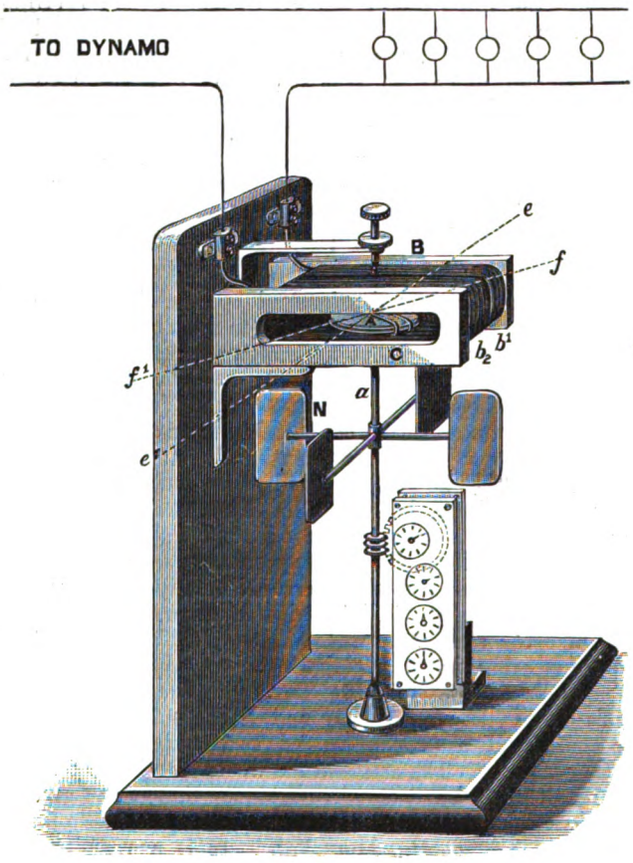
highly increased probability, as the lowering of the freezing point on addition of salts to water, and the additive properties of salt solutions, can be explained by it. In a preliminary notice Ostwald has announced that the conductivity of acids and bases can be calculated upon the basis of this hypothesis; and in a paper soon to be published in the *Zeitschrift f. Phys. Ch.* I will attempt to prove that the known facts regarding conductivity of mixtures, velocity of interaction and double decomposition between electrolytes can easily be accounted for on the same hypothesis.

Amsterdam, February, 1888.

THE SHALLENBERGER ALTERNATING-CURRENT METER.

We illustrate in the accompanying engraving a form of electric meter designed by Mr. O. B. Shallenberger, electrician of the Westinghouse Electric Company, and in which electrical energy is converted into mechanical motion, the rate of which



The Shallenberger Meter.

is directly proportional to the energy being consumed. We take our account from the *Electrical World* of New York.

The principal elements employed in the construction of the meter are—first, an armature of metal capable of rotation; second, an electric circuit, which is so arranged that when it is traversed by alternating electric currents a field of force is induced having a given polar line or axis with reference to the armature; and third, a circuit so related to the first circuit that currents are produced in such second circuit by the action of those in the first, the phases of which succeed those of the currents in the first circuit and set up for the armature a second field of force, the axis of which intersects that of the first. The armature may be built of soft iron, or of copper, or other non-magnetic metal, or it may be composed of a core of soft iron having a conducting circuit of other material surrounding.

Referring to the engraving, A represents a circular armature mounted upon a shaft, *a*, and placed within a coil, B. The coil is made in two sections, b^1, b^2, for convenience of construction, the shaft *a* passing between the two.

Alternating electric currents traversing this coil tend to establish a field of force whose polar line or axis is approximately in the direction *e e'*, at right angles to the shaft *a*. A second conductor, C, is placed in inductive relation to the conductor B and armature A. This conductor is closed upon itself. It is placed with its magnetic axis at an inclination to that of the coil B. Alternating electric currents, traversing the conductor C, establish a field of force for the armature, whose polar line or magnetic axis is approximately in the direction *f f'*—that is to say, inclined with reference to the polar line of the coil B. It is found in practice that when the coil B is traversed by alternating electric currents the armature will revolve.

In order to produce a rate of rotation of the armature proportional to the amount of energy supplied to the circuit, it is necessary that some retarding force should increase in its effect by the same law as that of the rotating effect produced by the current. If, for example, the tendency to rotation increases as the square of the current, then the retarding effect should increase as the square of the speed. Such a definite law of increase of retardation is secured by the application of fans or vanes, N, fixed to the shaft *a*. The resistance offered by the air to the rotation of these vanes affords the required retardation.

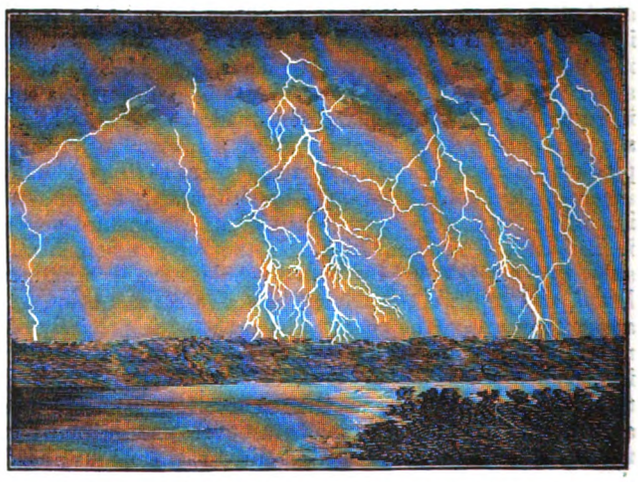
This meter is said to respond to the currents traversing the coils B in such a manner as to obtain a reliable and accurate measurement of the current, the number of revolutions performed in a given time being directly proportional to the current consumed during that time.

It is found, in practice, that the resistance of the coil B may be made very small, and the current consumed in operating the meter itself quite insignificant.

The number of ampere-hours are recorded by the registering train geared to the shaft.

We understand that this type of meter will be regularly employed by the Westinghouse Company in their central station work.

PHOTOGRAPH OF LIGHTNING.



Photograph of a lightning flash taken at Wakefield, Mass.

The above figure represents a remarkable lightning flash which was photographed recently during a storm at Wakefield, Mass.

Telegraphic Communication with the Hebrides.—Telegraphic communication with the islands of Coll and Tiree was opened last week. A wire is carried overland from Tobermory to Colgary on the western side of Mull, and then by cable to Coll.

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THE GAULARD-GIBBS' PATENT IN AMERICA.

The following is the judgment of the Circuit Court of the United States, District of Massachusetts, in equity, in the case of the Westinghouse Electric Company *v.* Sun Electric Company, *et al.*, which was delivered on the 7th ult. :—

This suit is brought to enjoin the defendants from infringing letters patent No. 351,589, granted October 26, 1886, to George Westinghouse, jun., assignee of Lucien Gaulard and John D. Gibbs, for improvements in methods and apparatus for the distribution and conversion of electric energy.

The case has been thoroughly and ably represented on both sides. The patent relates to that branch of the art of electric lighting known as the incandescent. The specification states that the "invention relates to the distribution of electrical energy for industrial purposes ; and it consists in an improved art or method and an organisation of apparatus, whereby the same is carried into effect, by means of which we are enabled to transmit from a central or supply station, through a main conductor, a primary electric current of comparatively small quantity, but of high potential, and at a point or points more or less distant, where the said electric energy is to be utilised, to transfer the energy residing in such primary current of high potential into one or more secondary currents of lower potential, but of greater quantity. . . . At a point where the electric current is to be utilised for any suitable purpose—as, for instance, in one or more incandescent electric lamps—we place one or more secondary generators or converters. The general principle of our secondary generator is analogous to that of the well-known inductorium, or induction coil, with this exception, that while the induction coil has heretofore usually been employed to transfer electric energy from currents of low potential and great quantity into currents of high potential and small quantity, the function of the secondary generator or converter, as applied in our invention, is precisely the reverse of this, namely, to transfer electric energy from currents of high potential to currents of low potential and increased quantity. We have constructed converters for effecting this result in a variety of forms, all of which involve the same principle. The most important and characteristic feature of our invention is that which renders it possible to make use of alternating and equal positive and negative currents of moderate quantity, but of very high potential in the primary or main line circuit, and to convert these into secondary or induced currents of much greater quantity, but of correspondingly lower potential at the place of consumption, which secondary circuits are employed to do the required work. Any required number of converters of the general construction described may have their primary circuits united with or included in the conductors leading from the primary generator. The manner of connecting such converters, whether in series, multiple arc, multiple series, or otherwise, will be understood by those skilled in the art to which our invention relates without the necessity of further explanation."

The specification then says that one arrangement is indicated in Fig. 3 of the drawings, which shows an arrangement of converters in series. Then follows this disclaimer: "We do not herein claim the connection of the converters in the line in any other arrangement than we have illustrated in the drawings." Fig. 3 of the drawings shows an arrangement of converters in series. The defendants connect their converters in what is known as the multiple arc system, which is quite different in construction and mode of operation from the series system.

There are five claims in the patent, the first being for the art or method, and the remaining four claims for the apparatus.

The first question which arises relates to the proper interpretation of the patent in view of the disclaimer. Undoubtedly, as originally drawn, the patent was intended to cover all forms of converters which transferred electric energy from currents of high potential to currents of low potential and increased quantity, whether connected in series, as indicated in Fig. 3 of the drawings, or in multiple arc or otherwise. The Patent Office refused to grant so broad a patent, and instructed the applicants that, in order to avoid an interference, they must confine the arrangement of converters to the series system, that being the arrangement shown in the article in *Engineering* of March 2, 1883, which the applicants declared contained a description of their invention. Thereupon the disclaimer was inserted. An examination of the file wrapper and contents discloses that the patent office believed this patent should be limited to the arrangement of converters in series, and that this was supposed to have been effected by the disclaimer ; otherwise an interference would have been declared. The patentees avoided such interference by inserting the disclaimer, and it is too late now to say that the disclaimer means in effect nothing. If we construe the patent to cover broadly a dynamo producing alternate currents of high potential with a single reducing converter, then the disclaimer is meaningless, because such construction would embrace converters connected in multiple arc or otherwise.

The patent states that the invention is for a system of electric distribution ; the true scope, therefore, of the invention is not confined to one converter, but to several converters arranged in a system, and, when the patentees disclaim all systems but the series, they should be held to it.

As we have said, Gaulard and Gibbs declare that the invention covered by the patent in suit is found in the article in *Engineering* of March 2nd, 1883. The defendants deny that the article describes converters which transform the current from high potential to low. Whoever may be right, it appears quite certain that the high potential of the primary, and the low potential of the secondary, or the long, thin primary wire and the short thick secondary wire, which become so important in the patent under consideration, are not specifically described or shown with clearness in the article in question. The system described in the article was a general one, and was intended to meet the conditions laid down in the English Electric Lighting Act, which provided that the "undertakers" shall not prescribe to householders and others to whom they supply the current the use of any particular kind or form of lamp. The Gaulard and Gibbs invention has a two-fold object, says the article ; firstly, it aims at rendering it practicable for undertakers to supply current at the most economical potential permitted by the terms of their provisional orders ; and, secondly, it is intended to make the user independent of the producer, and to enable him to apply the current he receives to any purpose he may please, such as arc lighting, incandescent light, the generation of power or of heat." If the article does show a converter which transforms electric energy from high potential to low, it is evident that Gaulard and Gibbs did not at this time regard this as a great discovery, or it would have been more clearly indicated. Undoubtedly the article was intended to outline a general system to supply to customers currents of high or low potential, as might be desired, by means of converters connected in series based upon the principle of the Ruhmkorff coil, but that this was to be accomplished by means of a primary current of high potential and secondary currents of low is not apparent.

Further, if the reducing converter, now made so important, was discovered by Gaulard and Gibbs in March, 1883, and constituted such a great invention, why did it not form the subjected matter of their subsequent American patent of April 29, 1884, and British patent of September 15, 1882 ?

These things go to prove that the prominence given to the reducing converter in the patent in suit was based upon something else than the article in *Engineering*. I am led to think that it was based upon the fact that, between the date of the article and the date of the patent in suit, other inventions had come to light, and that it was these improvements which induced Gaulard and Gibbs to set up the claim they make in their last patent.

In the patent granted to E. Thomson, July 14, 1885, the converters are arranged in series. The object of the invention was to provide a safety switch for the converters, but we there find described the primary or main current of high potential and the secondary current of low potential. The specification says : "The secondary coil is wound with such coarse wire, and the lamps used therewith are of such low volt potential as not in itself to produce dangerous discharges or shocks." Thomson seems to take it as a matter of course, in view of the prior state of the art, that there was no invention in reduction from high potential to low through a converter.

But the most important improvement was made by Zipernowsky and Déri in their English patent of March, 1885. This patent describes minutely a system of distribution by induction through potential-reducing converters combined in multiple arc, and it includes an alternating-current dynamo generating a current of high potential.

We see, then, that the state of the art in 1882, when the article in *Engineering* was written, and in 1886, when the patent in suit was issued, was quite different. It became very important, therefore, for Gaulard and Gibbs to obtain a patent for a single reducing converter, however it might be combined with others in a system. I think the importance given to this point in the patent an effort to expand the real invention of Gaulard and Gibbs, as contained in the article in *Engineering*, and that the patent office intended and did in effect limit the patentees to all they were fairly entitled to, namely, the arrangement of their converters in series in a system of electrical distribution.

By assuming that our interpretation of the effect of the disclamer is wrong, and that Gaulard and Gibbs are entitled under their patent to claim the exclusive right to a converter which transforms energy from high potential to low, in combination with a dynamo producing alternating currents, can so broad a claim be sustained in view of the prior state of the art ?

To uphold this position, of course Gaulard and Gibbs have to go back to the article in *Engineering* of March 2, 1883, as the date of their inventions, because this form of converter in combination with an alternating dynamo is clearly shown, as has been observed in the Thomson and Zipernowsky and Déri patents of 1885. But, admitting that the date of the invention was March 2, 1883, I have much doubt whether Gaulard and Gibbs could obtain a lawful patent for so broad a claim. The counsel for the plaintiffs in his closing argument admits that the induction coil or inductorium or converter, in its general sense, as a device used for taking off from the line at different points a portion of the electric energy, whether of the same or higher or lower potential, was well known. The article in *Engineering* states that the secondary generator or converter was based upon the same principle as the Ruhmkorff coil. In the English patent granted to Paul Jablochkoff, Nov. 9, 1877, we find described a system for producing and dividing electric lights which consisted in carrying a main alternating current round an unbroken circuit, and transferring its energy by means of induction coils to consumption circuits at the points where it was to be used. The converters are placed in series with one or more lamps in the secondary of each converter. But it is said that Jablochkoff contemplated a conversion from low to high potential, the reverse of Gaulard and Gibbs. At the same time it was well known that the converter would transfer energy from high to low, or low to high, as the primary wire was longer or shorter. Was it invention for Gaulard and Gibbs simply to reverse the coils and transfer the energy from high to low ?

In the English provisional specification of Edwards and Normandy, November 13th, 1878, the inventors propose to use either interrupted or alternating currents with a converter near every place where the light is to be produced. The specification says :—"At or near every point where it is required that a light shall be produced, we arrange a coil (or a series of coils) of insulated metallic wire or ribbon (preferably surrounding a bar or wires of soft iron), through which coil or coils the current from the principal wire first described can be passed when desired, or cut off by

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means of a key or lever. Round or adjacent to each coil of insulated wire described we form one or more secondary coils of insulated metallic wire or ribbon, arranged so that the passage of the rapidly intermittent current of electricity, as described, through the primary coil or coils generates a corresponding amount of electricity in each of the secondary coils. In order to facilitate the production of the induced electricity, *and to diminish its intensity and increase its quantity*, we prefer making the coil or coils in which the electricity is induced of a number of insulated wires or ribbons made up into a bundle or rope, the ends of the wires or ribbons at each end of the bundle or rope being in metallic contact with each other, which united ends are then joined to the conductor, conveying the induced electricity." Here is found distinctly stated the principle of a reduction from high potential in the primary to low potential and increased quantity in the secondary, which Gaulard and Gibbs assert is their great discovery.

The patent to J. B. Fuller, Nov. 26, 1878, is for an improvement in induction apparatus for lighting by electricity. The invention embraces converters arranged in series like those of the patent in suit to be operated upon by an alternating current. It is not stated whether the potential is to be raised or lowered in the converters, but the drawings appear to indicate that it was to be raised.

In the English provisional specification of J. H. Johnson, Dec. 24, 1878, while the inventor contemplated the raising of the potential in his converters, yet he says "the apparatus may be connected together . . . in such manner as to augment either the tension or the quantity of the current."

Thomas A. Edison took out a patent May 28, 1883 (the application having been filed August 14, 1882), for an apparatus for translating electric currents from high to low tension. In his invention he uses a continuous current of high tension in the main circuit, and reduces it to a continuous current of low tension in the secondary circuit.

This incomplete review of the prior state of the art would seem to show that at the date of the article in *Engineering* there was no invention in a single converter which transferred energy from high to low potential, as distinguished from a conversion from low to high. It seems to have been assumed in prior patents as a matter of common knowledge that, by the laws governing the inductorium or converter, the electric force transferred could be either of the same potential or of greater or of less, as might be desired. It required something further, something that might be called invention, to solve the problem of a successful system for electric distribution. Gaulard and Gibbs undoubtedly believed that, in the article in *Engineering*, they unfolded to the world a description of a successful system. So far as their system was a new invention, and is incorporated in the patent in suit, they are entitled to be protected. But they are expressly limited by their disclaimer to the series system, and therefore the defendants who use the multiple-arc system do not infringe.

Without entering further into the defences raised, I am satisfied, for the reasons given, that the bill should be dismissed.

Bill dismissed.

SEWAGE PURIFICATION BY ELECTROLYSIS.*

BY MR. WILLIAM WEBSTER, F.C.S.

The question of the disposal of sewage has occupied the attention of engineers and chemists for many generations past, and regarded from a hygienic point of view, cannot be too thoroughly considered.

In this short Paper it is not my intention to criticise the many processes in use at the present time, as there is no doubt all are doing their best to solve the question; but I must protest against sewage farms, where sewage is allowed to percolate through the land without previous treatment.

It is quite ten years since I carried out my first experiments in electrolysis, but in those days the available electric apparatus had not attained such completeness as we now have in it. The chemical changes which take place in sewage when it is electrolysed depend chiefly on the well-known facts that water and sodium, magnesium, and other chlorides (which are always present in sewage) are split up into their constituent parts. Thus, we have at the positive pole chlorine and oxygen set free, and these elements are liberated in a nascent state, a condition in which they are intensely active, so that the organic matter in the sewage is rapidly oxydised and burnt up to innocuous compounds. So rapid is this action that I will now act on a little Crossness sewage, and produce a disinfecting liquid, which is nothing more or less than hypo-chlorous acid, the strongest oxydising agent that is known. To obtain this quickly I must separate the positive action from the negative by a porous diaphragm. At the negative pole I obtain ammonia, potass, soda, magnesia, &c. So strong is the action of oxide of chlorine that I have found no pressed carbon plates would stand its action. I am, therefore, compelled in practice to use cut carbon or coke. [Demonstration made.]

It was this fact that made me investigate the cost, and the result was, knowing that iron salts were of great use in precipitating organic matter in solution, that I experimented with iron electrodes, for the oxydising acids produced by this action being probably 100 times more active than any acids produced by chemical processes alone, it necessarily followed that the iron salt produced must have similar properties. The nascent chlorine and oxygen generated partly unite, and, with the water, form hypo-chlorous acid, the positive iron plate being attacked, and ferrous hypochlorite formed; but a portion of the hypo-chlorous acid attacks the organic matter, for it is well known that putrefying sewage has a strong affinity for oxygen.

To still further strengthen this action, I have lumps of carbon cast into the iron plates, thus securing a supply of the before-mentioned acid. The iron plates are common casts run direct from the furnace into this form instead of pigs, and are used for the positive poles, the negative plates being thin rolled sheet. The positive plates are gradually acted on by the acids produced, but the negative plates are not acted on, and will remain in the same condition for years; this is so well known that I need not enlarge upon it. I have estimated that the waste of iron at the positive pole is about 1gr. per gallon, but, of course, this entirely depends upon the electric current used. The hypo-chlorite of iron formed at the positive pole is acted on by the free ammonia, sodium, potassium, and magnesium hydrates, and the ferrous hydrated oxide precipitated. This particular oxide of iron has the property of combining with organic matter, and it is a peculiarity of this salt to take a white hue, and then by exposure to the atmosphere to become green, and ultimately an ochrey red colour.

The ferrous hydrated or protoxide of iron is so beautifully precipitated, one may say, in its most active condition by this electrolytic process, that it takes up more organic matter than if precipitated chemically, for by chemical precipitation the iron oxide carries a large part of the suspended matter in the sewage with it, but only traces of the dissolved organic matter. In the electrical process the whole of the matter suspended is carried with the oxide of iron, together with a considerable portion of the organic matter in solution, and, if necessary, the whole of the soluble organic matter can be oxydised. The precipitate itself is carried to the surface by the numerous bubbles of hydrogen issuing from the negative pole, and the effluent may be run off quite clear from below, or may be run with the precipitate into settling tanks, where the deposit will take place in from half an hour to two hours; the precipitate, being exceedingly flocculent, subsides readily. The sludge formed does not hold so much water as by chemical process, and presses without any addition of lime. The effluent is less alkaline than the natural sewage, and, if necessary, can be rendered neutral by passing through coke filters arranged in such a way that the electric current can be applied, thus further purifying the effluent and delivering it in such a state that, personally, I should have no objection in drinking it. The reason of the alkalinity being reduced is that a small quantity of free ammonia is carried off with the hydrogen gas at the negative pole, and also by the formation of hypo-chlorous acid. It is by means of this coke filter that potable water can be purified either on a large or small scale, and the treated sewage is not liable to secondary fermentation, nor does it form a precipitate when mixed with ordinary river water. The chlorides are slightly diminished in quantity, owing to the escape of nascent chlorine at the positive pole. The amount of soluble mineral matter is not increased in quantity, as in ordinary precipitating processes.

The chloride of lime of commerce is really hypo-chlorite of lime. It has been suggested that the hypo-chlorous acid may possibly be as objectionable in its after effects as the salts of lime; but this is not the case, as hypo-chlorous acid is an unstable compound, which, having delivered up its oxygen in oxydising organic matter, changes into hydrochloric acid, which neutralises the alkalinity of the sewage.

As I have already demonstrated that hypo-chlorous acid can be obtained in quantities by means of a porous cell enclosing positive pole, so likewise by enclosing the negative pole in a solution of ammonia, &c., can be obtained from the raw sewage.

I have brought with me a weak solution of the disinfecting fluid obtained from sewage twelve months ago; also a sample of an effluent eight months old. I have shown that the sewage can be purified to any extent, even to conversion into a disinfectant; it therefore only remains for me to enter into the question of cost, which I will do as briefly as possible, and it is just as well to mention that this will be partly ruled by the particular state of purity you require in your effluent.

The chief expense is the engine power. My experience up to the present time is limited to treatment of about 100 gallons of sewage at any one time; and from a large number of experiments I found it would be possible to treat this quantity with about one-third horse-power; the dynamo and engine were unsuitable for my experiments, as the dynamo was only fit for electric lighting, and the engine twenty-five years old—without a governor; I should, therefore, prefer to think the horse-power over-estimated. The time occupied in treating every 100 gallons varies from five to ten minutes. The consumption of iron was one grain per gallon; the cost of this is easily estimated when one knows the market price of

* Abstract of a Paper read at the annual meeting of the Association of Municipal and Sanitary Engineers and Surveyors.

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PARTS PER 100,000.

Date of Experiment.	Appearance.	Odour.	Nitrogen as			Chlorine as Chlorides.	Oxygen required to oxidise organic matter.	Total solid matter in solution.	Loss on incineration of total solids.	Suspended matters.			
			Free Ammonia.	Albumenoid matter.	Nitrites and Nitrates.					Total.	Mineral.	Organic.	Ferric Oxide, Fe_2O_3.
1888.													
March 26	Raw sewage, very turbid and opalescent...	Bad	2·59	0·47	None	9·74	1·95	61·72	12·57	65·28	39·47	25·79	7·09
	Effluent, clear	None	2·30	0·30	None	9·19	1·07	57·43	9·14	None	...	...	...
April 20	Raw sewage, very turbid and opalescent...	Slight	1·88	0·19	Trace	5·27	1·17	42·43	7·90	47·31	33·01	14·30	6·13
	Effluent, clear	None	1·63	0·14	0·029	4·67	0·53	38·60	4·10	2·01	1·74	0·27	1·69
April 27	Raw sewage, very turbid and opalescent...	Slight	2·65	0·42	None	16·43	1·24	41·95	5·86	Not estimated.			
	Effluent, clear	None	2·28	0·18	0·017	13·79	0 52	37·40	2·85	None	...	...	...

CANAL WATER CONTAMINATED WITH SEWAGE.—LABORATORY EXPERIMENTS.

Carbon Plates.—Average of Forty Analyses.

	Free Ammonia.	Albumenoid Ammonia.
Before treatment	·073	·037
After treatment	·053	·014

Iron and Carbon Plates.—Average Result of Five Analyses of Sewage.

Before treatment	—	·431
After treatment	—	·08

pig-iron. By kind permission of the Metropolitan Board of Works, I have erected works at my own expense at the Crossness Outfall of sufficient capacity to treat sewage at the rate of one million gallons per diem, as I have sufficient confidence in this process to risk the large outlay entailed. For this I have had an Edison-Hopkinson dynamo specially constructed, giving an output of 1,600 amperes and twenty volts.

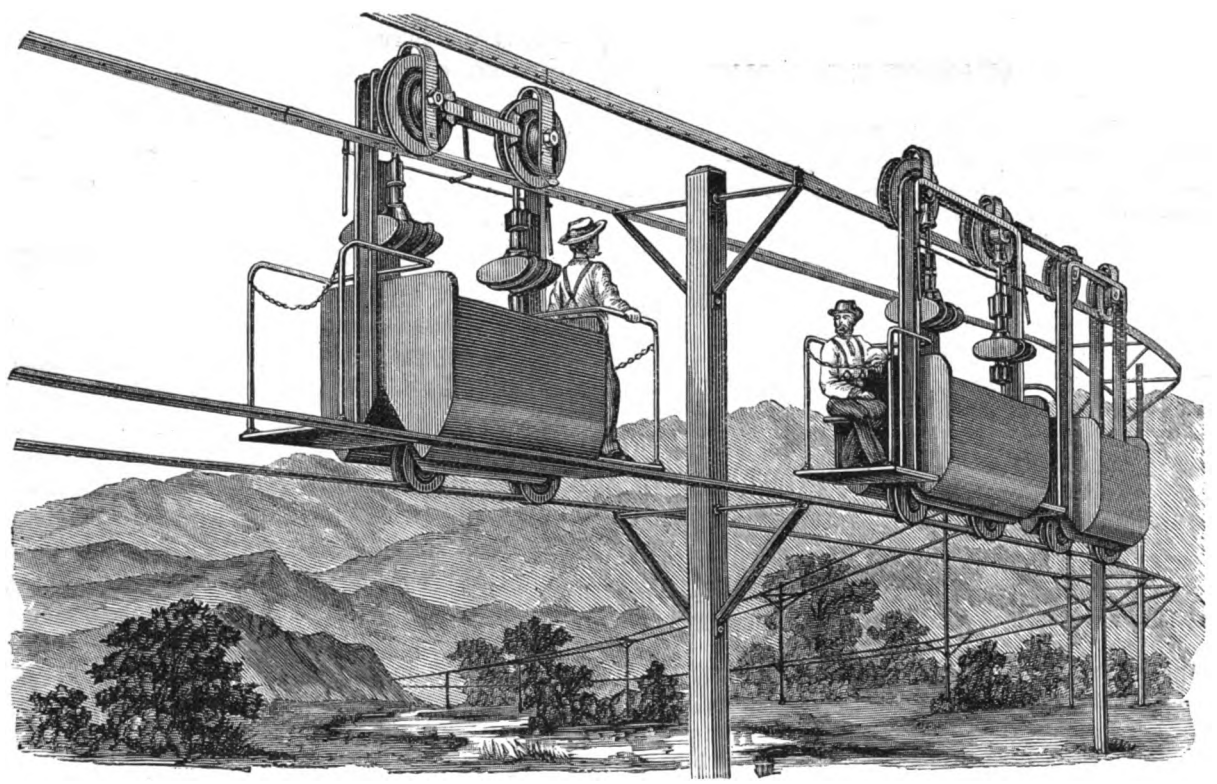
Unfortunately, the electrical portion of the works is not yet completed, or I should have hoped to have had the pleasure of inviting you to inspect them.

The question of cost resolves itself into this:—The more iron plates you introduce into the system the greater the surface, and the lower the resistance; consequently, the less horse-power required. The increase of the iron plates is only an increase of prime cost, and does not mean a greater waste of iron; this means a saving of labour, as the more iron originally used the less frequently it would require renewal.

I hope to prove that by using positive plates 1in. thick, their duration will be from five to ten years. If the proportion of one-third horse-power to 100 gallons in ten minutes holds good, as I am inclined to think it will, then 25 actual horse-power would be capable of purifying 1,080,000 gallons of sewage in twenty-four hours. I should much have liked to have gone into more minute details connected with these experimental tests, but until I have verified the present results on practical working scale, I feel it would be premature to quote figures.

The above table gives the results of a few analyses of sewage before and after treatment.

THE SPRAGUE TELPHERAGE SYSTEM.



The Sprague Electric Railway and Motor Company is now introducing a system of telpherage for mining work, and we illustrate herewith its *modus operandi*. The road or overhead track consists of two stationary steel cables, suspended one above the other between posts of wood or metal, fifty feet and upwards apart, and at such an elevation from the ground as not to interfere with surface traffic. The cars run on wheels, and are suspended between the upper and lower cables, the upper cable carrying most of the weight. By contact of the wheels with the cables the current is conveyed to an electric motor in the car, which imparts motion to the wheel by gears, &c. These cars can be of any pattern, dimensions or material required.—*Electrical World.*

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The Electrician.

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	3 months.	6 months.	12 months.
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„ Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	... 14 6	... 28 0
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THE GROWTH OF ELECTRICAL INDUSTRIES.

For a fuller appreciation of the progress of electrical industry since the British Association last visited the City of Bath our readers may usefully turn to the Presidential Address at the same place on Wednesday, and to the Address delivered by the President of Section G yesterday. The position of electrical science and electrical industry, as exemplified at the 1864 meeting—a retrospective account of which we gave in our last issue—and their position now, could hardly have been brought into stronger contrast than they are by these two meetings, although, in point of time, barely a generation has separated them. The Papers devoted to these subjects at the former meeting might be counted on the fingers of one hand; to-day they may be reckoned by the score. And even now not half or a quarter of the fields surveyed either by Sir Frederick Bramwell or by Mr. W. H. Preece have been separately reported upon at this year's meeting. The applications of electricity to industrial purposes, to the arts, and to objects of warfare, are multiplied almost beyond recollection; and though the fashion of the hour or the pecuniary interests immediately involved fixes attention on the more conspicuous of these applications, their

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intrinsic contribution to the industrial and social welfare of the nation is almost equalled, if not excelled, in the numberless and unrecognised services which electricity is everywhere rendering us, and of which Mr. PREECE has now very properly reminded us.

More than once in the course of his address the author, who may fairly claim to be a practical electrician, crosses swords with the theorist, or, more correctly, brandishes his weapon in the face of that unfortunate. Theorists, or philosophers, or physicists—for Mr. PREECE designates them in several ways—will, we fancy, be able to take care of themselves if they accept this challenge. Lord MANSFIELD once advised a newly appointed colonial judge always to deliver his judgments with boldness, but never to give his reasons. Science and practice would get along much more amicably, perhaps, if they observed this wholesome rule; the practice may be thoroughly sound though the reasons are all wrong, and, on the other hand, the reasoning may be all right but its application all amiss. We, therefore, will not here discuss the question whether electricity is "a form of matter or a form of energy," but rather content ourselves with agreeing with Mr. PREECE as to one ruling proposition which pervades the whole of his Paper, and to some extent that also of Sir F. BRAMWELL, namely, that the electrical engineer, by treating electricity as a form of something, has truly accomplished many wonderful things. And so long as he continues these achievements the world at large will trouble itself extremely little whether he acknowledges or denies his indebtedness to "the scientist, the theorist and the mathematician."

The long roll of discoveries and inventions which Mr. PREECE has enumerated is so magnificent and so comprehensive that its honours might be evenly divided without loss of self-esteem on either side. Between them, electrical science and electrical engineering have given us the electric telegraph, the telephone and the electric light. They have protected our buildings from lightning, and deprived railway travelling of its chief dangers. They have made easy the multiplication of works of art, and beautified the utensils of domestic life; the waste forces of nature are being utilised; avocations which were formerly dangerous or hurtful have been rendered safe and healthy; and industries which were an offence and a menace to society are becoming wholesome and innocuous. Of these benefits the telegraph is undoubtedly the widest in its operation, and grows wider every day in its subsidiary application to such purposes as fire alarms, bell ringing and telephony. The study of the electric light, too, besides its direct application, has opened up a wide field for the electrical transmission of power, for the welding of metals, and for painless operations in surgery. Some valuable statistics, the result of personal observation, are furnished by the author in relation to the hygienic value of the electric light. He tells us that in the Post Office Savings Bank, where gas was superseded two years ago by the new and purer illuminant, the average amount of illness among members of the staff has been diminished by about two days a year for each person—equivalent to a saving of the salary of eight clerks in that department. Besides, therefore, the advantage of better work performed by the staff, due to the improved atmospheric conditions which they enjoy, there is a saving of £266 a year, notwithstanding the acknowledged higher price of electricity compared with that of gas. As regards the mere production of the respective lights, Mr. PREECE finds that the cost for one candle light per annum of 1,000 hours is, in the case of London gas, 1s. 3d., against only 9d. for the electric glow lamp. Other considerations, however, have to be taken into account; and for supplying such places as the Post Office and the House of Commons with electricity produced on the premises, the glow lamp costs 22s. and a gas lamp 18s. per annum.

This difference in cost—compensated for, moreover, in other ways—will not deter those from using the glow lamp who study the welfare of their servants and their own best interests. On board ship the new light has gained a rapid and undisputed footing already. Not only are our warships equipped with arc and incandescent lamps, but the ocean-going passenger steamers are similarly provided; and no wonder, if, as Mr. PREECE alleges, it is on board ship that "the comfort, security, and true blessedness of the electric light is experienced." Concerning telegraphy and telephony Mr. PREECE is a still higher authority, and that part of his address which is devoted to these subjects is of exceeding interest and importance. Of the telephone he speaks in the language of an enthusiast; and no one who reads his address will have any room to suspect that the shortcomings of telephony in this country are in any way due to the Electricians of the British Post Office. Like his chief, the POSTMASTER-GENERAL, Mr. PREECE looks forward to the time when the patents of the existing owners shall expire; we shall then see what we shall see. Meanwhile, it is a painful confirmation of London's perennial complaint to learn that there are more telephonic subscribers, not only in New York, but in Stockholm, than there are in London, the largest city in the world.

When we turn to his facts and figures relating to the telegraph we are amazed and almost staggered at the immensity of its power and the rapidity of its growth. In this country alone the increase of telegraph business since the year 1870 is represented by fifty-two million messages per annum against six millions, and from being the luxury of the few the telegraph has become the servant of all. The business of the private companies, which amounted to £550,000 a year, has grown in the hands of the State to £2,000,000 a year, and the speed of transmission has increased from 100 or 150 words a minute as a rare performance, and for short distances, to 500 and 600 as a normal speed over a great number of lines, and to the geographical limits of these islands. Thirteen years ago it was thought a wonderful feat to transmit messages to Ireland through an intervening submarine cable at the rate of 80 words a minute. Recently when he was at Belfast Mr. PREECE timed messages arriving at the rate of 461 words a minute. The amount of news passing over the wires, chiefly in the night time, and appearing in the newspapers the next morning, averages 1,538,270 words per day, and this, of course, is mainly due to the speed at which they are despatched. On the question of speed Mr. PREECE is entitled to speak with some exultation. Not very long ago the American Press boasted that 500,000 words were sent out of Chicago in a single night. Mr. PREECE is like Mr. BALFOUR, he is not in a hurry to retort; he bides his time, and when it arrives he brings down a crusher. "500,000! Why, when Mr. GLADSTONE introduced his Home Rule Bill about two years and a-half ago, we sent from the central office no fewer than 1,500,000 words, and made no fuss about it." Some national pride, too, is aroused by Mr. PREECE'S reminder that of the submarine cables of the world 110,000 miles have been laid by British ships, and nearly £40,000,000 of British capital has been expended in completing that great enterprise. With such splendid proofs of the subjection into which he has brought

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the powers of electricity, a modern electrician may, perhaps, be forgiven the confident affirmative with which he is now inclined to answer that dumbfoundering query addressed to Job of old: "Canst thou send lightnings that they may go, And say unto thee, 'Here we are'?"

OBITUARY.

PROF. RUDOLF JULIUS EMANUEL CLAUSIUS.

In expressing our profound regret at hearing of the death of the far-famed professor who has so long and so ably occupied the chair of Natural Philosophy at the University of Bonn we echo the sentiments of the whole scientific world, which has lost in him one of the most profound investigators; and of the students of his University, who mourn the loss of one of the most able teachers in Europe. Prof. Clausius was born on 2nd January, 1822, at Cöslin, in Pomerania. He was educated at Berlin, where he early distinguished himself in mathematics and physics. He began his career as a teacher as *privat docent* in the Univerity of Berlin, and instructor in Natural Philosophy at the School of Artillery in that city. In 1857 he accepted the Chair of Natural Philosophy at the Polytechnic School at Zurich, which he retained until 1867. In 1869 he was appointed Professor of Natural Philosophy at the University of Bonn, a post which he held until his death. His fame will chiefly rest upon his development, together with Rankine and Thomson, of the science of thermo-dynamics; but this was by no means his only important work. It was he who first established the kinetic theory of gases upon a scientific basis, and his contributions to various scientific journals, embracing more than 100 Papers, cover a very wide field. His earliest investigations were in connection with the transmission of light through the atmosphere and the blue colour of the sky, but he very soon turned his attention to the thermo-dynamical researches with which his name is chiefly associated. His treatise on the mechanical theory of heat forms a standing monument to his memory, not only as a physicist of the most profound insight, but as an expositor of singular lucidity and power. His work throughout is remarkable for the manner in which he always subordinates his mathematical analysis, generally of a comparatively simple character, to the physical problems which he is considering, so that the reader gains an insight into the subject to an extent which is by no mean common in memoirs and treatises on mathematical physics.

Among his more important electrical Papers we may mention:—"The Mechanical Equivalent of an Electric Discharge and the Heating of the Conducting Wire which accompanies it;" "Electrical Conduction in Electrolytes;" "The Effect of Temperature on Electrical Conductivity;" "A New Fundamental Law of Electro-Dynamics;" "The Different Systems of Measures for Electric and Magnetic Quantities;" "The Employment of the Electro-Dynamic Potential for the Determination of Ponderomotive and Electromotive Forces;" "The Theory of Dynamo-Electrical Machines;" "The Theory of the Transmission of Power by Dynamo-Electrical Machines." These Papers have nearly all been translated in Taylor's "Scientific Memoirs" or in the *Philosophical Magazine*, and a translation of the Paper on "The Theory of Dynamo-Electrical Machines" appeared in Vol. XII. of *The Electrician*.

Although it does not deal with electricity, we must not omit to mention his very important Paper "On the Determination of the Energy and Entropy of a Body," translated in the *Phil. Mag.*, Vol. XXXII., 4th series, 1866, as it was in this Paper that the important conception of the entropy of a body was first propounded.

In 1877 Prof. Clausius published a small but important work on the "Potential Function and the Potential." In 1868, he was elected a foreign member of the Royal Society, and 11 years later he was the recipient of the Copley medal, the blue ribbon of the Society. He was decorated with numerous German orders, and he received the Iron Cross from the German Government and the ribbon of the Legion of Honour from that of France for his services as a caretaker of the wounded in the Franco-German War, for which he volunteered.

GENERAL LORD ALFRED PAGET, C.B.

The lamented death of General Lord Alfred Paget, which took place on board his yacht, the "Violet," near Inverness on the 25th ult., will recall to many of our readers the very earliest days of the electric telegraph, when its development as a commercial undertaking depended largely on the encouragement and support of men like the deceased nobleman. He was one of the original Directors of the Electric Telegraph Company, incorporated in 1846, under the able chairmanship of Mr. John Lewis Ricardo. Lord Alfred's interest in telegraphy never flagged; and at the time of his death he was a Director of the Eastern Telegraph Company, as well as of several other companies. Although in his seventy-third year, having been born in June, 1816, Lord Alfred Paget was enjoying good health, and his death, after a very short illness, was the result of an accidental chill caught while shooting on the moors. The remains of the deceased nobleman were brought to his residence, Upper Lodge, Bushey Park, and were interred in the family grave in Hampton parish churchyard, on Wednesday, the 29th ult. The funeral was attended by a large concourse of noblemen and gentlemen, amongst whom were Col. the Hon. Wm. Carrington, representing Her Majesty the Queen, and Major-General Ellis, who represented the Prince of Wales, the Eastern Telegraph Company being represented by Mr. J. D. Pender, Mr. G. Draper, Mr. W. T. Ansell, and others. The Vicar of Hampton conducted the service, which was partly choral, assisted by the Rev. Sholto D. Campbell Douglas, of Inverness, who had attended his lordship in his last illness. Lord Alfred Paget was married in 1847 to Miss Cecilia Wyndham, who survives him, and by whom he had a family of fourteen children. He was a General in the Army, Chief Equerry and Clerk Marshal of the Royal Household, and Member of Parliament for Lichfield from 1837 to 1865.

IMPROVEMENTS IN THE TELEPHONE SYSTEM OF GLASGOW AND THE WEST OF SCOTLAND.

By D. Sinclair, Engineer, National Telephone Company.

(Continued from page 531.)

A distinct feature in our telephone work is the change that has been made from the use of electric batteries to that of magneto-electric generators for ringing purposes. There is a very great economy effected by the use of generators, and in every way they are much more suitable than batteries. A magneto will work for years without any attention whatever, and it has power to signal through a resistance of from 12,000 ohms to 16,000 ohms, this being more than is required in practice.

The switch-board in all telephone exchanges is a very important part of the system, and many changes have been made in trying to arrive at a really satisfactory switch-board. Glasgow was started with the ordinary "Bell" board, and the "Universal" switch-board of the style known as Edison's. After some experience these gave place to "Williams'" boards, and for small exchanges of from 100 to 200 wires they are very satisfactory, but for larger exchanges the best boards are decidedly the "Multiple" switch-boards.

Were I to enter into all the details showing this, I should far exceed the limits of a Paper of this kind, but I will mention a few of the main points.

First. The principal and best feature of the multiple switch-board is that every operator has complete control over the number of wires she attends to, with power to join them to any other wire in the exchange without the intervention of any other operator.

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Second. The perfection with which the manufacturing details are carried out.

Third. The fact that it has capacity for carrying a greater number of wires in a smaller space than any other switch-board.

Fourth. An operator can attend to a greater number of subscribers than with any other switch-board.

The manner in which the wires are arranged so as to give each operator control over the whole is shown in Fig. 5, where the tables are numbered from 1 to 5.

The wire coming into the exchange from the test-box (say No. 1 wire) goes to a jack with that number on No. 1 table, and out to a jack with the same number on No. 2 table, going

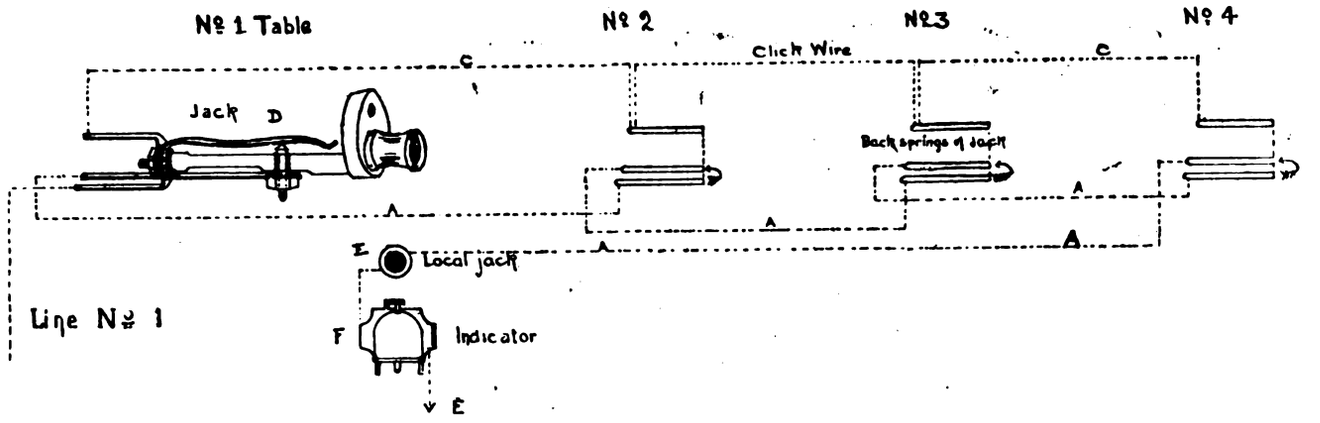

FIG. 5.—CONNECTIONS OF "MULTIPLE" SWITCH-BOARD.

A A shows line of subscriber No. 1 going to No. 1 jack on No. 1 table, then to No. 1 jack on each table in the room, returning to local jack E on No. 1 table, then through indicator F to earth. C C.—Click wire. By touching front of jack with plug the operator can tell whether a line is engaged or not. D.—Complete jack, showing insulated parts. Every subscriber's line follows a similar course through the whole of the tables.

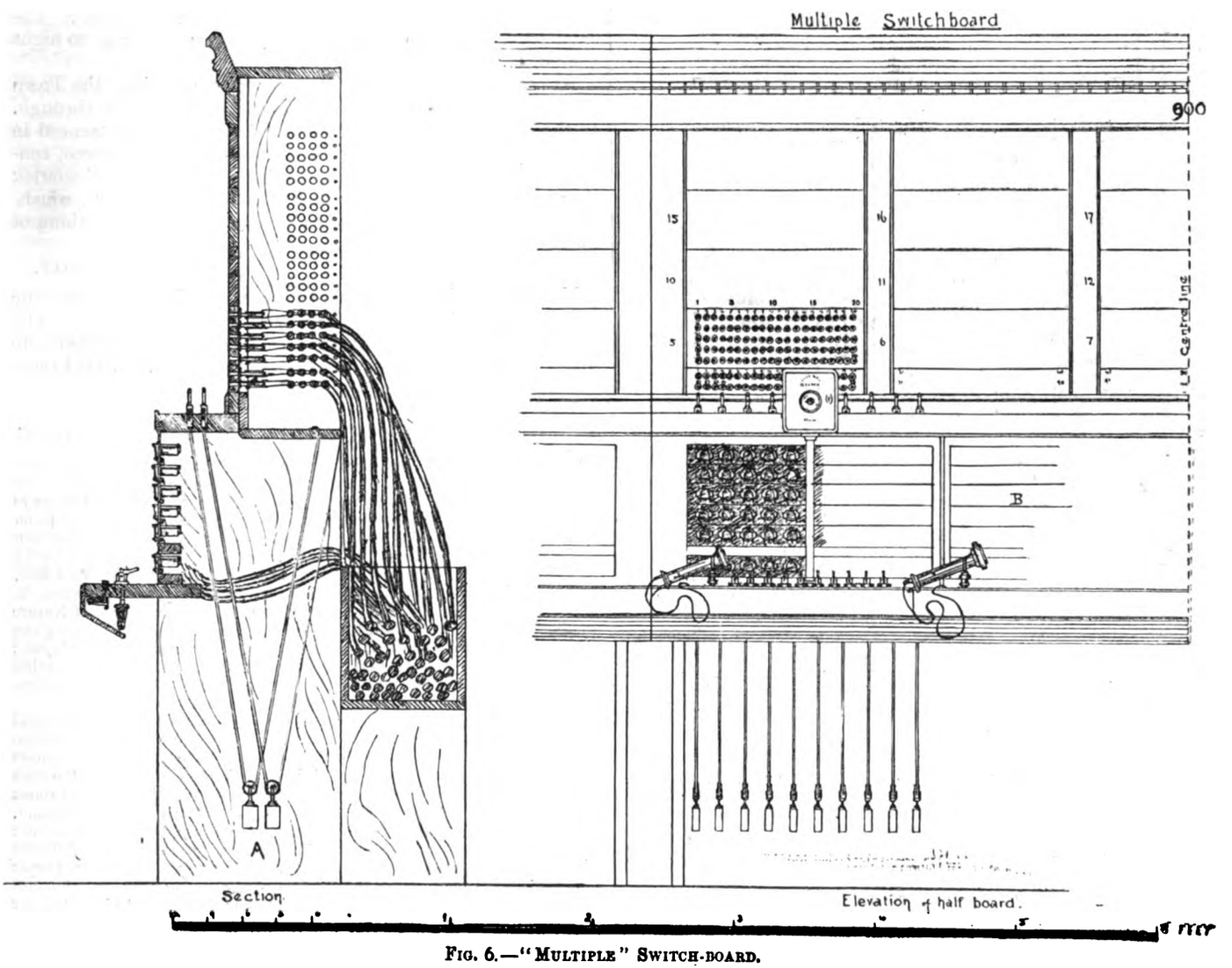

FIG. 6.—"MULTIPLE" SWITCH-BOARD.

A, section of board; B, elevation of half board.

We have this multiple system at work in our central exchange in Glasgow, where there are 10 boards of 200 lines each, or 2,000 lines in all.

thus in and out through every table in the room. Four tables only are shown in the figure. Finally it returns to No. 1 table, where it makes connection with its "local jack,"

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and through an indicator to earth. All the wires on this No. 1 table, which are 200 in number, follow the same course. Another set of 200 wires starts from the same table, passes round the room in the same way, and is taken from the last table to earth through the local jack on table 2. This system of every wire commencing at No. 1 table, going to all the other tables, and finishing at that on which its number exists, is carried on throughout, and is necessary to give the facility just mentioned of any operator having within her reach all the wires in the exchange.

Let us suppose that No. 1 subscriber rings the exchange and asks to be connected with No. 600. It would not do for the operator to connect 600 without first ascertaining that that wire was not already engaged. Provision is made on the "multiple" system for this being done by means of a test wire, without in any way interfering with the wire if engaged, and the user has no knowledge that the test is being made. The operator just touches the front of the jack with her connecting plug; if engaged a smart click occurs in her telephone, and she at once replies to No. 1 that "600 is engaged." If not engaged there is no click, and she inserts the plug and the connection is immediately completed.

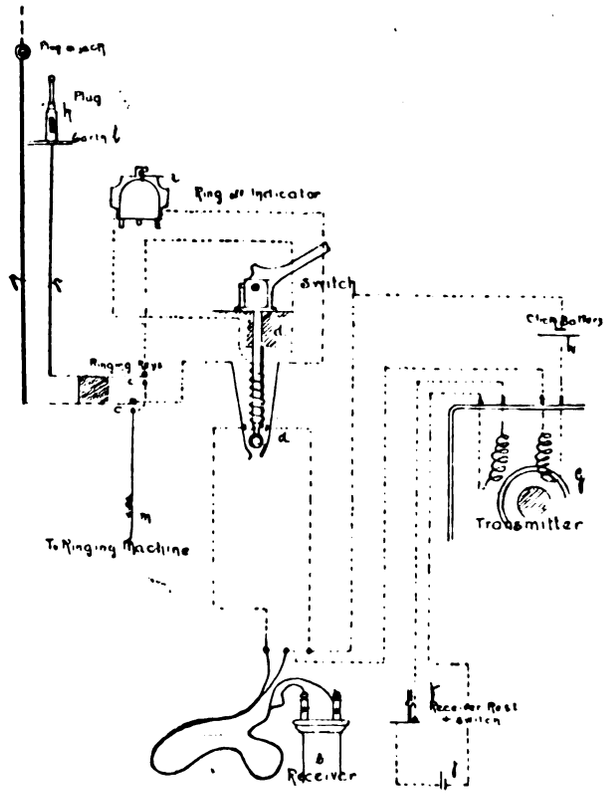

FIG. 6A.

C, connections, showing subscriber speaking to operator; *a*, plug inserted in jack; *b b*, connecting cords; *c c*, ringing keys; *d*, switch for cutting in or out operator's instrument; *e*, operator's receiver; *f*, receiver rest and local battery cut-out; *g*, operators transmitter; *h*, click battery; *i*, ring-off indicator; *j*, local battery; *k*, plug resting on earth strip *l*; *m*, ringing machine.

The indicators of both lines thus connected are cut out of circuit, and an indicator placed in the connecting cord circuit serves to show further requirements from either, until the plugs are withdrawn and both wires are back into normal positions.

Fig. 5 shows the connection of this click system with the ordinary line jack. Figs. 6 and 6A show front and sectional views and further details of the connections.

It must be added that these facilities are not given without a very considerable amount of wire, jacks, and work in setting up. In speaking of an exchange like this one in Glasgow, fitted up for 2,000 subscribers, I hope that we can look at it as a small exchange compared with what we expect in the future; but as all things are great or small by comparison only, it will be admitted that even fitting up an exchange of this size is a heavy undertaking, when it is said that we had to cut, fix, and solder on, then test, no less than 107,000 wires, making a total length of 132 miles in the exchange.

(To be continued.)

THE BRITISH ASSOCIATION MEETING AT BATH, 1888.

(FROM OUR CORRESPONDENT.)

BATH, WEDNESDAY.

The second meeting held by the British Association at Bath opened to-day under very favourable auspices, even the weather proving fine for a few hours. The local arrangements appear to have been admirably made. The sectional meetings are somewhat far apart, but this, however, was unavoidable, and is amply atoned for by the suitability of the rooms selected. Some £3,600 has been subscribed by the people of Bath; a large corrugated iron building has been erected as a reception room, where the members of the Association will find every telegraphic, telephonic and postal facility, as well as ticket, luggage and inquiry offices. The seventeen excursions are already being rapidly entered for. They comprise visits to Berkeley Castle, Bristol, Stonehenge, Wells, and Glastonbury, and last, but not least, the Severn Tunnel. The chief local attraction is the flower show, which was to-night brilliantly illuminated by the electric light.

At one o'clock Sir Henry Roscoe took the chair at the Town Hall, where the usual opening formalities were gone through. In the evening the meetings of the Association commenced in the Drill Hall. Sir Henry Roscoe, after a brief speech, concluded by resigning the chair to his successor, Sir Frederick Bramwell, who then delivered his inaugural address, which, although of a very interesting character, contained nothing of special interest to electricians.

THURSDAY.

Nearly the whole of the sections met this morning for the transaction of business. They were largely attended. The total number of tickets issued is 1,794. The weather continues fine. In the Mechanical Section (G) Mr. W. H. Preece delivered the following address:—

MR. PREECE'S PRESIDENTIAL ADDRESS IN SECTION G

"Canst thou send lightnings that they may go, And say unto thee 'Here we are,'" were pregnant words addressed to Job unknown centuries ago. They express the first recorded idea in history of the potentiality of electricity to minister to the wants of mankind. From Job to Franklin is a long swing in the pendulum of time. It was not until that American philosopher brought down atmospheric electricity by his kite-string in 1747, and showed that we could lead it where we willed, that we were able to answer the question addressed to the ancient patriarch. Nearly another century elapsed before this mysterious power of Nature was fairly conquered. It has been during this generation, and during the life of the British Association, that electricity has been usefully employed; and it is because I have taken a subordinate position in inaugurating nearly all of its practical applications, that I venture to make the developments of them the text of my address to this section.

People are singularly callous in matters affecting their own personal safety, they will not believe in mysteries, and they ridicule or condemn that which they do not understand. The Church itself set its face against Franklin's "impious" theories, and he was laughed to scorn by Europe's scientific sons; and even now, though commissions composed of the ablest men of the land have sat and reported on Franklin's work in England, France, and nearly every civilised nation, the public generally remains not only ignorant of the use of lightning conductors, but absolutely indifferent to their erection, and if they are erected, certainly careless of their proper maintenance. I found in a church not very far from here the conductor leaded into a tombstone, and in a neighbouring cathedral the conductor only a few inches in the ground, so that I could draw it out with my hand. Although I called the attention of the proper authorities to the absolute danger of the state of affairs, they remained in the same condition for years.

Wren's beautiful steeple in Fleet-street, St. Bride's, was well nigh destroyed by lightning in 1764. A lightning rod was fixed, but so imperfectly that it was again struck. In July last (1887) it was damaged because the conductor had been neglected, and had lost efficiency.

As long as points remain points, as long as conductors remain conductors, as long as the rods make proper connection with the earth, lightning

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protectors will protect; but if points are allowed to be fused or to corrode away, if bad joints or faulty connections are allowed to remain, if bad earths or no earths exist, protectors cease to protect, and they will become sources of danger. Lightning conductors, if properly erected, duly maintained, and periodically inspected, are an absolute source of safety; but if erected by the village blacksmith, maintained by the economical churchwarden, and never inspected at all, a loud report will some day be heard, and the beautiful steeple will convert the churchyard into a new geological formation.

We have not yet acquired that mental confidence in the accuracy of the laws that guide our procedure in protecting buildings from the effects of atmospheric electrical discharges which characterises most of the practical applications of electricity. Some of our cherished principles have only very recently received a rough shaking from the lips of Prof. Oliver Lodge, F.R.S., who, however, has supported his brilliant experiments by rather fanciful speculation, and whose revolutionary conclusions are scarcely the logical deduction from his novel premises. The whole subject is going to be thoroughly discussed at this meeting.

We are now obtaining much valuable information about the nature of lightning from photography. We learn that it does not, as a rule, take that zigzag course conventionally used to represent a flash on canvas. Its course is much more erratic and sinuous, its construction more complicated, and pictures have been obtained of *dark* flashes whose *raison d'être* has not yet been satisfactorily accounted for. The network of telegraph wires all over the country is peculiarly subject to the effects of atmospheric electricity, but we have completely mastered the vagaries of lightning discharges in our apparatus and cables. Accidents are now very few and far between.

The art of transmitting intelligence to a distance beyond the reach of the ear and the eye by the instantaneous effects of electricity had been the dream of the philosopher for nearly a century, when in 1837 it was rendered a practical success by the commercial and far-sighted energy of Cooke and the scientific knowledge and inventive genius of Wheatstone. The metallic arc of Galvani (1790) and the developments of Volta (1796) had been so far improved that currents could be generated of any strength, the law of Ohm (1828) had shown how they could be transmitted to any distances, the deflection of the magnetic needle by Oersted in 1819, and the formation of an electro-magnet by Ampère and Sturgeon, and the attraction of its armature had indicated how those currents could be rendered visible as well as audible.

Cooke and Wheatstone in 1837 utilised the deflection of the needle to the right and the left to form an alphabet. Morse used the attraction of the armature of an electro-magnet to raise a metal style to impress or emboss moving paper with visible dots and dashes. Steinheil imprinted dots in ink on the different sides of a line on paper, and also struck two bells of different sound to affect the ear. Bréguet reproduced in miniature the actual movements of the semaphore, then so much in use in France, while others rendered practical the favourite idea of moving an indicator around a dial, on which the alphabet and the numerals were printed, and causing it to dwell against the symbol to be read—the A B C instrument of Wheatstone in England, and of Siemens in Germany. Wheatstone conceived the notion of printing the actual letters of the alphabet in bold Roman type on paper—a plan which was made a perfect success by Hughes in 1854.

At the present moment the needle system of Cooke and Wheatstone, as well as the A B C dial telegraph, are very largely used in England on our railways and in our smaller post offices. The Morse recorder and the Hughes type printer are universally used on the Continent, while in America the dot and dash alphabet of Morse is impressed on the consciousness through the ear by the sound of the moving armature striking against the stops that limit its motion. In our larger and busier offices the Morse sounder and the bell system, as perfected by Bright, are largely used, while the press of this country is supplied with news which is recorded on paper by ink dots and dashes by means of the automatic apparatus at a speed that is almost fabulous.

Sir William Thomson's mirror—the most delicate form of the needle system—where the vibratory motions of an imponderable ray of light convey words to the reader, and his recorder where the wavy motion of a line of ink spirted on paper by the frictionless repulsion of electricity performs the same function, are exclusively employed on our long submarine cables.

Bakewell in 1848 showed how it was possible to reproduce facsimiles of handwriting and of drawing at a distance, and in 1879 E. A. Cowper reproduced one's own handwriting, the moving pen at one station so controlling the currents flowing on the line wire that they caused a similar pen to make similar motions at the other distant station. Neither of these plans, the former beautifully developed by Caselli and D'Arlincourt, and the latter improved by Robertson and Elisha Gray, has yet reached the practical stage.

The perfection of telegraphy has been attained by that chief marvel of this electrical age—the speaking telephone of Graham Bell. The reproduction of the human voice at a distance, restricted only by geographical limits, seems to have reached the confines of human ingenuity; and though wild enthusiasts have dreamt of reproducing objects abroad visible to the naked eye at home, no one at the present moment can say that such a thing is possible, although in face of the wonders that have been done no one dare say that is impossible.

The commercial business of telegraphy, when our thoughts and wishes, orders and wants, could be transmitted for money, was inaugurated in this country by the establishment of the Electric Telegraph Company in 1846, and until 1870 it remained in the hands of private enterprise, when it was purchased by the Government, and placed under the sole control of the Postmaster-General. It has been the fashion to decry the terms of purchase of the various undertakings then at work by those who have not understood the question, and by those who, being politically opposed to the Government in power at the time, saw all their acts, not only through a glass darkly, but through a reversing lens. A business producing £550,000 per annum was bought at twenty years' purchase, and that business has now increased to £2,000,000 per annum. 6,000,000 messages per annum have increased to 53,400,000. In August, 1870, the largest number of messages per week was 234,000. Last month it reached 1,276,000.

Every head post office has been made a telegraph office, every village of any size has its wire; messages which used to cost 12s. 6d. are now sent for 6d.; a tariff which was vexatious from its unfair variation is now uniform over the United Kingdom, and no one can justly complain of error or delay in the transmission of their messages. Silly complaints are sometimes inserted in the press, of errors which the most elementary knowledge of the Morse alphabet would detect, and little credit is given to the fact that the most perfect telegraph is subject to strange disturbances from terrestrial and atmospheric causes which admit sources of error beyond the control of the telegraphist. A flash of lightning in America may cause an extra dot in Europe and *mine* may become *wine*. An earthquake in Japan may send a dash through France and *life* would become *wife*. A wild goose flying against a telegraph wire might drive it into momentary contact with another wire and *sight* might become *night*. Everyone should know his Morse alphabet, and people should learn how to write. Nine-tenths of the errors made are due to the execrable caligraphy of the present day. As a matter of fact, in ninety-nine cases out of a hundred the telegraphist delivers to the editor of a newspaper "copy" far more accurate than the first proof submitted by the printer of his own leader. The quantity of news transmitted is enormous, an average of 1,538,270 words are delivered per day. The recent convention in Chicago when the Republican party of the United States nominated their candidate for the presidentship created so much business that every American paper has chronicled this big thing as unique. 500,000 words were sent on one night; but we in England, when Mr. Gladstone introduced his celebrated Home Rule Bill on April 8th, 1886, sent from the Central Telegraph Office in London 1,500,000 words.

The growth of business has led to vast improvement in the carrying capacity of the wires. Cooke and Wheatstone required five wires for their first needle instrument to work at the rate of four words per minute. One wire can now convey six messages at ten times the speed. The first Morse apparatus could work at about five words a minute; we now transmit news at the rate of 600 words a minute. Even in 1875 it was thought wonderful to transmit messages to Ireland at 80 words a minute. When I was recently in Belfast I timed messages coming at the rate of 461 words a minute. Duplex working—that is, two messages travelling on the same wire at the same time in opposite directions, the invention of Gintl, of Vienna—is now the normal mode of working, Edison's quadruplex is common, and the Delany system of multiplex working is gradually being introduced by which six messages are indiscriminately sent in either direction on one wire. The telegraphic system of England has been brought to the highest pitch of perfection. We have neither neglected the inventions of other countries, nor have we been chary of exercising inventive skill ourselves, and we have received our full meed of that reward which is always freely bestowed on a British Government official—neglect and abuse.

All parts of the civilised world are now united by submarine cables. *The Times* every morning has despatches from every quarter of the globe, giving the news of the previous day. 110,000 miles of cable have been laid by British ships, and nearly £40,000,000 of British capital has been expended by private enterprise in completing this grand undertaking. A fleet of 37 ships is maintained in various oceans to lay new cables and to repair breaks and faults—faults that arise, among other causes, from chafing on coral reefs, ships' anchors, the onslaught of insects, and earthquakes. The two cables connecting Australia and Java were recently simultaneously broken by an earthquake.

The politician, unmindful of the works of the engineer, is apt to apply to the credit of his own proceedings the growing prosperity of the world. The engineer, however, feels that steam and electricity in his hands have done more to economise labour, to cheapen life, to increase wealth, to promote international friendship, to alleviate suffering, to ward off war, to encourage peace, than all the legislation and all the verbosity of the politician.

The railways of this country are entirely dependent for the conduct of their traffic on the telegraph, and the security of their passengers is mainly due to the working of the block system. A railway, say between London and Bath, is broken up into certain short sections, and only one train is allowed on one section at one time. The presence, motion, and departure of trains is announced and controlled by electric signals, and the out-door signals are governed by these electric signals. There are few more interesting places to visit than a well-equipped signal-box on one of our main railways. The signalman is able to survey the lines all around and about him by aid of his electric signals; he can talk by telegraph or by telephone to his neighbours and his station master; he learns of the motion of the trains he is marshalling by the different sounds of electric bells; he controls his out-door signals by the deflection of needles, or the movement of miniature semaphores; he learns the true working of his distant signals by their electrical repetition; machinery governs and locks every motion he makes, so that he cannot make a mistake. The safety of railway travelling is indicated by the fact that while in the five years ended 1878 thirty-five people were killed annually from causes beyond their own control, in the five years ended 1887 the average has been reduced to sixteen. One person is killed in 35,000,000 journeys made by train. Wherever we are dependent on human agency we are subject to human error, and a serious accident very recently at Hampton Wick has shown how the most perfect machinery may be rendered valueless to protect life when perversity, thoughtlessness or criminality enter as factors in the case.

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At the meeting of the Association in Plymouth in 1877, I was able for the first time in this country to show the telephone at work. Since then its use has advanced with giant strides. There are probably a million instruments at work now throughout the civilised world. Its development has been regularly chronicled at our meetings. As far as the receiving part of the apparatus is concerned, it remains precisely the same as that which I brought over from America in 1877; but the transmitter, since the discovery of the microphone by Hughes in 1878, has been entirely remodelled. Edison's carbon transmitter was a great step in advance; and the modern transmitters of Moseley, Berliner, D'Arsonval, De Jongh, leave little to be desired. The disturbances due to induction have been entirely eliminated, and the laws regulating the distance to which speech is possible are so well known, that the specification of the circuit required to connect the Land's End with John O'Groats by telephone is a simple question of calculation. A circuit has been erected between Paris and Marseilles, 600 miles apart, with two copper wires of 6½ gauge weighing 540lb. per mile, and conversation is easily maintained between those important cities at the cost of three francs for three minutes. One scarcely knows which fact is the more astounding—the distance at which the human voice can be reproduced, or the ridiculously simple apparatus that performs the reproduction. But more marvellous than either is the extreme sensitiveness of the instrument itself, for the energy contained in one heat unit (gramme-water-degree) would, according to Pellat, maintain a continuous sound for 10,000 years.

The influence which electric currents exert on neighbouring wires extends to enormous distances, and communication between trains, and ships in motion, between armies inside and outside besieged cities, between islands and the main land, has become possible without the aid of wires at all, by the induction which is exerted through space itself. On the Lehigh Valley Railway, in the United States, such a system of telegraphing without wires is in actual daily use.

The conduct of telephonic business in England is still in the hands of those who hold the patents, and who maintain a most rigid monopoly. These patents have only a short period to run, and when they expire we may expect to find that England will not occupy the very retired position she holds now as a telephone country. Stockholm has more subscribers than London; there are 15,000 subscribers in and about New York, while the number in London is only 4,851.

Electric lighting has become popular, not alone from the beauty of the light itself, but from its great hygienic qualities in maintaining the purity and coolness of the air we breathe. The electric light need not be more brilliant than gas, but it must be more healthy. It need not be cooler than a wax candle, but it must be brighter, steadier, and more pleasant to the eye. In fact, it can be rendered the most perfect artificial illuminant at our disposal, for it can illumine a room without being seen directly by the eye; it can be made absolutely steady and uniform without irritating the retina; it does not poison the air by carbonic acid and carbonic oxide, or dirty the decorations by depositing unconsumed carbon; it does not destroy books or articles of vertu and art by forming water which absorbs sulphur acids; and it does not unduly heat the room.

In the Post Office Central Savings Bank in London it has been found, after two years' experience of electric lighting, that the average amount of absences from illness has been diminished by about two days a year for each person on the staff. This is equivalent to a gain to the service of the time of about eight clerks in that department alone. Taking the cost at the "overtime" rate only this would mean a saving in salaries of about £640 a year. The cost of the installation of the electric light was £3,349 and the annual cost of working £700 per annum, say a total annual cost of £1,034. The cost of the gas consumed for lighting purposes was about £700 a year, so that on the whole there was a direct saving of something like £266 a year to the Government, besides the material advantage of the better work of the staff resulting from the improved atmospheric conditions under which their work is done.

The production of light by any means implies the consumption of energy, and this can be measured in *watts*, or the rate at which this energy is consumed. A watt is $\frac{1}{746}$ part of a *horse-power*. It is a very convenient and sensible unit of power, and will in time replace the meaningless horse-power.

One candle light maintained by	tallow	absorbs	124	watts.
,,	,,	wax ,,	94	,,
,,	,,	sperm ,,	86	,,
,,	,,	mineral oil	absorbs 80	,,
,,	,,	vegetable oil	,, 57	,,
,,	,,	coal gas	,, 68	,,
,,	,,	cannel gas	,, 48	,,
,,	,,	electricity (glow)	absorbs 3	,,
,,	,,	electricity (arc)	,, ·5	,,

The relative heat generation of these illuminants may be estimated from these figures. Though the electric light was discovered by Davy in 1810, it was not until 1844 that it was introduced into our scientific laboratories by Foucault; it was not until 1878 that Jablochkoff and Brush showed how to light up our streets effectually and practically; it was not until 1881 that Edison and Swan showed how our homes could be illuminated softly and perfectly. Unpreparedness for such a revolution produced a perfect panic among gas proprietors; inexperience in the use of powerful electric currents resulted in frequent failure and danger; speculation in financial bubbles transferred much gold from the pockets of the weak to the coffers of the unscrupulous; hasty legislation in 1882 restricted the operations of the cautious and the wise; and the prejudice arising from all these causes has, perhaps fortunately, delayed the general introduction of electricity; but now legislation has been improved, experience has been gained, confidence is being restored, and in this beautiful town of Bath fifty streets are about to be lighted, and we see everywhere around and about us in our English homes the pure glow lamp replacing filthy gas and stinking oil. The economical distribution of the electric current over large areas is annually receiving a fresh impetus. The expensive systems defined in the Act of Parliament of 1882 have entirely disappeared. Hopkinson in England and Edison in America showed how a third wire reduced the weight of copper needed by 66 per cent. Gaulard and Gibbs in 1882 showed how the conversion of alternate currents of high electromotive force to currents of low electromotive force by simple induction coils would enable a mere telegraph wire to convey sufficient electricity to light a distant neighbourhood economically and efficiently. Lane-Fox in 1879 showed how the same thing could be done by secondary batteries; and Planté, Faure, Sellon, and Parker have done much to prove how batteries can be made to solve the problem of storage; while King and Edmunds have shown how the distribution by secondary batteries can be done as economically as by secondary generators. The Grosvenor Gallery Company in London have proved the practicability of the secondary generator principle by nightly supplying 24,000 glow lamps scattered over a very wide area of London. The glow-lamp of Edison, which in 1881 required 5 watts per candle, has been so far improved that it now consumes but 2½ watts per candle. The dynamo which in the same year weighed 50,000lb., absorbed 150 horse-power, and cost £4,000 for 1,000 lamps, now weighs 14,000lb., absorbs 110 horse-power, and cost £500 for the same production of external energy; in other words, its commercial output has been increased nearly six times, while its prime cost has been diminished eight times.

The steam engine has received equal attention. The economy of the electric light when steam is used depends almost entirely on the consumption of coal. With slow-speed low-pressure engines one kilowatt (1,000 watts, 1⅓ horse-power) may consume 12lb. of coal per hour; in high-speed high-pressure triple-expansion-condensing engines it need not consume more than 1lb. of coal per hour. Willans and Robinson have actually delivered from a dynamo one kilowatt by the consumption of 2lb. of coal per hour, or by the condensation of 20lb. of steam.

There is a great tendency to use small economical direct-acting engines in place of large expensive engines, which waste power in countershafting and belts. Between the energy developed in the furnace in the form of heat, and that distributed in our rooms in the form of light, there have been too many points of waste in the intermediate operations. These have now been eliminated or reduced. Electricity can now be produced by steam at 3d. per kilowatt per hour. The kilowatt hour is the Board of Trade unit as defined by the Act of 1882, for which the consumer of electric energy has to pay. Its production by gas engines costs 6d. per kilowatt-hour, while by primary batteries it costs 3s. per kilowatt-hour. The Grosvenor Gallery Company supply currents at 7¼d. per kilowatt-hour; a 20 candle-power lamp consuming 3 watts per candle, and burning 1,200 hours per annum, expends 82,000 watt-hours or 82 kilowatt-hours, and it costs, at 7¼d. per unit, 50s. per annum. If the electricity be produced on the premises, as is the case in the Post Office, in the House of Commons, and in many large places, it would cost 20s. 6d. per annum. I have found from a general average under the same circumstances and for the same light in the General Post Office in London that an electric glow lamp costs 22s. and a gas lamp 18s. per annum. The actual cost of the production of one candle light per annum of 1,000 hours is as follows:—

	s.	d.
Sperm candles	8	6
Gas (London)	1	3
Oil (petroleum)	0	8
Electricity, glow	0	9
,, arc	0	1½

The greatest development of the electric light has taken place on board ship. Our Admiralty have been foremost in this work. All our warships are gradually receiving their equipment. Our ocean-going passenger ships are also now so illumined, and perhaps it is here that the comfort, security, and true blessedness of the electric light is experienced.

Railway trains are also being rapidly fitted up. The express trains to Brighton have for a long time been so lighted, and now several northern railways, notably, the Midland, are following suit. Our rocky coasts and prominent landfalls are also having their lighthouses fitted with brilliant arc lamps, the last being St. Katherine's point on the Isle of Wight, where 60,000 candles throw their bright beams over the English Channel, causing many an anxious mariner to proceed on his way rejoicing.

Fontaine showed in Vienna, in 1873, that a dynamo was reversible; that is, if rotated by the energy of a moving machine it would produce electric currents, or if rotated by electric currents it would move machinery. An electric current is one form of energy. If we have at one place the energy of falling water we can by means of a turbine and a dynamo convert a certain portion of the energy of this falling water into an electric current. We transmit this current through proper conductors to any other place we like, and we can again by means of a motor convert the energy of the current into mechanical energy to do work by moving machinery, drawing tramcars or in any other way. We can in this way transmit and utilise 50 per cent. of the energy of the falling water wherever we like. The waste forces of Nature are thus within our reach. The waterfalls of Wales may be utilised in London; the torrents of the Highlands may work the tramways of Edinburgh; the wasted horse-power of Niagara may light up New York. The falls of Bushmills actually do work the tramway from Portrush to the Giant's Causeway, and those of Bessbrook the line from Newry to Bessbrook. Lord Armstrong lights his house at Craigside by a waterfall in his grounds.

The practicability of the transmission of energy by currents is assured, and the economy of doing this is a mere matter of calculation. It is a question of the relative cost of the transmission of fuel in bulk, or of the transmission of energy by wire. Coal can be delivered in London for 12s.

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per ton. The mere cost of the upkeep of a wire between Wales and London to deliver the same amount of energy would exceed this sum tenfold. For long distances the transmission of energy is at present out of the question. There can be no doubt, however, that for many purposes within limited areas the transmission of energy by electricity would be very economical and effective. Pumps are worked in the mines of the Forest of Dean, cranes are moved in the works of Easton and Anderson at Erith, lifts are raised in Banks in London; water is pumped up from wells to cisterns in the house of Sir Francis Truscott, near East Grinstead: ventilation is effected and temperature lowered in collieries; goods, minerals and fuel can be transmitted by telpherage.

The transmission of power by electricity is thus within the range of practice. It can be distributed during the day by the same mains which supply currents for light by night. Small industries, such as printing, watch-making, tailoring, boot-making, can be cheaply supplied with power. It is thus brought into direct competition with the distribution of power by steam as in America, or by air-pressure as in Paris, or by high-pressure water as in London; and the relative advantages and economies of each system are simple questions of calculation. When that evil day arrives that our supply of natural fuel ceases, then we may look to electricity to bring to our aid the waste energies of Nature—the heat of the sun, the tidal wave of the ocean, the flowing river, the roaring falls, and the raging storm.

There is a mode of transport which is likely to create a revolution in the method of working tramways. A tramcar carries a set of accumulators which supplies a current to work a motor geared to a pair of wheels of the car. The weight, price, day's work, and life of the accumulator is curiously the same as the weight, price, day's work, and life of horseflesh; but the cost of maintenance, the liability to accident, and the chances of failure are much less. Although very great improvements in batteries have been made, and they are now really practical things, sufficient experience in tramcar working has not yet been obtained to say that we have reached the proper accumulator. Nor have we yet acquired the best motor and mode of gearing; but very active experiments are being carried out in various countries, and nothing can prevent their ultimate success.

The property, which the electric current possesses, of doing work upon the chemical constitution of bodies so as to break up certain liquid compounds into their constituent parts, and marshal these disunited molecules in regular order according to a definite law upon the surfaces of metals in contact with the liquid where the current enters and exists, has led to immense industries in electro-metallurgy and electro-plating. The extent of this industry may be gathered from the fact that there are 172 electro-platers in Sheffield and 99 in Birmingham. The term electro-metallurgy was originally applied to the electro-deposition of a thin layer of one metal on another; but this is now known as electro-plating.

In 1839 Jacobi in St. Petersburg and Spencer in Liverpool laid the foundations of all we know of these interesting arts. Copper was deposited by them so as to obtain exact reproductions of coins, medals, and engraved plates. The first patents in this country and in France were taken out by Messrs. Elkington, of Birmingham, who still occupy the foremost position in the country.

The fine metals (gold and silver) are deposited in thin layers on coarser metals, such as German silver, in immense quantities. Christofle, of Paris, deposits annually six tons of silver upon articles of use and of art, and if the surfaces so electro-plated were spread out continuously they would cover 140 acres.

The whole of the copper plate used in Southampton for the production of our splendid Ordnance survey maps are deposited by current on matrices taken from the original engraved plates, which are thus never injured or worn, are always ready for addition or correction, while the copies may be multiplied at pleasure and renewed at will.

Nickel-plating, by which the readily oxidisable metals like iron are coated with a thin layer of the more durable material nickel, is becoming a great industry; the trappings of harness, the exposed parts of machinery, the fittings of cycles and carriages and innumerable articles of daily use are being rendered not only more durable but more beautiful.

The electro-deposition of iron, as devised by Jacobi and Klein, in the hands of Prof. Roberts-Austen, F.R.S., is giving very interesting results. The dies for the coins which were struck at our Mint on the occasion of the Jubilee of the Queen were modelled in plaster, reproduced in intaglio by the electro-deposition of copper, and on these copper moulds hard excellent iron in layers of nearly $\frac{1}{10}$th of an inch was deposited.

The exact processes of measurement, which have led to such vast improvement in our telegraphic systems, have scarcely yet penetrated into this field of electrical industry, and little is known at present of the exact relations of current and electromotive force with respect to surfaces of contact, rate of deposit and resistance of liquids. Captain Sankey, R.E., of the Ordnance Survey Department, has done some useful work in this direction.

The extraction of metals from their ores by deposition has received wide application in the case of copper. In 1871 Elkington proposed to precipitate copper electrolytically from the fused sulphide of copper and iron known to the copper smelter as "regulus." Thin copper plates were arranged to receive the deposited copper while the foreign metals, including gold and silver, fell to the bottom of the solution, the process being specially applicable, it was supposed, to regulus containing small quantities of the precious metals.

The electrical purification of copper from impure "blister copper" or "blade copper" has also made great progress, and special dynamos are now made which will, with an expenditure of 100 horse-power, precipitate 18 tons of copper per week. The impure metal is made to form the anode in a bath of sulphate of copper, the metal being deposited in the pure form on a thin copper cathode. It was not very long ago considered very economical to absorb ·85 horse-power in depositing one pound of copper per hour, but now the same work can be done with ·3 horse-power. Mr. Parker, of Wolverhampton, has done good work in this direction, and his dynamos in Messrs. Bolton's works have revolutionised this process. Both at Swansea and Widnes immense quantities of copper, in spite of the restrictive operations of the copper syndicate, are being produced by electro-deposition. Copper steam pipes for boilers are now being built up of great firmness, fine texture, and considerable strength, by Mr. Elmore, at Cockermouth, by electro-deposition on a rotating mandrel in a tank of copper. By this process one ton of copper requires only a little more than one ton of coal to raise the requisite steam to complete the operation.

It has been shown that the electrolytic separation of silver from gold by similar methods is perfectly practicable. The value of the material to be dealt with may be gathered from the fact, communicated to the "Gold and Silver Commission" now sitting, that nearly 90,000,000 ounces of silver are annually produced, and the greater portion of this amount contains sufficient gold to render refining remunerative. Although the old acid process of "parting" gold and silver remains practically undisturbed, there seems no reason to doubt that in the future electricity will render us good service in this direction, as it has already in the purification of copper.

There is not much actual progress to report in the extraction of gold from its ores by electrical agency. The conversion of gold into chloride of gold by the direct, or indirect, action of chlorine is employed on a very large scale in [Grass Valley] California and elsewhere. This fact has led to well-directed efforts to obtain by electrolytic action, chlorine which should attack finely divided gold suspended (with the crushed ore) in the solution from which the chlorine was generated, the gold, so converted into soluble chloride, then being deposited on a cathode. The process would seem to be hopeful; but is not as yet a serious rival to the ordinary chlorination method.

In the amalgamation of gold ores much is expected from the possibility of keeping clean, by the aid of hydrogen set free by the electric current, the surfaces of amalgamated plates.

It is well known that the late Sir William Siemens considered that the electric arc might render good service in the fusion of metals with high melting points, and he actually succeeded in melting 96 ounces of platinum in ten minutes with his electrical furnace. The experiments were interrupted by his untimely death; but in the hands of Messrs. Cowles the electric arc produced by 5,000 amperes and 500 horse-power is being employed on a very large scale for the isolation of aluminium (from corundum), which is immediately alloyed *(in situ)* with copper or iron, in the presence of which it is separated.

The heating power of large currents has been used by Elihu Thomson in the United States, and by Benardos in Russia, to weld metals, and it is said to weld steel without affecting its hardness. It has even been proposed to weld together in one continuous metallic mass the rails of our railways, so as to dispense entirely with joints.

The production of chlorine for bleaching and of iodine for pharmaceutical purposes, the economical production of oxygen, are also processes now dependent on the electrolytic effect of the electric current.

It is almost impossible to enumerate the various general purposes to which electricity is applied to minister to our wants and to add to our comforts. Everyone appreciates the silent efficiency of the trembling electric bell, while all will sooner or later derive comfort from the perennially self-winding electric clock. Correct mean time is distributed throughout the length and breadth of the land by currents derived from Greenwich Observatory. Warehouses and shops are fitted with automatic contact pieces, which on any undue increase of temperature due to fire create an alarm in the nearest fire station; and at the corner of most streets a post is found with a face of glass, which on being broken enables the passer-by or the watchful and active policeman to call a fire-engine to the exact spot of danger. Our sewers are likely to find in its active chemical agency a power to neutralise offensive gases, and to purify poisonous and dangerous fluids. The germs of diseases are attacked and destroyed in their very lairs. The physician and the surgeon trust to it to alleviate pain, to cure disease, to effect organic changes beyond the reach of drugs. The photographer finds in the brilliant rays of the arc lamp a sun which enables him to pursue his lucrative business at night, or during the dark and dismal hours of a black November fog of London.

We learn from the instructive and interesting advertising columns of our newspapers that "electricity is life," and we may perhaps read in the more historical portion of the same paper that by a recent decision of the New York Parliament, "electricity is death." It is proposed to replace hanging by the more painless and sudden application of a powerful electrical charge; but those who have assisted at this hasty legislation would have done well to have assured themselves of the practical efficacy of the proposed process. I have seen the difficulty of killing even a rabbit with the most powerful induction coil ever made, and I know those who escaped and recovered from the stroke of a lightning discharge.

The fact that the energy of a current of electricity either when it flashes across an air space, or when it is forced through high resistance assumes the form of heat of very high temperature led early to its employment for firing charges of gunpowder; and for many civil, military, and naval purposes it has become an invaluable and essential agent. Wrecks like that of the Royal George at Spithead were blown up and destroyed; the faces of cliffs and quarries are thrown down; the galleries of mines and tunnels are excavated; obstructions to navigation like the famous Hell Gate, near New York, have been removed; time guns to distribute correct time are fired by currents from Greenwich at 1 p.m. In the operations for war, both for attack and defence, submarine mining has become the most important branch of the profession of a soldier and a sailor. Big guns, whether singly or in broadside, are fired; and torpedoes, when an enemy's ship unwittingly is placed over them, are exploded by currents of electricity.

An immense amount of research has been devoted to design the best form of fuse, and the best form of generator of electricity to use to explode

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them. Gun tubes for firing consist of a short piece of very fine wire embedded in some easily fusible compound, while the best form of fuse is that known as the Abel fuse, which is composed of a small, compact mass of copper phosphide, copper sulphide, and potassium chlorate. The practice in the use of generators is very various. Some, like the Austrians, lean to the high-tension effects of static electricity; others prefer magneto machines; others use the dynamo; while we in England cling with much fondness to the trustworthy battery. Since the electric light has also become such a valuable adjunct to war purposes, it is probable that secondary batteries will become of immense service. The strong inductive effects of atmospheric electricity are a source of great danger. Many accidental explosions of fuses have occurred. An experimental cable with a fuse at one end was laid below low-water mark along the banks of the Thames at Woolwich. The fuse was exploded during a heavy thunderstorm. The knowledge of the causes of a danger is a sure means for the production of its removal, or of its reduction to a minimum. Low-tension fuses and metallic circuits reduce the evils of lightning, but have not removed them. Should war unhappily break out again in Europe, submarine mining will play a very serious part, and, paradoxical as it may appear—as has been suggested by the French ambassador, M. Waddington—its very destructiveness may ultimately prove it to be a powerful element of peace.

It seems incredible that, having utilised this great power of nature to such a wide and general extent, we should be still in a state of mental fog as to the answer to be given to the simple question—What is electricity? The engineer and the physicist are completely at variance on this point. The engineer regards electricity, like heat, light, and sound, as a definite form of energy, something that he can generate and destroy, something that he can play with and utilise, something that he can measure and apply. The physicist—at least some physicists, for it is difficult to find any two physicists that completely agree with each other—regard electricity as a peculiar form of matter pervading all space as well as all substances, together with the luminiferous ether which it permeates like a jelly or a sponge. Conductors, according to this theory, are holes or pipes in this jelly, and electrical generators are pumps that transfer this hypothetical matter from one place to another. Other physicists, following Edlund, regard the ether and electricity as identical, and some, the disciples of Helmholtz, consider it as an integral constituent of nature, each molecule of matter having its own definite charge, which determines its attraction and its repulsion. All attempts to revive the Franklinian, or material theory of electricity, have, however, to be so loaded with assumptions, and so weighted with contradictions, that they completely fail to remove electricity from the region of the mysterious. It is already extremely difficult to conceive the existence of the ether itself as an infinitely thin, highly elastic medium, filling all space employed only as the vehicle of those undulatory motions that give us light and radiant heat. The material theory of electricity requires us to add to this another incomprehensible medium embedded or entangled in this ether, which is not only a medium for motion, but which is itself moved. The practical man, with his eye and his mind trained by the stern realities of daily experience, on a scale vast compared with that of the little world of the laboratory, revolts from such wild hypotheses, such unnecessary and inconceivable conceptions, such a travesty of the beautiful simplicity of nature.

He has a clear conception of electricity as something which has a distinct objective existence, which he can manufacture and sell, and something which the unphilosophic and ordinary member of society can buy and use. The physicist asserts dogmatically: "Electricity may possibly be a form of matter—it is not a form of energy." The engineer says distinctly: "Electricity is a form of energy—it is not a form of matter; it obeys the two great developments of the present generation—the mechanical theory of heat and the doctrine of the conservation of energy." There must be some cause for this strange difference of views. It is clear that the physicist and the engineer do not apply the term electricity to the same thing. The engineer's electricity is a real form of energy; the speculative philosopher's electricity is a vague subjective unreality which is only a mere factor of energy and is not energy itself. This factor, like force, gravity, life, must, at any rate for the present, remain unknowable. It is not known what force is; neither do we know what is matter or gravity. The metaphysician is even doubtful as regards time and space. Our knowledge of these things commences with a definition. The human mind is so unimpressionable, or language is so poor, that writers often cannot agree even on a definition. The definition of energy is capacity for doing work. We practical men are quite content to start from this fiducial line, and to affirm that our electricity is a something which has a capacity for doing work; it is a peculiar form of energy. The physicist may speculate as much as he pleases on the other side of this line. He may take the factors of energy, and mentally play with them to his heart's content; but he must not rob the engineer of his term *electricity*. It is a pity that we cannot settle our difference by changing the term. Physicists might leave the term *electricity* to the form of energy, which is an objective reality, and which the ordinary mortal understands; while engineers would be quite content if speculative physicists and enthusiastic mathematicians would call their subjective unreality, their imaginary electrical matter, by some other term. If it be necessary to mentally create some imaginary matter to fulfil the assumptions and abstractions of their mathematical realisations, let them call it *coulombism* or *electron*, and not appropriate the engineer's generic and comprehensive term electricity. The engineer finds the motions of existing matter and of the ether quite sufficient to meet all his requirements, and to account for all those phenomena which are called electrical.

It seems paradoxical to assert that two unrealities can form a reality, or that two subjective ideas can become an objective one; but it must be remembered that in all electrical phenomena that which makes them real and objective is derived from without. The motion that renders an electrical phenomenon evident is imparted to it from some other form of energy. The doctrine of the conservation of energy asserts that energy is never destroyed, it is only transformed—work must be done to render it evident. No single electrical effect can be adduced which is not the result of work done, and is not the equivalent of energy absorbed. The engineer's notion of work—something done against resistance; and of power—the rate at which this change of condition is effected—are the keystones to the conception of the character of those great sources of power in nature whose direction to the uses and convenience of man is the immediate profession of those who generally assemble together in Section G of the British Association to discuss the "practical application of the most important principles of natural philosophy which has, in a considerable degree, realised the anticipations of Bacon and changed the aspect and state of affairs in the whole world."

I cannot pretend to have given a survey of all the practical applications of electricity; I have but briefly indicated the present area covered by the new and rapidly-growing industry. 5,000,000 people upon the globe are now dependent on the electric current for their daily bread; scarcely a week passes without some fresh practical application of its principles, and we seem to be only on the shore of that sea of economy and beneficence which expands with every new discovery of the properties of electricity, and spreads already beyond the mental grasp of any one single worker.

MATHEMATICAL AND PHYSICAL SECTION (A).

PROFESSOR G. F. FITZGERALD'S ADDRESS.

The British Association in Bath, and especially we here in Section A, have to deplore a very great loss. We confidently anticipated profit and pleasure from the presence in this chair of one of the leading spirits of English science, Dr. Schuster. We deplore the loss and we deplore the cause of it. It is always sad when want of strength makes the independent dependent, and it is doubly sad when a life's work is thereby delayed; and to selfish humanity it is trebly sad when, as in this case, we ourselves are involved in the loss. And our loss is great. Dr. Schuster has been investigating some very important questions. He has been studying electric discharges in gases, and he has been investigating the probably allied question of the variations of terrestrial magnetism. We anticipated his matured pronouncements upon these subjects, and also the advantage of his very wide general information upon physical questions, and the benefit of his judicial mind while presiding here.

As to myself, his substitute, I cannot express how much gratified I feel at the distinguished honour done me in asking me to preside. It has been one of the ambitions of my life to be worthy of it, and I will do my best to deserve your confidence; man can do no more, and upon such a subject "the less said the soonest mended."

I suppose most former occupants of this chair have looked over the addresses of their predecessors to see what sort of a thing was expected from them. I find that very few had the courage to deliver no address. Most have devoted themselves to broad general questions, such as the relations of mathematics to physics, or more generally deductive to inductive science. On the other hand, several have dealt each with his own speciality. On looking back over these addresses my attention was specially arrested by the first two past presidents of this section, whose bodily presence we cannot have here. They were presidents of Section A in consecutive years. In 1874 Provost Jellett occupied this chair, and in 1875 Prof. Balfour Stewart occupied it. Both have gone from us since the last meeting of this Association. Each gave a characteristic address. The Provost, with the clearness and brilliancy that distinguished his great intellect, plunged through the deep and broad questions surrounding the mechanism of the universe, and with impassioned earnestness claimed on behalf of science the right to prosecute its investigations until it attains, if it ever does attain, to a mechanical explanation of all things. This intrepid honesty to carry to their utmost the principles of whose truth he was convinced, the utter abhorence of the shadow of double dealing with truth, was eminently characteristic of one whom all, but especially we of Trinity College, Dublin, will long miss as a lofty example of the highest intellectual keenness and honesty, and mourn as the truest-hearted friend, full of sympathy and Christian charity. In 1875 Prof. Stewart gave us a striking example of the other class of address in a splendid exposition of the subject he did so much to advance, namely, solar physics. He brought together from the two great storehouses of his information and speculation a brilliant store, and displayed them here for the advancement of science. Him, too, all science mourns. Though, from want of personal acquaintance, I am unequal to the task of bringing before you his many abilities and great character, you can each compose a fitting epitaph for this well-known great one of British science. In this connection I am only expressing what we all feel when I say how well timed was the Royal bounty recently extended to his widow. At the same time the niggardly recognition of science by the public is a disgrace to the enlightenment of the nineteenth century. What chancellor or general, with his tens of thousands, has done that for his country and mankind that Faraday, Darwin, and Pasteur have done? The "public" now are but the children of those who murdered Socrates, tolerated the persecution of Galileo, and deserted Columbus.

In a presidential address on the borderlands of the known delivered from this chair the great Clerk Maxwell spoke of as an undecided question whether electro-magnetic phenomena are due to a direct action at a distance or are due to the action of an intervening medium. The year 1888 will be ever memorable as the year in which this great question has been experimentally decided by Hertz in Germany and, I hope, by others in England. It has been decided in favour of the hypothesis that these actions take place by means of an intervening medium. Although there is nothing new about the question, and although most workers at it have

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long been practically satisfied that electro-magnetic actions are due to an intervening medium, I have thought it worth while to try and explain to others who may not have considered the problem what the problem is and how it has been solved. A presidential address such as this is not for specialists; it is for the whole section; and I would not have thought of dealing with this subject only that its immediate consequences reach to all the bounds of physical science and are of interest to all its students.

We are all familiar with this, that when we do not know all about something there are generally a variety of explanations of what we do know. Whether there is anything of which there are in reality a variety of explanations is a deep question which some have connected with the Freedom of the Will, but which I am not concerned with here. A notable example of the possibility of a variety of explanations for us is recorded in connection with an incident said to have occurred in the neighbouring town of Clifton, where a remarkable meteorological phenomenon, as it appeared to an observing scientist, was explained by others as a bulls-eye lantern in the hands of Mr. Pickwick. Another kind of example is the old explanation of water rising in a pump, that "Nature abhors a vacuum," as compared with the modern one. Nowadays, when we know as little about anything, we say, "It is the property of electricity to attract." This is really little or no advance on the old form, and is merely a way of stating that we know a fact but not its explanation. There are plenty of cases still where a variety of explanations is possible. For example, we know of no *experimentum crucis* to decide whether the people I see around me are conscious or are only automata. There are other questions which have existed, but which have been experimentally decided. The most celebrated of these are the questions between the caloric and kinetic theories of heat, and between the emission and adulatory theories of light. The classical experiments by which the case has been decided in favour of the kinetic theory of heat and the undulatory theory of light are some of the most important experiments that have ever been performed. When it was shown that heat disappeared whenever work appeared, and *vice versâ*, and so the caloric hypothesis was disproved; when it was shown that light was propagated more slowly in a dense medium than in a rare, the sciences of light and heat were revolutionised. Not but that most who had studied the subject had given their adhesion to the true theory before it was finally decided in general estimation. In fact, Rumford and Davy's experiments on heat, and Young and Fresnell's experiments on light had really decided these questions long before the erroneous views were finally abandoned. I hope that science will not be so slow in accepting the results of experiment in respect of electro-magnetism as it was in the case of light and heat, and that no Carnot will throw back science by giving plausible explanations on a wrong hypothesis. Rowland's experiment proving an electro-magnetic action between electric charges depending on their absolute and not relative velocities has already proved the existence of a medium relative to which the motion must take place, but the connection is rather metaphysical and is too indirect to attract general attention. The importance of the striking experiments was that they put the language of the wrong hypothesis out of fashion. Elementary text-books that halted between two opinions, and, after the manner of text-books, leant towards that enunciated in preceding text-books, had all perforce to give prominence to the true theory, and the whole rising generation began their researches from a firm and true standpoint. I anticipated the same results to follow Hertz's experimental demonstration of a medium by which electro-magnetic actions are produced. Text-books which have gradually been invoking lines of force in some respects to the aid of learners and in others to their bewilderment, will now fearlessly discourse of the stresses in the ether that cause electric and magnetic force. The younger generation will see clearly in electro-magnetic phenomena the working of the all-pervading ether, and this will give them a firm and true standpoint for further advances.

And now I want to spend a short time in explaining to you how the question has been decided. An illustrative example may make the question itself clearer, and so lead you to understand the answer better. In colloquial language we say that balloons, hot air, &c., rise because they are light. In old times this was stated more explicitly, and therefore much more clearly. It was said that they possessed a quality called "levity." "Levity" was opposed to "heaviness." Heaviness made things tend downwards, levity made things tend upwards. It was a sort of action at a distance. At least it would have required such a hypothesis if it had survived until it was known that heaviness was due to the action of the earth. I expect levity would have been attributed to the direct action of heaven. It was comparatively recently in the history of mankind that the rising of hot air, flames, &c., was attributed to the air. Everybody knew that there was air, but it was not supposed that the upward motion of flames was due to it. We now know that this and the rising of balloons are due to the difference of pressure at different levels in the air. In a similar way we have long known that there is an ether, an all-pervading medium, occupying all known space. Its existence is a necessary consequence of the undulatory theory of light. People who think a little, but not much, sometimes ask me "Why do you believe in the ether? What's the good of it?" I ask them, "What becomes of light for the eight minutes after it has left the sun before it reaches the earth?" When they consider that they observe how necessary the ether is. If light took no time to come from the sun there would be no need of the ether. That it is a vibratory phenomenon, that it is affected by matter it acts through—these could be explained by action at a distance very well. The phenomena of interference would, however, require such complicated and curious laws of action at a distance as practically to put such a hypothesis out of court or else be purely mathematical expressions for wave propagation; in fact, anything except propagation in time is explicable by action at a distance. It is the same in the case of electro-magnetic actions. There were two hypotheses as to the causes of electro-magnetic actions. One attributed electric attraction to a property of a thing called electricity, to attract at a distance, the other attributed it to a pull exerted by means of the ether, somewhat in the way that air pushes balloons up. We do not know what the structure of the ether is by means of which it can pull, but neither do we know what the structure of a piece of India-rubber is by means of which it can pull, and we might as well ignore the India-rubber, though we know a lot about the laws of its action, because we do not know its structure, as to ignore the ether because we do not know its structure. Anyway, what was wanted was an experiment to decide between the hypothesis of direct action at a distance and of action by means of a medium. At the time that Clerk Maxwell delivered his address no experiment was known that could decide between the two hypotheses. Specific inductive capacity, the action of intervening matter, the delay in telegraphing, the time propagation of electro-magnetic actions by means of conducting material—these were known, but he knew that they could be explained by means of action at a distance, and had been so explained. Waves in a conductor do not necessarily postulate action through a medium such as the ether. When we are dealing with a conductor and a thing called electricity running over its surface, we are, of course, postulating a medium on or in the conductor, but not outside it, which is the special point at issue. Clerk Maxwell *believed* that just as the same air that transmits sound is able by differences of pressure—*i.e.*, by means of its energy per unit volume—to move bodies immersed in it, so the same ether that transmits light causes electrified bodies to move by means of its energy per unit volume. He believed this, but there was no experiment known then to decide between this hypothesis and that of direct action at a distance. As I have endeavoured to impress upon you, no *experimentum crucis* between the hypotheses is possible except an experiment proving propagation in time either directly, or indirectly by an experiment exhibiting phenomena like those of the interference of light. A theorist may speak of propagation of actions in time without talking of a medium. This is all very well in mathematical formulæ, but, as in the case of light, we must consider what becomes of it after it has left the sun and before it reaches the earth, so every hypothesis assuming action in time really postulates a medium whether we talk about it or not. There are some difficulties surrounding the complete interpretation of some of Hertz's experiments. The conditions are complicated, but I confidently expect that they will lead to a decision on most of the outstanding questions on the theory of electro-magnetic action. However, there is no doubt that he has observed the interference of electro-magnetic waves quite analogous to those of light, and that he has proved that electro-magnetic actions are propagated in air with the velocity of light. By a beautiful device Hertz has produced rapidly alternating currents of such frequency that their wave-length is only about two metres. I may pause for a minute to call your attention to what that means. These waves are propagated three hundred thousand kilometres in a second. If they vibrated three hundred thousand times a second the waves would be each a kilometre long. This rate of vibration is much higher than the highest audible note, and yet the waves are much too long to be manageable. We want a vibration about a thousand times as fast again with waves about a metre long. Hertz produced such vibrations, vibrating more than a hundred milion times a second. That is, there are as many vibrations in one second as there are seconds—in a day? No, far more. In a week? No, more even than that. The pendulum of a clock ticking seconds would have to vibrate for four months before it would vibrate as often as one of Hertz's vibrators vibrates in one second. And how did he detect the vibrations and their interference? He could not see them; they are much too slow for that; they should go about a million times as fast again to be visible. He could not hear them; they are much too quick for that. If they went a million times more slowly they would be well heard. He made use of the principle of resonance. You all understand how by a succession of well-timed small impulses a large vibration may be set up, it explains many things, from speech to spectrum analysis. It is related that a former Marquis of Waterford used the principle to overturn lamp-posts; his ambition soared above knocker-wrenching. So that it is a principle known to others besides scientific men. Hertz constructed a circuit whose period of vibration for electric currents was the same as that of his generating vibrator, and he was able to see sparks, due to the induced vibration, leaping across a small air space in this resonant circuit. The well-timed electrical impulses broke down the air-resistance just as those of my Lord of Waterford broke down the lamp-post. The combination of a vibrating generating circuit with a resonant-receiving circuit is one that I spoke of at the meeting of the British Association at Southport as one by which this very question might be studied. At the time I did not see any feasible way of detecting the induced resonance; I did not anticipate that it could produce sparks. By its means, however, Hertz has been able to observe the interference between waves incident on a wall and the reflected waves. He placed his generating vibrator several wave-lengths away from a wall, and placed the receiving resonant circuit between the generator and the wall, and in this air-space he was able to observe that at some points there were hardly any induced sparks, but at other and greater distances from his generator they reappeared to disappear again in regular succession at equal intervals between his generator and the wall. It is exactly the same phenomenon as what are known as Lloyd's bands in optics, which are due to the interference between a direct and a reflected wave. It follows hence that, just as Young's and Fresnell's researches on the Interference of Light prove the undulatory theory of optics, so Hertz's experiment proves the ethereal theory of electro-magnetism. It is a splendid result. Henceforth I hope no learner will fail to be impressed with the theory—hypothesis no longer—that electro-magnetic actions are due to a medium pervading all known space, and that it is the same medium as the one by which light is propagated, that non-conductors can and probably always do, as Prof. Poynting has taught us, transmit electro-magnetic energy. By means of variable currents energy *is* propagated into space with the velocity of light. The rotation of the earth is being

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slowly stopped by the diurnal rotation of its magnetic poles. This seems a hopeful direction in which to look for an explanation of the secular precession of terrestrial magnetism. It is quite different from Edlund's curious hypothesis that free space is a perfect conductor. If this were true, there would be a pair of great antipodes outside the air, and terrestrial magnetism would not be much like what it is, and I think the earth would have stopped rotating long ago. With alternating currents we *do* propagate energy through non-conductors. It seems almost as if our future telegraph cables would be pipes. Just as the long sound waves in speaking tubes go round corners, so these electro-magnetic waves go round corners if they are not too sharp. Prof. Lodge will probably have something to tell us on this point in connection with lightning conductors. The silvered glass bars used by surgeons to conduct light are exactly what I am describing. They are a glass, a non-conducting, and therefore transparent, bar surrounded by a conducting, and therefore opaque, silver sheath, and they transmit the rapidly alternating currents we call light. There would not be the same difficulty in utilising the energy of these electro magnetic waves as in utilising radiant heat. Having all the vibrations of the same period we might utilise Hertz's resonating circuits, and in any case the second law of thermodynamics would not trouble us when we could practically attain to the absolute zero of these, as compared with heat, long period vibrations.

We seem to be approaching a theory as to the structure of the ether. There are difficulties from diffusion in the simple theory that it is a fluid full of motion, a sort of vortex sponge. There were similar difficulties in the wave theory of light owing to wave propagation round corners, and there is as great a difficulty in the jelly theory of the ether arising from the freedom of motion of matter through it. It may be found that there is diffusion or it may be found that there are polarised distributions of fluid kinetic energy which are not unstable when the surfaces are fixed; more than one such is known. Osborne Reynolds has pointed out another, though in my opinion less hopeful, direction in which to look for a theory of the ether. Hard particles are abominations. Perhaps the impenetrability of a vortex would suffice. Oliver Lodge speaks confidently of a sort of chemical union of two opposite kinds of elements forming the ether. The opposite sides of a vortex ring might perchance suit, or maybe the ether, after all, is but an atmosphere of some infra-hydrogen element; these two latter hypotheses may both come to the same thing. Anyway we are learning daily what sort of properties the ether must have. It must be the means of propagation of light; it must be the means by which electric and magnetic forces exist; it should explain chemical actions and, if possible, gravity.

On the vortex-sponge theory of the ether there is no real difficulty by reason of complexity why it should not explain chemical actions. In fact, there is every reason to expect that very much more complex actions would take place at distances comparable with the size of the vortices than at the distances at which we study the simple phenomena of electromagnetism. Indeed, if vortices can make a small piece of a strong elastic solid we can make watches and build steam engines and any amount of complex machinery, so that complexity can be no essential difficulty. Similarly the instantaneous propagation of gravity, if it exists, is not an essential difficulty, for vortices each occupy all space, and they act on one another simultaneously everywhere. The theory that material atoms are simple vortex rings in a perfect liquid otherwise unmoving is insufficient, but with the innumerable possibilities of fluid motion it seems almost impossible but that an explanation of the properties of the universe will be found in this conception. Anything purporting to be an explanation founded on such ideas as "an inherent property of matter to attract," or building up big elastic solids out of little ones, is not of the nature of an ultimate explanation at all; it can only be a temporary stopping place. There are metaphysical grounds, too, for reducing matter to motion and potential to kinetic energy.

These ideas are not new, but it is well to enunciate them from time to time, and a presidential address in Section A is a fitting time. Besides all this it has become the fashion to indulge in quaint cosmical theories, and to dilate upon them before learned societies and in learned journals. I would suggest, as one who has been bogged in this quagmire, that a successor in this chair might well devote himself to a review of the cosmical theories propounded within the last few years. The opportunities for piquant criticism would be splendid.

Returning to the sure ground of experimental research, let us for a moment contemplate what is betokened by this theory that in electromagnetic engines we are using as our mechanism the ether, the medium that fills all known space. It was a great step in human progress when man learnt to make material machines, when he used the elasticity of his bow and the rigidity of his arrow to provide food and defeat his enemies. It was a great advance when he learnt to use the chemical action of fire; when he learnt to use water to float his boats and air to drive them; when he used artificial selection to provide himself with food and domestic animals. For two hundred years he has made heat his slave to drive his machinery. Fire, water, earth, and air have long been his slaves, but it is only within the last few years that man has won the battle lost by the giants of old, has snatched the thunderbolt from Jove himself, and enslaved the all-pervading ether.

The Indo-European Telegraph.—The second cable of the Indian Government, broken between Bushire and Jask, in the Persian Gulf, on the 13th ult., was repaired on the 1st inst., thus re establishing duplicate communication with Australia, China, and India, &c., by the Indo-European line. The delay caused by the breakage has been entirely worked off.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

CHAPTER IX.—*Magnetic Fields.*

(Continued from page 533.)

SECTION II.—ELECTRO-MAGNETIC FIELDS.

127. *Preliminary.*—The telegraph systems of Morse and Wheatstone, with their relay and translating apparatus, electric bells and telephone exchange annunciators, systems for the synchronising of clocks, and a large proportion of the industrial applications of electricity, depend for their action upon that great discovery made by Arago and Davy nearly seventy years ago, viz, that pieces of iron, steel, and other magnetic metals become magnetised when an electric current is passed through a coil of insulated wire surrounding them. A magnet so formed is termed an *electro-magnet.* Incidentally here we may remark that metals which are said to be *magnetic* are not necessarily magnetised, the terms magnetic and non-magnetic indicating simply whether they are or are not *capable of being magnetised.* The two important principles of the electro-magnet may be thus stated :—

1. Reversal of the direction of current round the iron causes a reversal of its magnetic polarity.

2. Cessation of the current causes almost complete disappearance of magnetic polarity in the case of soft annealed iron.

To this might be added the important aid now available for the manufacture of powerful steel magnets magnetised electromagnetically with the aid of currents now obtainable from dynamos and accumulators.

Considering the first principle—viz., that of reversal—it is found experimentally that if the current circulates in a clockwise direction round the iron core the end of the same nearest to the observer is a south pole, and *vice versâ.* This will be seen to be the case in the two Figs. 102 and 103, although the direction in which the wire is wound on is different in the two cases.

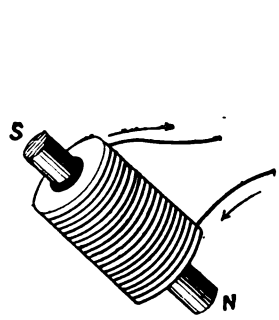

FIG. 102.

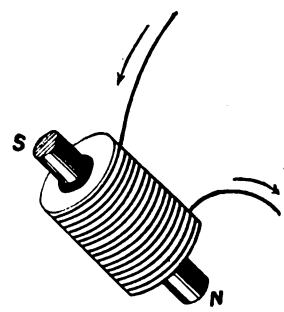

FIG. 103.

The winding of the coil or helix in Fig. 102 is called right-handed, the wire being wound on in a clockwise direction; while that in Fig. 103 is left-handed; and it will be seen that, in order to produce the same magnetic polarity in each, the current must be passed through in opposite directions in each as regards the ends of the coils. The current then circulates round each core the same way, producing the same poles in each. Reversing the current in either of these reverses the polarity.

An iron-filing diagram, taken with the electro-magnet of an ordinary telegraph "sounder," is shown in Fig. 104, a current being passed through the coils. The current was adjusted till the electro-magnet just supported the weight of the armature. Here we have precisely the same delineation of field as in the previous cases of permanent magnets. The two upright cores of soft iron are screwed to the horizontal iron keeper or "yoke" (Y).

The magnetic circuit is indicated by the dotted lines through the two cores and the yoke in Fig. 105, where it will be seen

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that this circuit completes itself through the air between the two poles by the curved lines of force, one typical line being shown in the figure. The direction assumed for these lines has already been explained (para. 104), and is marked by arrow heads in the figure. Now, when there is an iron "armature" in proximity to the poles of the electro-magnet, most of the

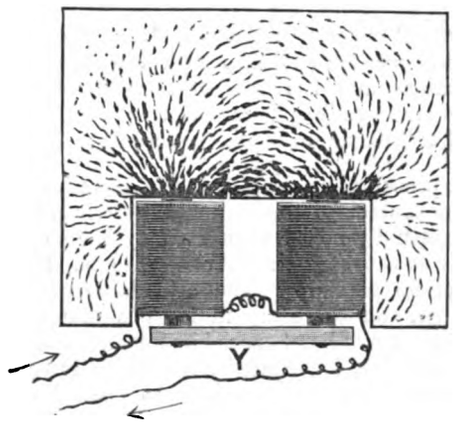

FIG. 104.

lines of force are deflected, or turned from their original direction, and pass through the armature (Fig. 106). Noticing the direction in which these lines pass through the interior of the armature it will be clear (para. 104) that the latter becomes magnetised, its poles, *s n*, being as shown. Attraction must, therefore follow, and the armature is drawn towards the poles, N S, against the force of the counteracting spring. Every

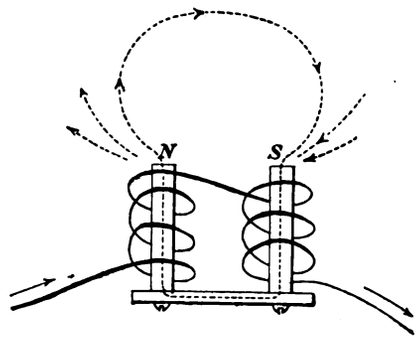

FIG. 105.

time the electrical circuit is completed by means of a "key" (*see* Fig. 34) this attraction occurs, and ceases when the circuit is broken, by means of which, with the Morse code of signals made up of dots and dashes, signals can be sent from one end of a line to the other, and read by sound, or by the ink-writer, as the case may be.

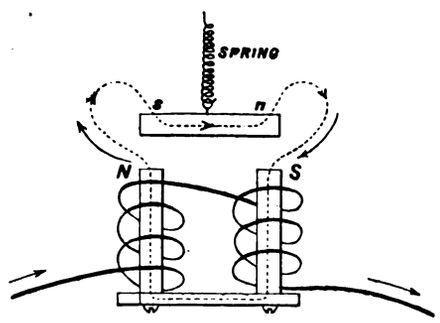

FIG. 106.

If we take an iron-filing diagram of the field when the armature is held away from the poles, or placed far enough away not to yield to the attraction (Fig. 107), the deflection of the lines of force through the armature is made evident; the position of the armature being seen by the absence of any filings, since the latter only take up the position of the curves of force through the air. We have here between the armature and the poles of the electro-magnet what is termed "magnetic induction"—that is, the magnetism of the armature is "induced" in it by the action of the poles of the electro-magnet; or we may look at it another way, viz., the armature

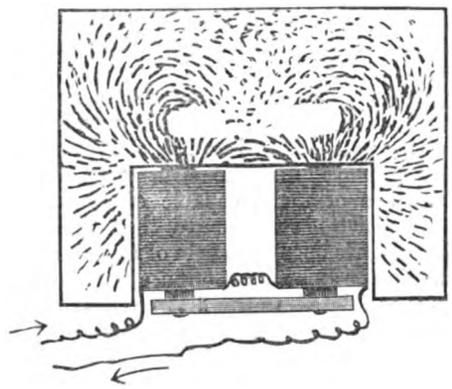

FIG. 107.

is placed in a magnetic field, and immediately becomes a magnet itself by "induction" from the field.

It will be seen by the figures (105 and 106) that the current must pass round the two cores of the electro-magnet in the opposite direction to produce opposite poles at the upper end of the cores. The winding for this is easy to remember by considering the two cores as put end to end where they join the yoke, so as to make one bar; the winding is then a simple helix wound continuously along the bar, in order to produce opposite poles at the extremities.

In the rapid transmission of signals it is very important to overcome, as far as possible, the *time* taken by the electro-magnet to become magnetised and demagnetised. To overcome this retarding effect of the coils, which is a property depending on their self-induction, the two coils are wound in multiple arc (paras. 41 and 61), as shown in Fig. 108, for the fast-speed Wheatstone receivers. More will be said upon this point when self-induction is considered.

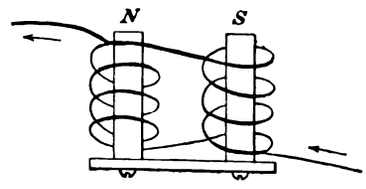

FIG. 108.

If the cores were not connected together by the yoke, the poles of the electro-magnet would be much feebler, because there would then be two air gaps to be bridged over by the lines of force instead of one. Further, if a complete circuit of iron were formed by bridging over both upper and lower pairs of core ends by yokes, there would be many more lines of force created through the interiors of the cores, but there would be practically no external field. An external field is, however, required in the case of a "sounder" to cause attraction of its armature, and therefore the only air gap left is that immediately beneath it. The rule is, let there be a magnetic circuit of iron everywhere except in the particular position where external magnetic action is required.

(*To be continued.*)

Bridlington Quay.—At a Local Board meeting on Tuesday the question of lighting the Sea Wall Parade with electric light was brought forward, and a resolution passed instructing the committee to ascertain upon what terms it could be done.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *August 25th*, 1888.

Last week I sent to you a description of the new meter which is patented by Prof. Forbes, which is a variation of his well-known mill wheel coulomb meter. This week I note that another patent has been issued on a like meter, designed for electric current, by Mr. O. B. Shallenberger, the electrician of the Westinghouse Company. This meter is simple in construction, and depends upon a quite novel principle. As described in the patent issued to Mr. Shallenberger, the principal elements employed in the construction of the meter are :—First, an armature of metal capable of rotation; second, an electric circuit, which is so arranged that when it is traversed by alternating electric currents a field of force is induced, having a given polar line or axis with reference to the armature; and third, a circuit so related to the first circuit that currents are produced in such second circuit by the action of those in the first, the phases of which succeed those of the currents in the first circuit, and set up for the armature a second field of force, the axis of which intersects that of the first. The armature may be built of soft iron, or of copper or other non-magnetic metal, or it may be composed of a core of soft iron, having a conducting circuit of other material surrounding. The meter is said to respond to the currents traversing the coils in such a manner as to obtain a reliable and accurate measurement of the current, the number of revolutions performed in a given time being directly proportional to the current consumed during that time. By the arrangement of circuits in this fashion the fields of force set up between the coils of the armature are such as to cause an attraction between them which sets the armature in rotation when the alternating currents pass through the coils. The shaft to which the armature, which is in the form of a disc, is attached, carries vanes which retard the motion of the armature in the same ratio as the tendency to rotation increases—that is, as the square of the speed, being thus in exact relation to the square of the current. I learn that this form of meter has been in successful operation at the Westinghouse factory, and that it will soon be put out on central station work.

A circular has been distributed in this country, which is causing no small amount of comment among the patent attorneys and electric light people. It purports to come from Shippey Brothers (Limited), of London, England. The circular states that a convention of patent experts was held recently at Washington to discuss certain questions in connection with incandescent lamp manufacture, and that the said convention gave an award to the firm which conferred upon it the monopoly of the manufacture of incandescent lamps of 100 candle-power and upwards. It is also stated that the convention gave a certificate as to the priority of invention to the same people for fancy striped and coloured lamps for decorative lighting. Everybody wants to know what it all means. I have still to meet an electrical expert who attended the said convention, and I have still to learn of any firm that took steps to call the said convention together. The circular states that the Shippey firm do not intend to manufacture lamps, but will maintain their rights under patents referred to, and will grant licenses on royalty the French, Belgian, and American patents being for sale. Why anybody in England or anywhere else abroad should imagine for a moment that such a convention, if it were held, could adjudicate on the value of patents, I am utterly at a loss to understand. It would seem as if an explanation from Shippey Brothers was in order.

The American Association for the Advancement of Science is holding its annual meeting at Cleveland from the 15th to the 22nd of this month. Reports from Cleveland would indicate that a very enjoyable and profitable meeting has been held during the present week. Over 300 members were in attendance, and the influx to the city of other visitors has, of course, been large. Some Papers of interest to electricians have been read, and others will probably follow. One of the most interesting is that by Prof. A. A. Michelson, of the Case School of Applied Science at Cleveland, "On the Desirability of Utilising Light Waves in Establishing Standards of Measurement." Another Paper of interest was that by Prof. E. L. Nichols and Mr. W. S. Franklin "On Experiments as to the Direction and Velocity of Electric Currents." A valuable Paper with practical bearing was that by Mr. C. J. H. Woodbury "On the Protection of Watches from Magnetism," and Mr. Woodbury pointed out that with the rapidly extending use of dynamos and the general introduction of motors, especially on street railways, watches that were unaffected by magnetism had become an absolute necessity.

Extensive preparations are now being made for the meeting in this city next week of the National Electric Light Association. It is generally hoped that we may have cool weather, as attendance at the sessions will otherwise be deprived of a good deal of its pleasure. The attendance promises to be unusually large, and there are indications that some of the Papers to be read will be of special importance and value. Dr. Schuyler S. Wheeler, for example, the energetic young expert of the Board of Electrical Control, is to present a Paper on "Electrical Conductors" in New York City; and Mr. W. Lee Church, whose excellent Paper on the advantages of small high-speed engines in stations instead of large low-speed engines attracted so much favourable notice at home and abroad a few months ago, will present another Paper on the topic "Electrical Steam Engineering." Other Papers are promised on special features of motor work and on the measurement of alternating currents for commercial purposes. This meeting will be immediately followed at the same place by the annual gathering of the National Telephone Exchange Corporation. This body, by the very nature of things, and unlike the Electric Light Association, has no tendency to rapid increase of membership, but still it maintains its organisation and affords the telephone men an opportunity to get together to discuss questions of special interest.

I note that the *Electrical World* this week issues a special supplement, entitled "A Day with Edison at Schenectady," describing a visit made to the Edison machinery works at that place. An interesting description of the works is given, supplemented by a large number of fine illustrations, which convey even more vividly than words an idea of the magnitude of the operations there carried on. It appears that the works employ from 700 to 800 men all the year round, and that it is nothing unusual to have in hand 200 or 300 dynamos, and 300 or 400 motors at the same time.

CORRESPONDENCE.

MR. KAPP'S REPORT ON THE LINEFF SYSTEM OF ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your reprint of my report on the Lineff system of electric traction there is a typographical error on page 544. The pressure at which current is supplied to the cars should be 280 and not 230 volts, as will be evident from the fact that I have fixed the working pressure at the station at 300 volts, and the loss of pressure along the line at 20 volts.—Yours, &c.,

Wimbledon, August 31, 1888. GISBERT KAPP.

UNIPOLAR INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In my letter on this subject in last week's *Electrician*, third line, for "incompatible" please read *as* compatible. This error, for which bad caligraphy is responsible, completely mars the meaning of the first paragraph.—Yours, &c.,

Staveley, 31st August, 1888. R. SNOWDON.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: As Mr. Snowdon's letter (after correcting the misprint of incompatible for compatible in its first paragraph) contains no addition to the discussion beyond his statement that he has "shown" what, as a matter of fact, he has simply asserted, it is unnecessary for me to trespass further on your space, as your readers will have no difficulty in assigning their proper weight to Mr. Snowdon's "proofs."—Yours, &c.,

G. W. DE TUNZELMANN.

THE RECHNIEWSKI ALTERNATE-CURRENT MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of Aug. 24 you illustrate a machine designed by Mr. W. C. Rechniewski, stated to be manufactured by us. We must beg, however, to correct one or two mistakes. The machine illustrated was not constructed by us, but was built in France, and is, indeed, very French in constructive design. Further, the machine was not designed or constructed primarily with a view of working as an alternate-current motor, but as a dynamo, the view being that the use of a Pacinotti armature, together with a laminated field and poles, would give the advantages of the low magnetic resistance of the former, with the absence of Foucault currents in the poles, which generally arise from the use of this form of armature.

In the machine in question, however, which was submitted to us to test, the poles were bored with a greater clearance at the tips than in the centre, and as this form of boring (which we used in dynamos constructed in the latter end of 1885, and which has more recently been patented by Dr. Hopkinson for an analagous purpose) is quite sufficient to practically eliminate Foucault heating, the advantage of the laminated field is not apparent. Furthermore, however suitable for small dynamos, such a construction is, in our opinion, hardly solid enough for heavy machines. Of its performance as a motor we cannot speak very favourably. In our opinion the objection stated in your "Editorial Notes" on the currents induced in a coil short-circuited by the brush is fatal to the practical use of this form of motor, as with no load on it is possible to put an alternating current through it which, whilst insufficient to start it, is sufficient quickly to burn a coil out.

Even when running the same cause gives rise to very destructive sparking.—Yours, &c.,

W. T. GOOLDEN AND CO.

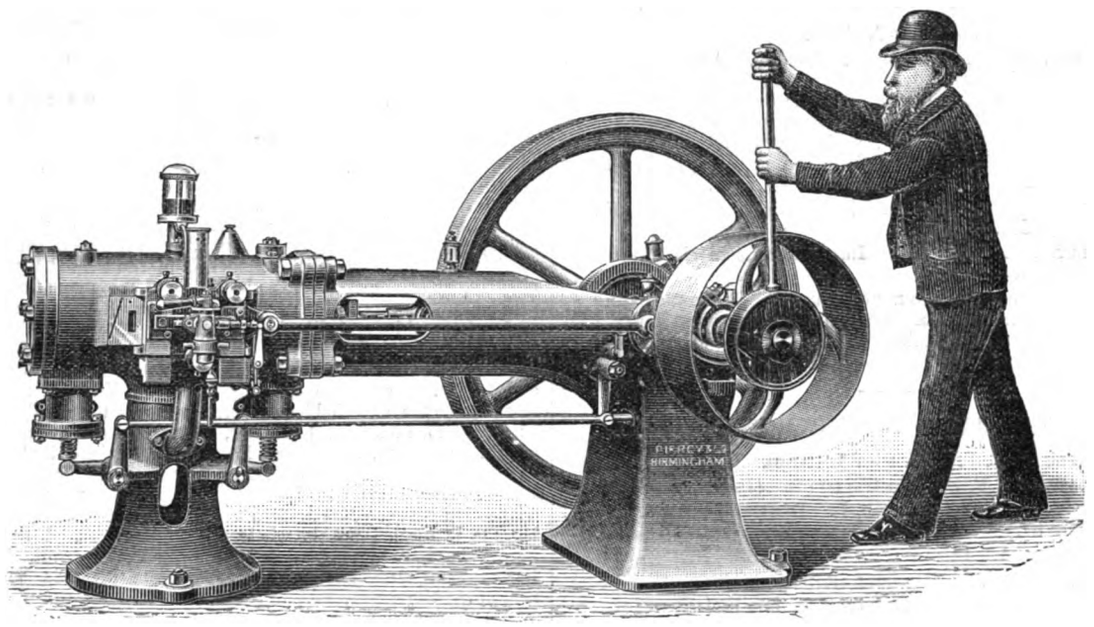
Halifax, Aug. 24, 1888.

LEA'S HAND STARTER FOR GAS ENGINES.

Lea's "Hand Starter" is designed to enable one man to do the work of two in starting a gas engine, and obviates the risk of accident attending the common practice of pulling round the fly-wheel. The attendant can start the engine without going inside the fence or handrail around the engine.

The apparatus, as will be seen in the figure, forms a smooth circular terminal at the end of the crank shaft, and is thus incapable of catching clothing, and even when the engine is running at full speed a slight pressure of the hand will arrest the motion of the body of the apparatus.

To use the starter, after lighting the igniting burner of the gas engine, the attendant places a bar or lever in one of the holes of the starter, as shown in the engraving, and works it up and down like a pump handle, thereby turning the crank shaft. When the engine begins to work the attendant ceases to work the bar, and withdraws it at leisure. The bar can be put in and taken out while the engine is at full speed.



Lea's Hand Starter for Gas Engines.

The attendant can turn the crank shaft, but the crank shaft cannot turn the attendant.

PATENT RECORD.

RECENT APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

12,198. F. T. SCHMIDT. Keighley. Improvements in electrical switches. August 24, 1888.

12,235. F. HAZLETT and J. H. PERCIVAL. London. Application of electricity to the lighting of road vehicles. August 24, 1888.

12,264. F. E. ELMORE and A. S. ELMORE. Cockermouth. Improvements in the means of preparing metallic surfaces for the reception of non adhesive electro deposits. August 25, 1888.

12,829. S. ZIANI DE FERRANTI. London. Improvements in electric propulsion on railways. August 25th, 1888.

12,290. A. SCHANSCHIEFF. London. Improvements in galvanic batteries. August 25th, 1888.

12,297. G. A. ABRATH. Sunderland. Switch-board and handles. August 25, 1888.

12,309. E. W. JOHNSTONE. London. An improved rose for electrical purposes. August 27, 1888.

12,332. J. CAUDERAY. London. Improvement in electric meters. August 27, 1888.

12,376. W. L. WISE. London. Improvements in electric accumulators, and in means for their manufacture (J. T. V. Gestel, United States). August 28, 1888.

12,383. C. WELLS. London. Improvements in electric arc lamps. August 28, 1888.

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12,395. A. J. Boult. London. Improvements in electro-therapeutic belts (H. P. Pratt, United States). August 28, 1886.

12,396. W. P. Thompson. Liverpool. Improvements in electric motors for self-winding clocks (D. W. Edgecomb, United States). August 28, 1888.

12,409. R. A. Scott. Clapham. Improvements in effecting and controlling the feed of the carbons used in the arc lamp of electric "search lights" or "projectors." August 28, 1888.

12,437. W. A. Conner and J. W. Marsh. London. Improvements in electrical conductors or cables. August 29, 1888.

12,446. J. J. Ebel. Charlton. Improvements in electric telegraphs. August 29, 1888.

12,452. A. Sandron. London. Improvements in electrical locomotives and traction engines. August 29, 1888.

12,455. J. Sherrin and J. V. Sherrin. London. Improvements in the application of primary batteries and electro-motors to tricycles and other velocipedes. August 29, 1888.

12,505. S. Ziani de Ferranti. London. Improvements in joints for electric mains. August 30, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

September 1, 1888.

13,960. A. Coleman and H. F. Jackson. London. A novel combination of spring-jack and lightning arrester for use in or with a test-board for telephone wires and means of carrying, and a method of arranging any required number of sets or apparatus formed of such combination; such invention being applicable also for the purpose of a telephone switch-board, and for other analogous electrical purposes. October 14, 1887.

14,390. R. Morris. London. An electric firing fuse or primer. October 22, 1887.

14,658. G. E. Fletcher. Stockport. Improvements in electric indicators. October 28, 1887.

9,501. W. A. S. Benson, J. Lovegrove and E. Hinton, trading as W. A. S. Benson and Co. London. An improved screw grip for adjustable lamp and other standards, and for electric pendant lamps. June 29, 1888.

SPECIFICATIONS PUBLISHED.

10,611, 1887. Milburn, R. P. Electrical batteries. (Price 6d.)

10,833, 1887. Boardman, F. R. Electric lamps. (Price 8d.)

10,952, 1887. Anspach, L., and Gerard, L. Dynamo electric machines, &c. (Price 8d.)

11,802, 1887. Shippey, A. Incandescent lamps. (Price 8d.)

12,203, 1887. Hemming, T. L. Dynamo electric machines. (Price 8d.)

13,320, 1887. Statter, J. G., and Brunton, S. L. Electric regulators. (Price 8d.)

13,558, 1887. Everitt, P., and Allen, P. R. Casings for electrical conductors, &c. (Price 8d.)

14,024, 1887. De Benardos, N. Secondary batteries. (Price 8d.)

14,029, 1887. Allsop, F. C. Electrical tramways and railways. (Price 11d.)

5,681, 1888. Snell, C. S. Electrical switches. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

Lancashire and Cheshire Telephonic Exchange Company (Limited).

The seventh annual meeting of this Company was held on Tuesday, in the Town Hall, Manchester, Mr. Alderman Joseph Thompson (the Chairman) presiding. The Directors' report was taken as read.

The Chairman moved that the report and statement of accounts be received and adopted, and that a balance dividend for the year at the rate of 7 per cent. per annum, less income-tax, be declared and paid forthwith. Referring to the death of the late Chairman, Mr. Charles Moseley, he said Mr. Moseley was most active in his work, and most kind and genial. The Directors requested him (Mr. Thompson) to take the place of Mr. Moseley. He could not but feel the great difference there was between himself and their late Chairman, who had studied the whole subject of telephony, was conversant with it, and was indefatigable in his exertions. He and his colleagues had given a great deal of time during the past year to the affairs of the Company, and he hoped the shareholders would be satisfied with the result of their labours. They would find from the report that the allocated income in 1888 was £89,797. 5s. 10d., and in 1887 it was £82,490. 14s. 6d., showing an increase of £7,306. 11s. 4d. The income in 1887 showed an increase over that of 1886 of £9,982. 1s. 4d. The service of trunk wires and call offices brought in an increase of £4,000 in 1885, and had steadily increased until now it was double what it was three years ago. The figures were—for 1885, £4,000; 1886, £5,000; 1887, £6,500; 1888, £8,000. This was most satisfactory, but it was only an indication of the great possibilities of the future. This £8,000 of income would represent the enormous number of 320,000 sixpenny telegrams. This showed one of two things—either that there had been a great disturbance of the telegraphic service in consequence of the institution of telephones, or, what was more probable, that the telephones had been an immense benefit to the commercial interests of the district. But they might also look at it in another way. It not only represented a saving of sixpence upon every message, but it allowed three minutes' conversation instead of twelve words. The number of subscribers' calls had continued to increase at the rate of about half a million a year. The aggregate number of messages sent in one year over the wires of the company was 12 millions, and these were carried at the rate of about one penny per communication, which showed what a very valuable instrument the telephone was in the hands of commercial people. There had been an increase of 1,609 miles in the length of wire in use. In 1888 they had 8,737 miles. Last year they had 7,128 miles. The company at first had some hesitation as to whether they should go beyond the large towns, or whether they should include in their system the smaller towns, and more especially whether they should connect these smaller towns with each other. After very careful consideration they decided that it was their duty, though it might not at the moment seem to be to their interest, to put as many towns as possible in communication one with the other. The Directors felt that they had obtained a very valuable concession which had practically become a monopoly, and that, having the privilege of serving towns like Manchester, Liverpool, and Blackburn, there was a certain claim on the part of the public that they should afford communication with those smaller towns. The Directors now felt that within certain limits it was very desirable in many respects to cover the country to as large an extent as possible. There was an almost boundless field open to them. They already had many towns connected with their system, but the Directors had felt that it was desirable to go even beyond their own system, and to get communication with other systems, more especially with the National Telephone Company. The main object the Directors had in this movement was, of course, to enable their subscribers to have as free communication as possible. But they also had another object in view. They felt that when their patents expired the position of the Company would be greatly strengthened if its system and the system of kindred companies covered the whole of the United Kingdom. Consequently, by arrangement with the National Telephone Company, telephonic communication had been set up between all the towns on the system of the Lancashire and Cheshire Telephonic Exchange Company and the principal towns in Yorkshire. Messages between any of the Lancashire and Cheshire towns were charged 6d. per conversation for three minutes, and for 1s. conversation could be had with Yorkshire. Since the last meeting of the shareholders several towns had been added to the trunk wire system, including Lancaster, Colne, Nelson, Brierfield, Leigh, Tyldesley, Longridge, Ribchester, Macclesfield and Bollington. Wires were in progress of erection to link up Ramsbottom, Tottington, Clitheroe, Bacup, Altrincham and Bowdon. They were very hopeful that the connection between Macclesfield and Bollington would prove very useful, because it opened up the whole of the Potteries. If sufficient support were offered, it was intended to extend the trunk line system to Barrow, for already several Manchester firms had sought this connection. Ulverston, Chester, Congleton, Wrexham, and other North Wales towns were to be included, and once the trunk system reached Wrexham they would be within a few miles of Oswestry, which was the district of the Western Counties Company, who had promised to run wires to meet them at their boundary at Oswestry whenever they were ready. This would bring the district of the Lancashire and Cheshire Telephonic Exchange Company in touch with Shrewsbury and other important towns on the Western Company's territory. The Directors had had inquiries as to whether Manchester and London could not be connected, and that subject was receiving consideration. It must be remembered, however, that it did not rest with the Lancashire and Cheshire Company so much as with the United and the National Company. He might, however, say that a wire had been run part of the way, and it was very probable that before long Manchester and Liverpool would be in direct communication with Birmingham and London. They had also had inquiries for connection with Glasgow, and if they got their system in North Lancashire, with Cumberland and Westmoreland thoroughly established, there was no reason why they should not go still further, and become connected with Glasgow. This subject also would have the careful consideration of the Directors, but a year or two might elapse before the whole programme was carried out. Judging from what had already been accomplished in a little more than three years, it was evidently only a question of time for still more to be done. He hoped the work of the Directors would have the approval of the shareholders, and that they would be encouraged to make still further progress. He desired next to refer to the switch-board arrangement at the central offices. The subscribers had felt that there were delays in obtaining communication. This, in the system formerly in vogue, was unavoidable. It was found from the experience of Liverpool and other places that by the adoption of the new American system a great improvement might be made, and at a very considerable expense the Directors had carried out the American plan. The new system was much quicker than the old. The old system was very good for small centres, but it became very tedious and caused much delay in large centres. By the new system they had been enabled to concentrate their work, and thereby they effected a considerable saving of time. An immense amount of labour was involved in concentrating all the wires into one switch-room, and bringing the new boards into operation, but, with the exception of a few days at Whitsuntide, the Manchester service was very little disturbed by the change. There had been a decrease of about £1,200 in the expenditure on maintenance. It was only right to say that this was not due to any neglect of work, nor did it indicate that there was an excessive expenditure in the two previous years. The wires that were originally laid were iron. These had gradually worn out, and had been renewed by copper

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wires. This was a great advantage, because the copper wires had a greater conductive power, and were also much thinner, and were consequently not such a disfigurement in the sky. They could be run much better in cables, and did not look so hideous as the huge iron wires used to. The condition of the plant was very good. As regarded general expense, there was every year a steady increase, but this was inevitable. He now desired to refer to their connection with the United Company. They obtained a license from that company to work in the Lancashire and Cheshire district. They were subject to them under certain conditions. The Lancashire and Cheshire Company had to pay a royalty to the United Company, and the United Company had a right to sit on the Board, audit the accounts, and say whether or not there should be a fresh issue of capital. The Lancashire Company had to get their instruments through the United Company, and it would scarcely be wondered that sometimes there was a difference of opinion between the company's Board and the London authorities. He was glad to be able to say, however, that the relations between the two were now most friendly, and that certain matters of dispute which had existed for several years were now happily settled. The patent for the instruments would shortly expire, and when that time arrived it was quite possible that there might be something like opposition, or an attempt at opposition. The directors had long felt that the old adage, "Union is strength," was true of property as of other things. That feeling also pervaded the minds of the directors of the United Company and the subsidiary companies, and the result of conferences between the directors of the several companies was that there was a possibility of their all becoming amalgamated. Already the accounts of the various companies had been placed in the hands of a first-class firm of accountants, Messrs. Griffiths, of London, and these gentlemen were trying to bring these accounts into something like harmony. When their reports were presented an earnest attempt would be made to bring about amalgamation. Whenever that should happen it would be the duty as well as the pleasure of the Directors to call the shareholders together and lay the matter before them. With a greatly increasing business it was of course necessary to have more money, but pending the settlement of the question of amalgamation it was thought undesirable to ask for a fresh issue of stock, and as a matter of fact the Directors had not required more money. Now he had to refer to the relations of the Company with the Post Office Department. These, though friendly, were not in a certain sense satisfactory. They did not quarrel with one another, but the Directors thought that the Post Office put certain restrictions on their actions which ought to be removed, and they had tried to get them removed. In February last the directors of several telephone companies had an interview with the Postmaster-General, and laid their case before him. It was thought that the Postmaster-General would make some concessions, but, he was sorry to say, up to this time they had had no answer to their appeal. The Post Office had put a restrictive hand upon the proceedings of t lephone companies. He thought it would be greatly to the interest of the commercial community if that hand was very greatly relaxed. The grievances of the telephone companies were these: Fir t, the royalty charged by the Post Office, the view of the companies being that this charge, which was an indirect form of taxation, should be removed. Even if the telephone somewhat affected the income of the Telegraph Department, what did that matter? They got increased celerity, cheapness, and convenience. The Government ought to give the telephone companies a free hand or else take them over altogether, as they did the telegraph companies. If the Government would forego their royalties on telephones the amount thus saved by the companies could be put to the credit of the subscribers, and the commercial class would thereby greatly benefit. But he was sorry to say the General Post Office did not try to benefit commerce. It seemed most arbitrary for the Government to levy a royalty and to tie the hands of the companies with licenses and restrictions upon the transmission of news. At the present time the Lancashire and Cheshire Company provided a telegram service in Manchester, Liverpool, and Blackburn; but the revenue which they derived in the shape of commission was very far short of clearing the rental charged to them by the Government for the use of the telegram wires between the three exchanges and the three post offices. Their contention was that the Post Office Department ought to provide the telegram service free of charge, both in its own interests and in the interests of public convenience. The Lancashire and Cheshire Company had been asked to provide a telegram service to subscribers in other towns than Manchester, Liverpool, and Blackburn, but the charges made by the Post Office Department prevented them from doing so. In the United States the telegraph companies, so far from charging the telephone companies for rental of wires for the telegram service, paid the telephone companies a commission on the business received by telephone. He thought it not unreasonable to expect the English Postal Department to meet the telephone companies liberally in the matter. They simply asked for free wires. To illustrate the position of the telephone companies in England he would give them the result of one year's working of the telegram service; 10,005 messages, representing a money value of £466. 19s. 9½., were sent along their wires to the post offices of Manchester, Liverpool, and Blackburn. The Lancashire and Cheshire Company charged their subscribers a commission of £41. 15s. 0½d., but the postal authorities charged the Lancashire and Cheshire Company £310 for the use of the wires, which caused a total loss to the Company of £268. 4s. 11½d. for the year, without counting the clerical labour, the stamps, and the cost of collecting the telegrams and money of their subscribers. He thought they might claim some consideration from the Postal Department by reason of the fact that their wires saved a large amount in porterage, as something like 6,000 telegrams were delivered from the three post offices direct to the subscribers of the Lancashire and Cheshire Company without the intervention of the messengers. The Company had put up the wires to the Post Office at their own cost. He thought that the telephone system ought to be connected with the Postal Telegraph Office, so that the time of the public might be saved. It was of the utmost importance that they should have call offices conveniently placed so that the public could use them. He considered it would be a great public advantage to have call offices established in every post office. In some countries this was done, and call offices also existed in railway stations. He thought the experiment ought to be tried in England, but the Telegraph Department would not allow telephone call offices to be placed in their post offices. The Postal Department had also prohibited the telephone companies supplying news messages, such as the results of elections and of cricket matches, and the cotton reports. This showed that the convenience of commerce was not considered as it ought to be. The Post Office, indeed, was more anxious to maintain a huge monopoly than to accommodate the public. It had been his experience in telephony that the greater the freedom of action the greater the volume of business, and they had a right to ask the Department to remove the restrictions they now placed upon the use of the telephone.

Mr. ELI HEYWORTH, the Deputy-Chairman, seconded the adoption of the report, and the motion was carried.

Mr. Heyworth and Mr. C. S. Agnew were re-elected Directors, and Mr. C. R. Trevor (of the firm of Pilling and Trevor) was re-appointed one of the auditors.

A vote of thanks was passed to the Chairman, and this brought the proceedings to a close.

Manchester Edison-Swan Company (Limited).

The sixth ordinary general meeting of this Company was held on Monday last, at the Memorial Hall, Manchester. In the absence of Mr. V. K. Armitage, Chairman of the Company, Sir J. C. Lee took the chair.

Mr. JOHN E. SHARPLES, the secretary, read the following report of the Directors:—The net profit, including last year's balance, amounts to £1,781. 15s. 3d., which it is proposed to appropriate as follows: To payment of dividend at 5 per cent per annum, £1,000; to reserve fund, £500; balance to be carried forward, £282. In accordance with special resolutions, passed on 5th September, 1887, and confirmed on 3rd October, 1887, the name of the Company has been changed from the Manchester and District Edison Electric Light Company to Manchester Edison-Swan Company (Limited), and a reduction of the capital has been effected by cancelling capital which has been lost, to the extent of £1 per share upon each of the 20,000 "A" shares issued, and by reducing the nominal amount of all the "A" shares in the Company's capital from £10 to £9 per share. The Company's stock and plant have now been depreciated to their present market value and all losses written off, thus leaving the assets of the Company in a sound condition, because enabling the Directors to place £809. 18s. to a depreciation fund for future contingencies. The work of the past year has, on the whole, been satisfactory, showing an increase of business with a decrease in the expenses, and the Directors think the result cannot fail to be encouraging to the shareholders. The Directors, as in previous years, do not propose to ask any remuneration for their services; but if the work of the Company continues to be successful the attention of the shareholders will be drawn to this matter at a future meeting. Since the last general meeting the Directors have to deplore the loss by death of their esteemed colleague, Mr. Charles Moseley. Mr. J. R. Williamson, the Company's manager, has been elected to fill this vacancy on the Board, and the shareholders are asked to confirm his appointment as Director. Mr. Edward Cross retires in accordance with the Company's Articles of Association. He is, however, eligible, and offers himself for re-election.

In moving the adoption of the report, the CHAIRMAN said that in accordance with the decision arrived at in September last the capital of the Company had been reduced by £1 per share. The money had actually been lost, and it was thought well, as explained by the Chairman a year ago, to look the circumstances boldly in the face, and write off the necessary amount; so that now the figures in the balance sheet only represented actual values, except, of course, the £13,000 paid for patent rights, the present value of which is difficult to determine. The report in the hands of the shareholders showed a balance of £1,781. 15s. 3d. in favour of the Company. Out of that balance it was proposed to pay a dividend of 5 per cent., which would absorb about £1,000, to place £500 to reserve fund, and to carry forward £281. 15s. 3d. to the next account. The orders received during the year would have been more numerous than they had ever been but for the difficulty in carrying the wires either over or under the streets. If the Corporation gave them permission to cross the streets, business could be done on much more advantageous terms than at present.

Mr. J. R. WILLIAMSON, who seconded the motion, said that the Act of 1882, instead of facilitating the progress of the electric light, as it was intended to do, had done the very reverse. The electric lighting companies had had their hands tied ever since. During the present year, however, action had been taken, with the result that the objectionable clauses had been altered, and no doubt a great impetus would be given to electric lighting. Large lighting stations would be established all over the country within a few years, and he expected the company would participate in much of this work. He was glad to say that the business done showed an improvement over that of any previous year, and further, as the expenses of the company had been reduced, the result was so far satisfactory that the Directors recommended a dividend of 5 per cent.

Mr. N. SHELMERDINE said that in view of the probable increase in the business of the Company, he thought it was desirable to keep their ready money and trade with it rather than declare a dividend.

The CHAIRMAN replied that the Directors had very carefully considered the matter, and they thought the shareholders should share in any advantages that had been gained by careful trading. There was now every prospect of the Company becoming a dividend-paying company.

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The motion was then put to the meeting, and the report and balance-sheet adopted and approved.

On the motion of the CHAIRMAN, seconded by Mr. GRIMSHAW, a dividend of 5 per cent. was declared, and it was resolved to use the remainder of the balance in the manner recommended by the Directors.

On the motion of the CHAIRMAN, seconded by Mr. ERNEST CREWDSON, Mr. Edward Cross was re-elected a Director, and the appointment of Mr. J. R. Williamson as managing director was confirmed. The auditors were re-elected, and a vote of thanks was accorded to the Directors for their past services.

The Chatham, Rochester and District Electric Lighting Company.

The second ordinary general meeting of the Chatham, Rochester and District Electric Lighting Company (Limited) was held at the Sun Hotel, Chatham, on Tuesday evening, the Mayor of Rochester (Councillor F. Wingent) presiding.

The SECRETARY (Mr. J. J. Acworth) having read the notice convening the meeting, the Directors' report was read, as follows:—

"As we do not propose to transact any business this evening, we feel bound to explain the object of now calling you together. No. 18 of the Company's Articles of Association prescribes that general meetings shall be held at least once in every year, as may be prescribed by the Company in general meeting, and if no other time and place be prescribed, a general meeting shall be held on the first Monday in July in every year, at such time and place as the Directors may appoint. Your Directors being anxious, if possible, to get the works in operation before calling the shareholders together, did not convene this meeting on the day appointed by the Company's Articles. Having, however, met with several delays, which could neither be seen or averted, it was thought best to hold their meeting without any further delay, although it will be now necessary to adjourn it for the transaction of business, which cannot be brought forward at the present time. At our first general meeting, which was held last November, we told you that 667 shares only had been taken up. This, of course, was insufficient for the purposes which your Directors had in view; but we are now glad to be able to inform you that since then the whole of the shares have been applied for and allotted. The first and one of the most important questions which had to be considered after the holding of the last general meeting was that of selecting a suitable site for erecting a central station. Much time, care and consideration were given to this matter. Advertisements were inserted in the three local papers inviting offers of land. The site which was eventually selected as being the best, you are doubtless all aware, was a portion of the Victualling Office, Rochester, the sub-lease of which, together with a couple of offices, has been secured upon satisfactory terms. On securing the latter, the registered office of the Company was removed from 22, High-street, to the Victualling Office, Rochester. Having obtained possession of the wharf, plans for the central station were prepared, and the work of making foundations and erecting buildings was set in hand with as little delay as possible. The most serious part of this business was making the necessary foundations to receive the machinery. It has, however, been done well, at a rather heavy cost. The buildings are now practically complete, the engines and boilers are fixed in place, and have been run to-day for the first time, and the dynamo electric machinery is now being erected, and will be in working order before the end of the present week. As might have been expected, considerable difficulty has been experienced in getting our mains run up and down the street, although the Corporation of Rochester and the Local Boards of Chatham and Gillingham have given us permission to cross the streets with our wires. We are, however, glad to say that the Chatham circuit is now rapidly approaching completion, and we believe that by the middle of next week it will be so; we shall then be prepared to take on customers for lighting. Taking all things into consideration, we believe we have considerable cause for encouragement since we last met. The Liverpool Electric Lighting Company has declared a dividend of 7½ per cent.; Taunton 5 per cent, and Hastings 3 per cent. In the latter case the dividend would have been much larger had not the company been severely handicapped by circumstances which occurred years ago. From this it will be seen that electric lighting has now become a paying business, and the fact is so well recognised that a wonderful activity is now evinced in every branch of electrical work; in proof of this, we can advance no better example afforded by the Woodhouse and Rawson Company, which declared an interim dividend of 12½ per cent., besides which a sufficient sum was carried forward to a reserve fund, which would have raised the dividends to 40 per cent. As the merits of electric lighting are becoming more fully recognised and also public confidence in the financial soundness of the same, it is not surprising to find that many towns are adopting the electric light, or else taking steps for so doing, such as London, Edinburgh, Dublin, Bradford, Birmingham, Liverpool, Glasgow, Southampton, Cheltenham, Leamington, Bath, Bournemouth, Poole, Weston-super-Mare, Ilfracombe, Exeter, Queenstown, Waterford, &c., &c."

On the motion of Mr. E. SMITH, seconded by Mr. S. J. HART, it was unanimously resolved that the meeting be adjourned to November 20th, 1888.

Pilsen-Joel and General Electric Light and Power Company (Limited).

An extraordinary general meeting of this Company was held at the Cannon-street Hotel on the 20th ult., under the presidency of Sir Rawson W. Rawson, K.C.B.

The notice convening the meeting having been read,

The CHAIRMAN said the sole object of the meeting was to confirm the resolution which was passed at the previous meeting to proceed to voluntary liquidation. That was with the prospect of carrying out an agreement which had been entered into between the Directors and Mr. Gwynne, with the sanction of a large maiority of the shareholders. Since the previous meeting, however, circumstances had occurred which had entirely altered the state of affairs. Mr. Fyfe, who had taken an active part in the affairs of the Company, not always nor generally with very happy results—and he (the Chairman) was quite sure that it would not be with happy results on this occasion—had sought and obtained an injunction restraining the Directors from carrying out the agreement. The judge did not go into particulars and did not pronounce a definite opinion upon the statements made by Mr. Fyfe or the counter-statements presented by the Directors; but he was under the impression that most important questions were raised, one being whether there could be such a resolution as that upon which the agreement in question was entered upon. He doubted whether the shareholders even were in a position to come to a resolution in a general meeting, such as the last, to sell the whole of the business of the Company. Upon that ground he decided to issue an interlocutory injunction restraining them from carrying out the agreement until the question could be argued in Court. This was merely a motion for a restraining injunction: it was not a motion to deal with the question at all, but merely to stop the proceedings until the question could be decided. Mr. Fyfe's grounds appeared to be three: the inability either of the Directors or of the shareholders to proceed in the manner in which they did proceed, that was to vote a sale and then proceed to liquidation. There was no doubt that the liquidator, if and when appointed, would have power to carry out a sale of that description, but the judge was under the impression, although it was contested by counsel, that there was a doubt whether any such power existed in the case of the Directors and shareholders. The Directors were now called upon to take action under these circumstances. Their sole desire had been, was, and would be, to carry out the wishes of the majority of the shareholders, to consult the interests of all, whether in the majority or the minority, and to wind up the affairs of the Company, which it seemed were not likely to be carried on in a satisfactory way under present circumstances, to the best possible advantage. They had not yet had time to consider what action should be taken. But one very important action had already been taken which, at all events, would satisfy the shareholders that neither Mr. Gwynne nor the Directors had the least desire to force the contract upon any portion of the shareholders who did not consider that it was just and equitable. Mr. Gwynne had offered in the most handsome manner to cancel the agreement, with the undertaking that he would not claim an indemnity for any loss or damages which such cancelment would entail upon him. The Directors had agreed to the cancellation, but whether that was a benefit to the shareholders or not was questionable. Mr. Fyfe and the Directors held very opposite views as to the value of the property for selling purposes. There had been plenty of opportunity during the preceding three months of ascertaining the value of the property. The Directors were satisfied that Mr. Gwynne's offer, by which he took upon himself all the liabilities and risks of the concern, was as good a one as they were likely to obtain. But, as they told Mr. Fyfe when he expressed a contrary opinion at the last committee meeting which he attended, if a better offer presented itself they would be only too happy to entertain it. No such offer had been presented, and no signs of any such offer being likely to be presented were apparent. The Directors were desirous of averting from the shareholders the certain waste of their funds which would be caused by the litigation that now lay before them, and the litigation which might follow under any circumstances in connection with the opposition raised by Mr. Fyfe and those who supported him. But since the previous week, when the case was heard, they had had insufficient means and opportunity for entering upon the consideration of the best course to be adopted with the view of meeting the wishes and consulting the interests of all the shareholders, because it must be borne in mind that whilst one portion of the shareholders were unwilling to advance any more money for the carrying on of the affairs of the Company, another body, holding three-fourths of the capital, were disposed to carry on the business under efficient management. Under these circumstances the Directors were of opinion that it was not desirable at that meeting to take action for confirming the resolution for the liquidation of the Company. They might find that such a course was the best to adopt eventually, but they would have to look into their financial position very carefully. He would remind them that when they reduced the call from 5s. to 3s. in the early part of the year, it was with the desire of calling up no more money than was requisite to meet the liabilities and to carry on the affairs until some such action as was taken at the last meeting could be taken for deciding the future of the Company. But now they were almost in the month of September, and there must be some weeks' delay before they could take renewed action. No time, he could assure them, would be lost; but there was quite a possibility that it would be necessary to call up more money to carry on until a decision could be come to. That, of course, was one of the consequences of the action taken by Mr. Fyfe. He regretted it exceedingly, for he thought the litigation might have been avoided. It was not the intention of the Board to move the confirmation of the resolution, and therefore the resolution would drop. The business of that meeting was therefore at an end.

Discussion ensued as to the best course to be now adopted. There were suggestions that 2s. per share should be called up and the Directors instructed to proceed with the business, but there were objectors to this, and eventually it was understood that the present position of inactivity would be maintained for a further period of two months, during which

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the Board would cast about for a definite policy, and Mr. Fyfe would pursue his endeavours to bring forward, or induce some one else to bring forward, the "better offer" of which he had spoken.

NEW COMPANIES REGISTERED.

BARNET AND DISTRICT ELECTRIC SUPPLY COMPANY (LIMITED).—This company was registered on the 25th ult., with a capital of £5,000, divided into 490 Ordinary shares of £10 each, and 190 Founders' shares of £1 each, to adopt and carry into effect an agreement bearing date the 27th of July, 1888, and made between Henry Francis Joel of the one part and Walter Bramall, as a trustee for the company, of the other part, for the purchase of all the rights, benefits, and advantages of Henry Francis Joel, under a contract with the Barnet Local Board, for the lighting of the district by electricity, and the supply of electricity to shops, private houses and other buildings. The first subscribers are :—

	Shares.
*J. Ross, 1, Basinghall-street, London, E.C., merchant	10
W. M. Porter, Fairlawn, Northaw, Potters's Bar, N., merchant	10
J. Ewart, 46, Longridge-road, S.W.	10
*J. Palmer, jun., 50, Finsbury-square, E.C., merchant	10
*H. F. Joel, 31, Wilson-street, E.C., electrical engineer	10
*W. Mossop, Bycullah-park, Enfield	10
A. Morley, 1, Rocliffe-street, Islington, N., electrical engineer	10

The holders of the Ordinary shares are to receive in each year a preferential dividend of 7½ per cent. on the paid-up capital, and one moiety of the surplus profits after this payment in each year shall belong to the Founders' shares, and the remaining moiety shall be divided amongst the Ordinary shareholders. The qualification shall be the holding of shares of the nominal value of £100 in the capital of the company. Each director shall receive £10 per annum as remuneration for his services, and an additional sum of £50 is payable to the managing director.

BEDFORD ELECTRIC LIGHT COMPANY (LIMITED).—Registered by Richard Jordan, 120, Chancery-lane, W.C., with a capital of £15,000 in shares of £1 each. Object: to enter into contracts for electric lighting, either alone or in conjunction with other means, and for the supply of electric energy for power or transmission, and for fixing, maintaining, sealing, hiring, or otherwise dealing with transformers, wires, lamps, primary, secondary, or storage batteries, and all other electrical appliances and equipments with any corporation or person, and to supply or manufacture, purchase or hire, take in, exchange or otherwise acquire, sell and supply all machinery, motors, generators, lamp materials, or appliances in connection with the production, transmission, storage, and use by any means and any purpose of light and heat, and electric, magnetic or other force. The first subscribers are :—

	Shares.
Sir H. Mance, Menora, Newnham-road, Bedford	1
T. Jessopp, St. Paul's-square, Bedford	1
R. B. Stafford, Cauldwell House, Bedford	1
W. B. Jessopp, 3, St. Paul's-square, Bedford	1
O. T. Christie, Hoddesdon, Herts	1
T. Spencer, Ashburnham-road, Bedford	1
D. Bower, Springfield House, near Bedford	1

The number of directors shall not be less than three, and the first directors shall be appointed by the signatories to the Memorandum of Association. The qualification of every director shall consist of his being the registered holder of 100 shares in the company. By way of remuneration for their services the directors shall be paid a yearly sum of £250, to be divided as the directors may determine.

REES MINERS' PATENT SAFETY ELECTRIC LAMP COMPANY (LIMITED).—This company was registered on the 25th ult., with a capital of £50,000, in shares of £5 each, of which Nos. 1 to 50 (inclusive) are Founders' shares, to acquire under an agreement to be made between John Price Rees of the one part and Thomas M. Field, as trustee for the company, of the other part, certain letters patent for the United Kingdom and elsewhere of the Rees Miners' Patent Safety Electric Lamp and the Rees Double Liquid Primary Battery, and all future improvements, and any extensions of the same, to carry on the business of electricians, electrical engineers, and workers, and dealers, in electrical motive power and light. The first subscribers are :—

	Shares.
G. Holdsworth, Cremorne Wharf, Chelsea, metal manufacturer	1
T. M. Field, 41, Earl's Court-square, S.W.	1
H. Gerard, C.E., 31, Crondall-road, Fulham, S.W.	1
J. P. Rees, 1, Trinity-place, Trinity-street, Southwark, S.E., electrician	1
J. D. Ayres, 6, Old Jewry, E.C., agent	1
T. Baker, 422, Mansion House-chambers, E.C., surveyor	1
G. S. Anderson, 52, Queen Victoria-street, E.C., merchant	1

There is not to be less than three nor more than seven directors, in addition to any managing director or directors; qualification of a director, other than the first directors, shall be the holding of £500 in shares or stock of the company. The first directors are to be appointed by the subscribers; the remuneration to the directors for their services shall be the sum of £1,000 per annum, to be divided amongst them as they may determine.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 31, 1888, amounted to £4,805.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the month of August, 1888, amounted to £1,643, against £1,614 in the corresponding period of last year, showing an increase of £29.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of August, 1888, amounted to £38,103, against £36,274 in the corresponding period of 1887. Increase, £1,829.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of August, 1888, amounted to £43,703, and to £43,609 in the corresponding period of 1887.

GREAT NORTHERN TELEGRAPH COMPANY.—Traffic returns: Receipts in August, 1888, £23,200; 1st January to 31st August, 1888, £179,200; corresponding months, 1887, £174,120; ditto, 1886, £169,960.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 31st, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,991.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this company for the month ended August 31st, 1888, amounted to £5,450.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated receipts of this company for the half month ended 31st August, 1888, were £2,469, as compared with £2,059 in 1887. May receipts, estimated at £5,793, realised £5,830.

PATENT

SILICIUM BRONZE AND SILICIUM COPPER WIRE.

The best for overhead Telephone and Telegraph Lines,

AND ALL ELECTRICAL PURPOSES.

Hard Drawn High Conductivity Copper Wire.

ROLLED AND DRAWN

PHOSPHOR BRONZE.

PHOSPHOR BRONZE

BEARINGS, BUSHES,

AND OTHER PARTS OF

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SOLE PROPRIETORS of the British, Indian and Colonial Patents,

THE PHOSPHOR BRONZE COMPANY (Limited),

87, Sumner Street, Southwark, London, S.E.

WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Sept 5, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Sept. 5, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	40½ 41⅛	3 6 3	Jan., Apr., July, Oct.	41⅛	40½
2,614,820	Stock	10/0	Do. Preferred	68 69	4 1 0	,, ,,	68⅝	68¼
2,614,820	Stock	nil.	Do. Deferred	13⅜ 14¼	...	February	14⅜	14
130,000	£10	3/0	Brazilian Submarine	13 13¼	5 5 8	Mar., June, Oct., Dec.	13⅜	13
16,000	10	9/0	Cuba Submarine	13¼ 13⅜	6 3 9	February and August	...	...
6,000	10	10/0	Do. Preference	18 19	5 5 3	,, ,,	...	...
12,931	5	4%'87	Direct Spanish (£4 paid)	3⅜ 4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference	9½ 10⅛	4 15 3	April and October	...	...
60,710	20	2/0	Direct United States	9¼ 9⅜	4 5 3	Jan., Apr., July, Oct.	9⅜	9¼
380,000	10	4/0	Eastern	12⅜ 12⅝	4 15 1	,, ,,	12 9/16	12 5/16
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜ 15¼	3 19 0	,, ,,	...	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	3 18 0	February & August	...	...
250,000	10	2/6	Eastern Extension	13 13¼	4 18 6	Jan., Apr., July, Oct.	13 3/16	13 1/16
22,050	10	8/3	German Union Telegraph and Trust	9 9½	7 7 4	January and March	...	...
179,177	10	3/0	Globe Telegraph and Trust	6¾ 7	5 0 0	Jan., Apr., July, Oct.	6 15/16	6¾
178,992	10	3/0	Do. 6 per Cent. Preference	14 14¼	4 4 3	,, ,,	14⅜	14
150,000	10	7½%'87	Great Northern	13⅜ 14¼	5 5 3	Jan., July, and April	14 1/16	13⅜
17,000	25	37/6	Indo-European	37 39	6 8 3	April and October	...	...
33,348	10	3/0	London Platino Brazilian	6 6½	...	May and November	...	...
9,000	8	4/0	Reuter's	7⅜ 8	5 0 0	April and October	8	...
338,225	Stock	13½%	Submarine	130 140	10 7 0	February & August	...	...
30,000	10	6/0	West Coast of America	7 7½	6 13 4	January and July	7	...
150,000	Stock	8%	Do. Debentures	110 115	6 19 2	June and December	...	...
88,321	10	nil.	West India and Panama	1⅜ 1⅞	...	...	1 15/16	1 9/16
34,563	10	10/0	Do. 1st Preference	12 12½	...	April and October	12 5/16	11⅜
45,181	15	9/0	Western Brazilian	12¼ 12½	5 1 3	March & September	12½	12¼
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds xd	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	£5 7s. '87	Consolidated Telephone and Maintenance	½ ⅝	5 10 0	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	1/16 1/16	3 9 0	...	...	...
80,000	5	10/0	United	13¼ 13½	5 9 0	June and December	13 9/16	13 7/16
50,000	5	2/6	United River Plate	5⅜ 5⅝	...	April and October	5⅝	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3 3½	...	...	3½	...
23,692	5	nil.	Do. (fully paid)	4 4½	...	February & August	4 5/16	4
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅜ 2⅝	...	...	...	...
312,000	½	5% '86	Maxim-Weston	1/16 1/16	...	February	1/16	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39 40	5 19 9	March and July	39⅝	..
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	17 18	5 14 3	February & August	...	...

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

BOARD OF DIRECTORS.

The Right Hon. Sir H. J. SELWIN-IBBETSON, P.C., Bart., M.P., *Chairman.*
LORD CLAUD J. HAMILTON, *Deputy Chairman.*

Hon. EVELYN ASHLEY.
J. SPENCER BALFOUR, Esq.
MICHAEL BIDDULPH, Esq., M.P.
W. P. BOUVERIE, Esq.
ARTHUR CLARKE, Esq.
Sir WILLIAM FORWOOD.
EDWARD LAWRENCE, Esq.
ERNEST NOEL, Esq.
Sir JOHN PENDER, K.C.M.G.
J. DENISON PENDER, Esq.
The Right Hon. LORD SUDELEY, P.C., F.R.S.
LEOPOLD SALOMONS, Esq.
JOHN C. SALT, Esq.
C. A. WHITMORE, Esq., M.P.

Offices—**WINCHESTER HOUSE, OLD BROAD STREET. LONDON, E.C.**

The principal objects of the Corporation are:—

1. Performing the duties of Trustee, Executor and Administrator.
2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

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GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

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NOTES.

We do not propose this week to comment upon the Papers read in the sections at the meeting of the British Association which has just been brought to a conclusion, but next week we shall publish a detailed review of the results of the meeting, as regards electrical science, from the pen of Dr. Oliver Lodge. We therefore content ourselves with the remark that, in spite of some falling off in the numerical attendance, the meeting has been full of interest to electricians from beginning to end. The attraction has, however, chiefly centred in Section A (Mathematics and Physics), where the presence of Prof. Fitzgerald, Sir William Thomson, Lord Rayleigh, Prof. Rowland, and Dr. Oliver Lodge, has sustained an unflagging interest in the proceedings. The absence of an electrical section has been to some extent atoned for by the division of Section A into two portions, one of which was labelled "Mathematics," and the other "Electricity and Light." Since we seem now to be rapidly approaching the time when optics will be recognised as a mere branch of electro-magnetism, this arrangement may already be considered the equivalent of a purely electrical section.

In Section G (Mechanical Science) only one day was devoted to the application of electricity, and the Papers read, although interesting enough in their way, were scarcely of first-rate importance; nor did they, as a whole, possess the charm of novelty. Almost the only exception to this latter statement is to be found in Mr. Lowrie's Paper on the method of measuring alternating currents which is employed at Eastbourne, and Mr. Edmunds' very remarkable device for distributing electricity from secondary batteries. These two Papers, together with Prof. Forbes' Paper on "Electric Lighting in America," were discussed together, and we shall give the Papers and discussion next week.

In requesting Prof. W. E. Ayrton to repeat his lecture "On The Electric Transmission of Energy," the inhabitants of Bath have paid the Professor a very marked compliment, as this is the very first occasion in the history of the Association in which such a thing has happened; that the compliment is a well deserved one, all who were present on the first occasion would bear unanimous testimony. The remarkable manner in which Prof. Ayrton managed to steer between the Scylla of Technicality and the Charybdis of Inaccuracy excited the admiration of all who were conversant with the subject; whilst the dry humour of his style and the happy fertility of his local allusions simply brought down the house. Mr. Pickwick and his memorable adventures in Bath have, of course, afforded an unfailing resource for the witticisms of the lecturers at this meeting. We think that the inhabitants of Bath are to be much congratulated on the opportunity a second time afforded them of obtaining a sound, if elementary acquaintance, with one of the most interesting and most important problems of the day in so remarkably pleasant a form.

One observation of Prof. Ayrton's—our American friends would call it a Pointer—deserves, we think, to go down to posterity as the most concise explanation hitherto advanced of the different aspect, from an engineering point of view, presented by a study of Europe and of America in the closing years of the Nineteenth Century. There are two possible definitions of Inertia, says Prof. Ayrton; in this country it is defined as resistance to motion, and in America as resistance to standing still.

As was to be expected, the British Association, so far as it condescended to notice the subject of capital punishment by electricity, stamped it with emphatic disapproval. An assembly of English gentlemen who respect their profession could hardly do less.

The discussion on lightning conductors by Sections A and G of the British Association conjointly, which took place on Tuesday last, was of a most interesting character, and we shall give it in full next week. It was opened by Mr. W. H. Preece and continued by several engineers and leading physicists.

Lord Armstrong's recent article on "The Vague Cry for Technical Education" is answered in this month's *Nineteenth Century* by Sir Lyon Playfair, who is greatly exercised because so high an authority as Lord Armstrong has thrown cold water on the programme of the "Central Association for the Promotion of Technical Education." The question between these two disputants and the schools they severally represent seems to us to be one mainly of practical expediency; and a perusal of Dr. Playfair's Paper by no means convinces us of his competency to judge a matter of that sort. Lord Armstrong, like most captains of industry, knows exactly what he wants and how to get it; but he is rather afraid of getting more than he wants, which he probably would do if Sir Lyon Playfair had his own way. To put the matter bluntly, Lord Armstrong approves of technical and even scientific training only when and

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where they *are* needed; Sir LYON PLAYFAIR would scatter these accomplishments broadcast in case they *may be* needed. Sir LYON asserts that their value is proved by the prevalent demand for them among the artisan classes. It is rather soon to speak so confidently; we suspect meanwhile that the chief value of technical training in the estimation of the artisan is that it will help him to better his condition—in other words, to rise above his fellow workers. The case of 39,000 workmen being thrown out of employment by the invention of a new method of making steel does not help the argument, unless Sir LYON PLAYFAIR wishes us to believe that these men would have been kept in work had they understood the process as well as BESSEMER.

ONE other remark we should like to make on Sir LYON PLAYFAIR'S article. Here, as elsewhere, he is peculiarly given to contrasting the educated and uneducated workman, by applying the term "brute" and "animal" to the latter, just as though the exercise of man's physical energies reduced him to the level of a horse. This same Dr. PLAYFAIR once called the skilled telegraphist, who was not also an accomplished electrician, an "ambidextrous monkey." All such comparisons are not merely inaccurate, they are highly inexpedient until we have entirely displaced manual labour by the aid of machinery; and when that time arrives the artisan will be nearer akin to an automaton than to any known animal, and will need technical education about as little. Probably neither Lord ARMSTRONG nor Sir LYON PLAYFAIR speaks his whole mind in discussing this question of technical education. The learned doctor hopes to create an unlimited supply of WATTS, STEPHENSONS, ARKWRIGHTS, CARTWRIGHTS and BESSEMERS, by giving the multitude technical education, whilst his practical opponent apprehends that there would be nobody left to work their inventions if we succeeded, and everybody left discontented if we failed.

IN another column will be found a paragraph on "The Manufacture of Light," extracted from Dr. LODGE'S valuable Papers on "Modern Views of Electricity," now appearing in *Nature*. Many of us have vaguely longed to know the secret of the direct production of light unaccompanied by heat, by the glow-worm, the fire-fly, and some still lower forms of animal life. Dr. LODGE has put these vague longings into articulate form. At present there does not seem much prospect of attaining the desired end, but if our gradually-increasing knowledge of the internal nature of molecules should ever lead to a practical method of producing light vibrations directly, unaccompanied to any great extent by heat vibrations, it will constitute one of the greatest boons that scientific investigation has ever conferred upon man.

DR. VAN DER WEYDE read a Paper last week before the Electric Light Convention in New York, dealing with Mr. BROWN'S recent experiments upon the internal resistance of dogs. The learned doctor is, of course, perfectly right in taking exception to Mr. BROWN'S method of connecting his voltmeter in series with his ammeter, and, as he very truly remarks, the readings so obtained would tend to be lower than the true value of the voltage. This leads us to suppose that the dogs, which were alleged to have succumbed to 300 volts or less, in reality fell victims to much higher potential differences. Dr. VAN DER WEYDE, indeed, goes into a most ingenious calculation (based upon the output of the dynamo employed to excite the field of the alternator), from which he deduces as a probable value of the E.M.F. no less than 82,063 volts. Of course, as Dr. WEYDE himself remarks, "this is an exaggerated estimate," but it is sufficient, he thinks, "to show the worthlessness of all the figures as given by Mr. BROWN." An abstract of this remarkable Paper will be found further on in this issue.

AT the conclusion of Dr. VAN DER WEYDE'S Paper, Dr. OTTO MOSES moved a series of resolutions, which were unanimously adopted, as follows:—

Whereas, The National Electric Light Association read with some uneasiness the persistent effort of rival interests to educate the public to a distrust of high potential electric currents, and

Whereas, They would protest with all energy against recent efforts to pit against each other continuous and alternating current systems of electrical distribution, which efforts have as their covert purpose the destruction of the harmony of action now existing between them, and

Whereas, This association for mutual protection recognises distinctly the danger of unfair legislation such as has distroyed the electric lighting interest of Great Britain; therefore be it

Resolved, That the National Electric Light Association emphatically declares that it is beyond doubt possible to produce and distribute high-tension currents for public use without any more danger or difficulty than attends the distribution of gas and water in our dwellings; and further be it

Resolved, That they would impress all legislators with the fact that success in the electric light and power business is based chiefly upon economy in the size of conductors, and that to utilise this fact high-tension currents were adopted in the first stages of development of electric lighting, and have been used ever since and will continue to be used; and, further, be it

Resolved, That it is our conviction that there is no difference in the danger attending the use of continuous or alternating currents, and that both may be so transformed before being used as to render them a perfectly harmless and tractable means of distributing electric power for use in cities.

MOST extraordinary accounts are being received in this country from New York with reference to the performances of the electric sugar refining invention of the late Prof. FRIEND; and the shares of the company have consequently risen to a quite alarming figure during the past week. We can offer no opinion as to the invention itself, as we know little more about it than the people who are planting their money upon it. But we have a decided opinion that a secret of the kind which this is represented to be cannot long be kept, and that the public may easily be deluded into paying too high a price for it, even if it answer all the expectations at present entertained of it.

Leeds.—The new reading room in connection with the Leeds Municipal Buildings was opened last week. It is lit by 112 incandescent lamps.

The Java-Macassar Cable.—Preparations are being made in Batavia for laying a direct submarine cable from Java to the port of Macassar.

Restoration of Communication with the East. — The Eastern Telegraph Company notify the restoration by their cables of telegraphic communication with India and the Far East.

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St. Helena.—From a Blue Book, just published, relating to St. Helena, we learn that no lightning has visited that island since 1878, and storms are unknown.

Dunfermline.—The villages of Aberdour, Cowdenheath, and Burntisland, in West Fife, have been connected with the Dunfermline centre of the National Telephone Company.

Pisek.—The electric lighting of Pisek (Bohemia) was inaugurated on the occasion of the Emperor of Austria's visit to the town in connection with the army manœuvres.

Proctor's Mechanical Stoker.—We have received from the makers a copy of reports from firms using this mechanical stoker, which appears to be coming into extensive use.

University College, Dundee.—We have received the calendar of this college for 1888-89, the sixth session of the college. An engineering and mechanical laboratory has been added since last session, and also a department for instruction in the processes of dyeing and bleaching.

Bristol.—The contract for the erection of electrical controlling apparatus and signals, in connection with the machinery in a new granary built by the Docks Committee of the Council of the City of Bristol, has been secured by Messrs. King, Mendham and Co, electrical engineers, of that city.

House-to-House Electric Light Supply Company.—We are informed that this company has accepted the tender of Messrs. Peto Brothers for the erection of their first Central Electric Lighting Station at West Brompton. It is stated that the building will be completed by the middle of November.

Death of Mr. R. A. Proctor.—We regret to learn that Mr. R. A. Proctor, well known as a writer on popular astronomy, and as the editor of the popular scientific magazine entitled *Knowledge*, died at New York on Wednesday from yellow fever, contracted recently in Florida. Mr. Proctor was in his fifty-first year.

Postal Telegraph Servants in France.—Great discontent is reported to exist among the telegraph and postal clerks all over France at the way in which promotion is made. A meeting to discuss grievances was held on Tuesday night at the Salle Eliot in Paris, and it was decided to at once get up a monster petition.

Sir John Pender, K.C.M.G.—Sir John Pender had a private audience of the Sultan on Saturday, and received from His Majesty the Grand Cordon of the Medjidieh. Sir John, with his guests, the Dean of Westminster, Sir G. Elliott, Sir Robert Herbert, and Mr. James Pender, are on a visit to Constantinople on board his yacht.

India-rubber.—From Rangoon *The Times* correspondent announces the decision of the Indian Government to abolish the india-rubber monopoly and throw open the trade to all who are willing to pay a license. It is added that the abolition of this and other monopolies in Upper Burmah will greatly assist the commercial development of the country.

Castleford.—At the last ordinary meeting of the Castleford Local Board, in consequence of the gas company having positively declined to make any reduction in the price of gas supplied to the Board, it was resolved, on the recommendation of the Finance Committee, "That the clerk make inquiries as to the feasibility and cost of providing a substitute for gas."

Winter Sessions.—The 1888-89 Session of the Royal College of Science of Dublin has commenced, and the 1888-89 Session of University College, Bristol, begins on 10th October. Full particulars will be found in our advertisement columns. The winter session of the Charterhouse Science and Art Schools and Literary Institute will commence on October 1st.

Sir James Anderson.—Messrs. W. H. Beynon, fine art publishers, of St. Albans Lodge, Cheltenham, have just issued (for private circulation) a portrait of Sir James Anderson, F.R.G.S., F.G.S., &c., as a companion to that of Sir John Pender, executed by the same firm in 1883. The portrait is on a large panel of a deep rich tint, the high lights being picked out with white. The likeness, we are able to say, is an excellent one.

Manganese Steel for Resistance Coils.—Manganese steel is being employed by Dr. E. Hopkinson in the construction of resistance coils. The resistance of this material is 75 microhms per cubic centimetre at 15° C., and the temperature coefficient is 0·00136 per degree Centigrade, as compared with ·005 for ordinary iron, while its magnetic permeability (see *The Electrician*, March 9, 1888, and March 30, 1888) is also exceedingly small, being only about $\frac{1}{6000}$ that of iron.

Cutting Glass by Electrically Heated Wire.—We are informed that several American glass factories now cut the large cylinders of window glass by encircling the cylinder with a fine wire, which is then heated to redness by an electric current, and a drop of water being allowed to fall upon the hot glass a perfectly clean cut is obtained. The old method was to draw out a fibre of white hot semi-molten glass from the furnace by means of tongs, and to wrap it round the cylinder.

Electric Lighting at the British Association.—The electric lighting in connection with the meeting of the British Association at Bath was carried out by Messrs. Laing, Wharton and Down. A Thomson-Houston 6-unit constant-current dynamo was employed to light the 13 arc lamps, which burnt remarkably well. The Sidney Gardens were also illuminated nightly by Mr. Massingham, with 30 Thomson-Houston arc lamps. The current was brought from a temporary plant occupying the site where the central lighting station is to be placed. The arrangements were excellent, and the light left nothing to be desired in the way of steadiness and brilliancy.

Fleetwood.—The committee recently appointed at a meeting of Fleetwood ratepayers to inquire into the methods and cost of lighting in other towns have had several meetings to consider proposals from electric lighting and other companies; and when the sanction of the Board of Commissioners has been obtained the committee will proceed to towns to which they have been invited, to examine modern systems of lighting. The inducements to adopt the electric light are said to be locally very strong, and it is probable that for street illumination the committee may recommend the formation of a company to undertake the lighting of the town by electricity.

Electrical Search Lights.—It appears from the interesting account of the naval manœuvres which appears in the current *Fortnightly Review* that, although frequently serviceable in warding off the attacks of torpedo boats, the electric search lights failed to detect the escape of the "Warspite," "Iris," and "Severn" from Bantry Bay on the night of August 3, although several times levelled at them. The reasons for this failure seem to have been—first, the intense gloominess of the night, attended by a soft white haze; but chiefly, perhaps, because of the escaping vessels being carefully blackened all over, and rendered indistinguishable on the dark water.

Dundee Telephonic Fire Alarm.—A fire took place at Messrs. Bryden's premises in Dundee on Wednesday, 29th August. It was the first at which the firemen were called by the new electric bell arrangement recently fitted by the National Telephone Company at the Central Police Office. The apparatus was found perfectly satisfactory, and the men

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were summoned to the police office and turned out in a remarkably short space of time. On an alarm of fire being received by telephone or otherwise at the police office, the attendant has only to pull out a pin, and bells are immediately rung loundly for nearly one minute at every fireman's house in the town. This arrangement has been introduced by the National Telephone Company in several other towns.

A New Portable Battery Cell.—A handy form of single liquid cell has been devised by Mr. Barber Starkey, of Kilry Lodge, Alyth, N.B. It consists, says *Industries*, of a cylindrical vessel in two halves, which are screwed together. The interior is separated by a perforated plate of insulating material, which supports the electrodes. The latter project into the lower compartment, which contains the electrolyte when the cell is in use; but upon turning the vessel upside down the electrode projects upwards, whilst the electrolyte escapes into the other compartment through the perforations in the diaphragm, and the cell is thus put out of use. To facilitate the turning over, the cylinder is provided with trunnions, and suspended from a handle by which the apparatus can be readily carried about.

Electric Lighting in the City.—At a meeting of the City Commissioners of Sewers, held at the Guildhall on Tuesday, the Clerk presented a communication from the East Strand and District Electric Light and Power Company, asking for the Commissioners' consent to the application they are about to make to the Board of Trade for a Provisional Order or license to supply electricity in the portion of the city from Farringdon-street and New Bridge-street, westward. On the motion of Mr. J. V. Moore, it was referred to the Streets Committee for consideration and report. An application from the London Electric Supply Corporation for the Commissioners' consent to a license being granted to them by the Board of Trade for the supply of electricity within the city was similarly referred.

Voltametric Control of Ammeters.—In testing the correctness of ammeters, M. Latschinow measures the time which a given number of amperes take to evolve one cubic centimetre of hydrogen in the voltameter. The accompanying table gives the number of minutes which one ampere takes to liberate one cubic centimetre of hydrogen at different temperatures. It is thus only necessary to pass the current for a certain time through the ammeter and voltameter, and then to correct for pressure.

Temperature. Degree.	Time. m.	s.	Temperature. Degree.	Time. m.	s.
15	13	21·4	..... 20	13	2·0
16	13	17·6	..... 21	12	58·0
17	13	13·7	..... 22	12	54·1
18	13	9·9	..... 23	12	50·0
19	13	6·0	..... 24	12	46·0

The Hartmann and Braun Ammeters.—The firm of Hartmann and Braun are now making a new form of ammeter and voltmeter, in which residual magnetism is reduced to a minimum. The instrument consists of a solenoid, in the interior of which there are soft iron semi-cylindrical segments, placed at regular intervals. In these intervals there are movable segments attached to the axle of the pointer, and projecting slightly beyond the fixed segments. When a current is passed through the instrument, the movable segments are drawn towards the strongest part of the field; that is to say, towards the prolongation of the fixed segments. The controlling force is gravity. It is claimed for this arrangement that while the field produced is practically as strong as if there were a solid core within the solenoid, yet, owing to the comparatively small size of the segments, there is but little residual magnetism.

Antwerp.—The electric light station belonging to the Antwerp goods depôt was burnt down on the night of the 15th and 16th August, and electrical plant to the value of £1,000 was destroyed. The fire was caused by an overheated chimney setting the woodwork of the building alight. The installation comprised three Gramme dynamos, two small Siemens dynamos, 48 Jablochkoff arc lamps, and the necessary steam plant. The railway company naturally expected a prolonged stoppage of the electric light. However, thanks to the energy of M. Gruss, electrician in charge, and of M. Bandsept, engineer to the Société d'Eclairage du Centre, which owns the station, 24 arcs were running on the evening of the 18th, and at the present moment the whole 48 lamps are working as regularly as before the fire. Such a rapid piece of work naturally entailed great labour and expense, and reflects the highest credit on all concerned.

Target Practice by the Electric Light.—According to the *Wezer Zeitung*, the German military authorities have lately been trying the electric light with a view of testing its utility in siege operations. The night was very dark, and the marksmen were 400 metres from the target, the light being 200 metres behind the shooting party. Two experiments were made. The marksmen were first placed within the region of light so that their sights were well defined; under these conditions 90 per cent. of the shots struck the targets about the height of a man's breast. The marksmen were then placed in the dark, and told to fire on to the lit-up targets; the shooting proved somewhat inferior. The plant consisted of an 18 horse-power engine, and a dynamo placed on a cart. The projectors can be 200 metres away from the dynamo, if circumstances require it. The apparatus is only intended to be used in attacking and defending fortified places.

Paris.—The installation of electric light recently provided for the Théâtre du Gymnase comprises 2 Belleville boilers, 2 Lecouteux and Garnier engines, 2 Thury dynamos, and 883 Khotinsky incandescent lamps of various candle-power. The engine and dynamo room is somewhat small, having a superficial area of less than 300 square feet. The engines are of the high-speed, non-condensing, variable expansion type. The dynamos are shunt-wound and have an output of 200 amperes and 70 volts at 350 revolutions; they are driven direct by means of a Raffard flexible coupling. The lamps are run off accumulators of the Schenek-Farbaky pattern. The accumulators are divided into two groups of 56 cells, each group of cells being arranged 2 in parallel and 28 in series. These cells weigh 250 kilos each, the lead weighing 200 kilos. As they have a capacity of 1,400 ampere-hours, their output amounts to 7 ampere-hours per kilogramme of lead, or 5·6 ampere-hours per kilogramme of dead weight.

Electric Light Statistics for Belgium.—Some interesting statistics relating to the present position of electric lighting in Belgium have been compiled by M. Wybauw. Belgium possesses, it appears, 302 isolated installations, with a grand total of 1,907 arc lamps and 21,248 incandescent lamps. Brussels has 38 installations, comprising 29 arcs and 4,281 incandescents. Antwerp comes next with 22 installations, which comprise 194 arcs and 1,320 incandescents. Liège has 20 installations, with 176 arcs and 662 incandescents. Accumulators are employed only in some half-a-dozen cases. Central stations are almost out of the question in Belgium, owing to the fact that all the large towns except Brussels have very stringent contracts with the gas companies. In 1885 a central lighting station was started at Antwerp, but was promptly closed by the legal proceedings of the gas company. Two or three small affairs, scarcely entitled to be called central lighting stations, are the only things of the kind to be seen in Belgium.

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Eastbourne.—At a meeting last week of the Eastbourne Town Council the resolution of the Lighting and General Purposes Committee, recommending the discontinuance of the electric light, came up for consideration. Councillor Chambers believed that he would be representing the views of a great many members of the council when he said that he had heard with great regret of the possible loss of the electric light. He maintained that it had been a great success from an illuminating point of view, and it had been a great success from an Eastbourne point of view as raising the character of the town, and therefore it would be a retrograde step for them to lose the electric lamps if by any reasonable negotiations they could retain them. He would move that further negotiations be made with the Eastbourne Electric Light Company, inviting them to suggest some alternative terms, such as extinguishing the lights at 10:30 p.m. After some discussion the amendment was put, three voting for it and ten against. The whole of the report was then adopted.

Brazilian Telegraph and Telephone Statistics.—According to a Ministerial statement published by the *Rio News*, the extension of the Government telegraph lines measures 10,633 kilometres with 18,364 kilometres of wire and 170 stations. The submarine cables in connection with the land lines are about 48 kilometres. The Director-General estimates at over 1,000,000 milreis annually the loss to the Government lines through the competition of the Western and Brazilian cables. Reference is made to the probable improvement in the receipts of the Government lines when the D. Pedro II. Telegraph Company commences operations. The Minister states that he proposes establishing telephonic communication in connection with telegraphic. This had already been tried at Maccio with success, the receipts from subscribers more than paying the first cost of establishment, and leaving something for repairs. It is thought that the trifling increase of expense will be more than counterbalanced by the facility with which private individuals may be able to communicate with telegraphic stations, and thus an increase of revenue be secured.

The Zone of Maximum Intensity in Arc Lighting.—According to the report upon arc lights of the committee charged with the photometric tests of lamps shown at the last Antwerp Exhibition, if S = the mean spherical luminous intensity, H = the horizontal luminous intensity, and M = the maximum luminous intensity, there exists between these three quantities the relation $S = \frac{H}{2} + \frac{M}{4}$. This empiric formula gives in most cases values which do not differ materially from those determined by exact calculation. The mean intensities of luminosity in each of the two hemispheres are fairly represented by $\frac{H}{4}$ for the superior hemisphere, and by $\frac{H+M}{4}$ for the inferior hemisphere. The zone of maximum intensity of light is the surface of a cone having the arc for its apex, and generated by a plane, one edge of which coincides with the vertical axis of the two carbons, and the other edge making with this line an angle of about 50°. It is to be understood, of course, that this zone of maximum luminous intensity is limited to the lower area of the conical figure thus described. This determination applies more particularly to arc lamps supplied by continuous currents.

The Electrical Distribution of Time.—The lecture on "The Electrical Distribution of Time," delivered before the Franklin Institute, by Commander Allan D. Brown, U.S.N., Assistant Superintendent Naval Observatory, January 13th, 1888, and published in the *Journal* of the Institute, has been republished in pamphlet form. Commander Brown traces the electrical distribution of time as far back as 1816 to a telegraph dependent upon timepieces for its working, which was invented by Ronalds. We agree with the *Engineer* that this is rather far-fetched. Ronalds used two clocks, on the dial of which the letters of the alphabet took the place of hours. In front of the dial stood a pithball electrometer. The clocks were started at the same moment with the hand pointing to the letter A, and then as the clock of the transmitter pointed to the letter he wished to use, the clock at the receiving end pointed to the same letter. The sender put down a key, which, by the aid of a current, caused the pithballs to fly apart, and thus indicated to the receiver what letter proved part of the message. All this had nothing to do with the telegraphic distribution of time signals in the modern sense of the words.

Exports of Telegraphic Wires.—A comparison of the export return for August with those of previous years is again unfavourable, though some improvement is shown on the shipments of July. According to the Board of Trade returns issued on Friday last, the aggregate shipments to August 31 last of "metals and articles manufactured therefrom, except machinery," in which category telegraphic wire, &c., is included, were valued at £25,066,672, as against £22,552,097 in the first eight months of 1887—an increase of £2,514,575. This large increase is one of the most satisfactory features of the returns, and has been referred to as one of the best indications of our improving export trade. Telegraphic material, however, does not participate in the improvement, as will be seen in the comparative table below, and the fact is more noteworthy considering the considerable advance in the price of copper :—

Exports of Telegraphic Wires and Apparatus connected therewith.

	1886.	1887.	1888.
First quarter	£124,074	£131,879	£88,077
Second „	354,331	56,933	156,136
Six months	£478,405	£188,812	£244,213
July	219,463	195,950	21,571
August	154,789	114,162	110,323
Eight months	£852,657	£498,924	£376,107

The Corrosion of Lead Pipes.—The extensive use of lead-coated wires renders the question of the corrosion of lead when exposed to atmospheric and other influences of importance to electricians. Prof. Carnelly and Mr. Frew, of University College, Dundee, have arrived at the conclusion that in lead pipes carrying water corrosion is much greater when the pipes are exposed to the air. The corrosive action of water is diminished to about one-fourth, and that of slaked lime to one-fifth, when air is excluded. The corrosive action of blue clay and aluminium hydrate is, however, increased somewhat by excluding the air. Calcium carbonate, old mortar, calicum silicate, and a mixture of calcium carbonate and sand are not much affected in their corrosive power whether air be excluded or not. With potassium nitrate, however, the exclusion of air is important, since it becomes about as protective as calcium silicate when air is kept out, and as corrosive as water when exposed to air. Slaked lime is a powerful corroder, whether air be excluded or not. Peaty soil exerts a slight protective action on lead pipes. Sand, calcium carbonate, old mortar, calcium silicate, and a mixture of sand and calcium silicate exert a protective influence. The amount of silica in soft water reduces its corrosive power; and silica can be readily supplied to the water by passing it over a mixture of flints and limestone. A *mixture* of calcium carbonate and sand is better than either alone, perhaps by the formation of calcium silicate.

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Hence also, perhaps, why *old* mortar is better than new in point of protective properties. The protective action of magnesium oxide is also very remarkable, being nearly equal to that of calcium silicate.

Electric Sugar.—The New York correspondent of the *Financial News*, writing under date of Sept. 7, says:—A trial of the new electric sugar process took place to-day. I am told this evening, at the office of the Electric Sugar Refining Company, that 13 barrels, of an average of 325lb. each, were refined in one hour and ten minutes. This is practically the first test of the new process. Three sizes of refined sugar were produced, and as a result the company claim that the process is established, and the machinery to operate it. Mr. Willett (a prominent sugar merchant in this city) witnessed the experiment, and says:—"At the trial about 13 barrels of refined sugar of various grades were produced, by every appearance to experts being freshly made sugars. Visitors were not allowed to inspect the machinery, or take any precautions against deception; but their confidence in the success of the manufacture was increased by what they saw. The sugar produced was beautiful in colour, entirely dissimilar from any refined sugars produced by refiners in America. Three different grades ran from one granulator. Four more grades were exhibited as having been produced at the same time in a private room from the same operation, all having the appearance of freshly made sugar. As far as the experiment went it was satisfactory, but not conclusive. The strain on the new machinery prevented a larger product. The time taken for the conversion from raw to refined sugar was 25 minutes. One barrel of refined sugar was filled every two minutes." I am told, further, that the experiment was hastened to-day in order to accommodate certain parties before leaving this country. A much larger experiment will be made in about a month. A fuller account of this invention was given in *The Electrician* of July 27th, 1888.

Electric Motors in Flour Mills.—The *Progressive Age* says that the first flour mill to use electric motors for power was built in Laramie, Wyoming, during last winter, by the Laramie Electric Light and Power Company, which company also operates the plant and furnishes that city with electric light. The plant is supplied with fuel-economising engine outfits and Edison dynamos far in advance of capacity to their present requirements, so their natural action was to use this surplus capacity in the driving of a flour mill rather than purchase an additional engine and boiler plant for the same duty. The mill has 125 to 130 barrels capacity per day, and besides supplying the local demand for flour, ships also flour to Yellowstone Park, the cattle ranches, Government posts, and mining camps within a radius of 200 miles. It has been in operation for about six months. The building is of stone, three stories in height, with basement. Seven double sets of 7 × 18 rolls accomplish the reductions of wheat and middlings. Centrifugals are used for bolting. The mill is complete in every detail, having all necessary cleaning machinery, packers, bran dusters, and dust collectors to enable the owner to do close milling. On the first floor of the mill are located two motors, one of which is connected by belt to the main shaft in the basement which drives all the rolls, scalpers, bolts, and elevators. The other motor is connected by belt to the fast shaft upstairs driving purifiers, cleaners, and the other machinery about the mill. Electricity comes from the lighting station to these motors by means of two copper wires, each of which is about 150ft. in length. These motors are under the eye of the miller, and can be stopped and started at will. Their convenient location avoids the necessity of long shafting and heavy belting, saving by this means power and machinery. Electric lights light the mill by night and steam heats it in cold weather. The absence of any fires about the mill insures a low rate of insurance, and makes this property a desirable risk. The two motors run at constant speed at 226 volts, and when running at full capacity require a current of about 150 amperes, or 48 horse-power; hence it is a very light running mill, for most milling engineers allow about 60 horse-power for a mill of this size. In cases where a mill owner has a good water-power a distance of five or ten miles from some good town, the electrical method of power transmission is practical, and has advantages over any other. The installation of the outfit would be the principal expense, but after that there would be practically no expense, for the machinery requires very little repair with proper handling.

The Electric Cable Railway on the Burgenstock.—In our issue of August 31st we gave some account of this interesting line from the pen of a non-technical writer. The following technical details appeared last week in *Industries*:—"The Bürgenstock, although a lower mountain than either the Righi or Pilatus, offers a most charming view over the Lake of Lucerne, and has thus become a favourite resort of tourists. A cable line was opened for passenger traffic two months ago, and is remarkable as being the first instance where the cable system and electric traction have been combined. On the Bürgenstock there was neither fuel nor water available, and it became necessary to carry the motive power to the railway, over a distance of about two and a-half miles, from a generating station on the River Aa, where a 60 horse-power turbine has been established. The transmission of energy takes place by means of a 20-ampere current under a pressure of 1,600 volts. At the generating station there are two Thury dynamos, each capable of an output of 25 amperes at 800 volts, when driven at 800 revolutions per minute. The two machines are coupled in series, and the circuit is arranged on the three-wire system, the wires being of naked copper 180mils. diameter, and supported on poles. The total length of the railway is 3,100ft., and the grade varies from 32ft. to 57ft. in 100ft. It is a single line, with a passing place about midway between the two termini. There are two cars, each accommodating thirty passengers, one car ascending whilst the other is descending. The cars are suspended from the ends of a steel wire cable, the bight of which passes over a series of cable pulleys at the top station, where the motors are installed. The wheels on one side of the car have inner and outer flanges; on the other side they are without flanges, by which means the passage of the crossing place is made possible without the employment of any switch. Midway between the rails is laid one of Herr Abt's steel racks into which gear spur wheels attached to the under side of the car, and which are controlled by brakes, one hand-worked and one automatic. In regular work the spur wheels run idle; but should the cable break, the car is instantly gripped and held in place by the spur gear, a hanger with cross head passing under the foot of the rack rails preventing the spur wheels from jumping out of gear. Power is supplied to the winding pulley in the engine house at the upper terminus of the line by two Thury motors, which are coupled in series and joined in the usual manner with the three-wire circuit. There is some power to spare, and this is utilised for driving a lighting dynamo supplying current to the glow lamps in the hotels. During the daytime one generator and one motor suffice to work the railway, and some of the primary current is sent to a small motor placed at the pumping station lower down the side of the mountain, from where the hotels are supplied with potable water. The speed of the cable is 200ft. per minute."

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NOTE ON MAGNETIC HYSTERESIS.

BY J. A. FLEMING, M.A., D.SC.

When an ascending magnetisation curve is drawn connecting the values of magnetising force and corresponding magnetisation, we find on examination that the curves for soft iron rings or longish iron bars present a certain general similarity. For very small values of the force the curve begins by rising at a small angle. By the time the force has reached about 1 C.-G.-S. unit or so a pretty sharp upward bend begins to take place, and then the curve continues upwards, passing through a point of contrary flexure in its upward path. For a value somewhere between 5 and 10 C.-G.-S. units of the magnetising force another bend or "knee" occurs in the curve, bringing it down to a lesser slope, at which diminished slope it then proceeds upwards for further forces, but as far as experiment has yet indicated it never becomes quite horizontal. When the bar or ring has reached the state popularly called saturation, let the magnetising force be gradually diminished. It is found that the magnetisation now has, during the descent, for the same force a higher value than during the ascent. If at any point in the descent we pause and begin again to increase the magnetising force, and then after a certain rise decrease it again to the point at

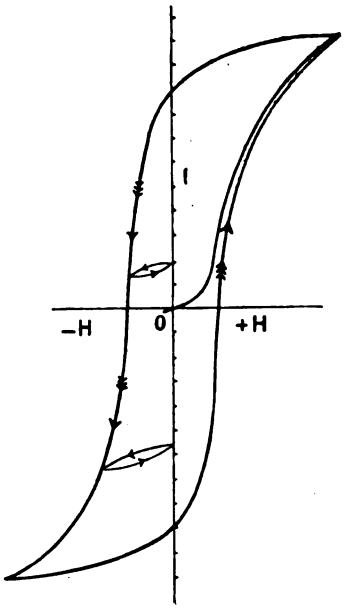

FIG. 1.

Magnetisation curve for very soft iron ring, showing loops due to hysteresis on the descending branch, and enclosed area due to a complete cycle (Ewing).

which we first arrested the descent, these values of the magnetisations exhibit *a loop* on the magnetisation curve (Fig. 1). If we operate on a ring, and draw the complete magnetisation curve described in carrying the ring from strong magnetisation in one direction to strong magnetisation in the other, we find the curve has two branches (Fig. 2) enclosing a large area. If the horizontal distances or abscissæ represent magnetising force **H**, and corresponding vertical ones the magnetisation I, then any area on the plane of **H**, I, is analytically represented by the integral $\int \mathrm{I}\, d\,\mathrm{H}$.

The physical meaning of these loops or enclosed areas in the magnetisation curves seems first to have been pointed out by Prof. E. Warburg.* This "lagging behind" of the magnetisation has been called by Prof. Ewing *magnetic hysteresis*.

The quantity $-\int \mathrm{I}\, d\,\mathrm{H}$, or the area of any loop of a magnetising curve formed by taking the metal through a complete magnetic cycle, represents in absolute measure the energy spent per unit of volume in performing this cycle. Thus, in Fig 2 the whole area included between the upward and downward curve represents the work spent per unit of volume of the ring in taking the ring from strong positive to strong negative magnetisation and back again.

The curve in Fig. 2, taken from a paper by Prof. Ewing, represents the course of the magnetisation in conducting the ring from strong positive magnetisation O C to equally strong negative O F. The "residual magnetism" or "retentiveness" is represented by O E, and may amount to as much as 93 per cent. of the maximum magnetisation. The work spent in carrying the iron round the magnetic cycle or along the course C D E F A G C is represented by the integral $-\int \mathrm{I}\, d\,\mathrm{H}$, and is represented numerically per unit of volume by the area

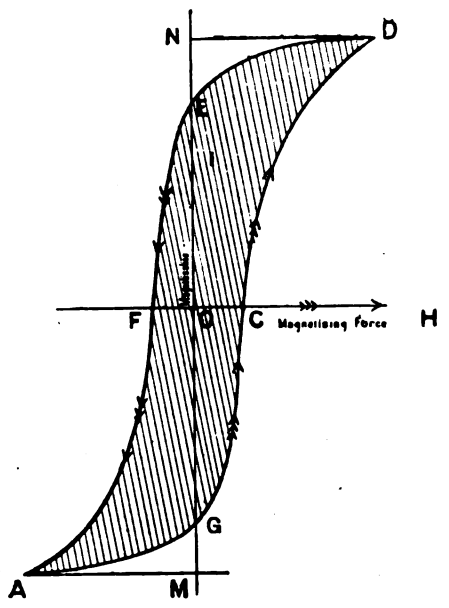

FIG. 2.

Complete Magnetisation Curve for soft iron ring (Ewing) carried from strong positive to strong negative magnetisation. The arrows show the direction of the magnetising operation, the shaded area the work done due to hysteresis.

(shaded) enclosed by the two curves. It has been shown by Maxwell* that the energy represented by a certain magnetic induction, **B**, produced by a certain magnetising force, **H**, is numerically equal per unit of volume of the material to $-\frac{1}{8\pi}$ times the product of the magnetic induction and the magnetic force resolved in the same direction. In the case before us **B** and **H** have the same direction; hence, differentiat-

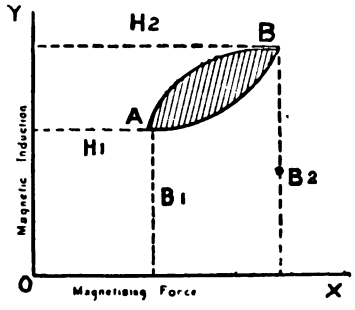

FIG. 3.

ing this expression for the energy per unit of volume, we have the expression

$$d\,\mathrm{E} = -\frac{1}{8\pi}(\mathrm{H}\, d\,\mathrm{B} + \mathrm{B}\, d\,\mathrm{H})$$

which denotes the value of the increment of energy per unit of volume expended in increasing **B** by $d\,\mathrm{B}$ and **H** by $d\,\mathrm{H}$.

When the change is cyclic

$$\int \mathrm{H}\, d\,\mathrm{B} = \int \mathrm{B}\, d\,\mathrm{H},$$

* Wiedemann's *Annalen*, XIII., p. 141, 1881

* "Electricity and Magnetism," Vol. II., § 636.

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for if we are integrating the area of a closed loop (Fig. 3), A B, we arrive at the same result, viz., the area of the loop, whether we proceed by integration along O X, which is obtaining the value

of $$\int_{H_1}^{H_2} \mathbf{B}\, d\,\mathbf{H},$$

or proceed by integrating along O Y and obtain

$$\int_{B_1}^{B_2} \mathbf{H}\, d\,\mathbf{B}.$$

Hence, integrating the equation

$$d\,E = -\frac{1}{8\pi}(\mathbf{H}\, d\,\mathbf{B} + \mathbf{B}\, d\,\mathbf{H}),$$

for a complete cycle of magnetisation gives us

$$E = -\frac{1}{4\pi}\int \mathbf{B}\, d\,\mathbf{H};$$

but by the fundamental equation

$$\mathbf{B} = \mathbf{H} + 4\pi\,\mathbf{I},$$

and hence $$\mathbf{B}\, d\,\mathbf{H} = \mathbf{H}\, d\,\mathbf{H} + 4\pi\,\mathbf{I}\, d\,\mathbf{H};$$

but $\int \mathbf{H}\, d\,\mathbf{H}$ is zero for a complete cycle, because for each value of $\mathbf{H}$ or $d\,\mathbf{H}$ there is one of equal value and of opposite sign; hence $$\int \mathbf{B}\, d\,\mathbf{H} = 4\pi \int \mathbf{I}\, d\,\mathbf{H}$$

and $$E = -\int \mathbf{I}\, d\,\mathbf{H}.$$

In his paper entitled "Researches in Magnetism" (*Phil. Trans.*, Part II., 1885), Prof. Ewing has given the values of the energy dissipated in ergs per cubic centimetre experimentally determined for complete magnetic cycles performed on various samples of iron :—

Sample of iron operated upon.	Energy dissipated in ergs per cubic centimetre during a complete cycle of doubly-reversed strong magnetisation.
Very soft annealed iron	9,300 ergs.
Less soft annealed iron	16,300 ,,
Hard drawn steel wire.....	60,000 ,,
Annealed steel wire	70,500 ,,
Same steel, glass hard	76,000 ,,
Pianoforte steel wire, normal temper..	116,000 ,,
Same, annealed.....	94,000 ,,
Same, glass hard	117,000 ,,

From the above we can deduce that, roughly speaking, it requires 28 foot-pounds of energy to make a double-reversal of strong magnetisation in a cubic foot of soft iron. The energy so expended can take no other form than that of heat diffused throughout the mass.

A similar table of experimental results has been given by Dr. J. Hopkinson (*Trans.* Roy. Soc., Part II., 1885, p. 463), in which Paper the chemical analysis of the samples operated upon is given. The highest value of specific hysteresial dissipation was found for Tungsten steel, oil hardened, in which the value of the energy in ergs per cubic centimetre dissipated in a complete magnetic reversal was 216,864.

This *static hysteresis* is a quality of iron in virtue of which reversal of magnetisation is accompanied by dissipation of energy. If we fall back upon current hypotheses of magnetism (Ampere-Weber-Maxwell) to afford us some explanation of it, we can find it to some extent by supposing that the magnetic molecules or molecular magnets, the arrangement of which constitutes magnetisation, move stiffly, and the dissipation of energy we are considering is the work done in making the necessary magnetic displacement against a sort of internal magnetic friction.

This dissipation of energy into heat during magnetisation is something quite apart from any production of heat by eddy (or so-called Foucault) electric currents induced in the mass, and would take place in iron so perfectly divided that no eddy currents could exist.

One result of Prof. Ewing's researches has been to show that if the iron is kept in a state of mechanical vibration hysteresis is greatly diminished, and the value of the energy dissipated in a complete cycle is much reduced. The removal of strong residual magnetism from soft iron by slight tapping or twisting has also been noticed and commented on by Prof. Hughes.*

If we place the above facts side by side we see that in magnetising the field magnets of an ordinary continuous-current dynamo, work has to be done to a small amount at first to bestow upon the iron its initial magnetisation. If iron possessed the property of retaining strongly some 90 per cent. of its maximum magnetisation when the magnetising force is withdrawn there would be no further need for a field-exciting current; but as the least shock or vibration removes the slightly held magnetisation of iron, we see that one function of the field-exciting current, and of the energy expenditure necessary to maintain it, is to keep on reproducing the magnetism which the continual vibration knocks out of the iron. Hence, in an ordinary dynamo, we may consider that one part of the duty of the field-exciting current is to keep on re-generating magnetisation because mechanical vibration is continuously tending to remove it.

Hysteresis will also operate to cause a dissipation of energy in the armature of dynamos. For in this case we have a mass of soft iron, viz., the armature core, which has its direction of magnetisation reversed every revolution. Suppose the core has a volume of 9,000 cubic centimetres, and that it makes 15 revolutions per second. Taking the specific hysteresis for this sample of iron at 13,356 ergs, we find that the dissipation of energy in ergs per second is equal to $9{,}000 \times 15 \times 13{,}356 = 180 \times 10^7 = 180$ joules, or a loss of about a quarter of a horse-power.

Experiments have been made by Joule and others to determine by direct observation the heating effect of magnetisation upon iron, but in these direct experiments it is probable that the results were mostly impure, and qualified largely by the production of heat by local currents.†

Since about 10,000 ergs per cubic centimetre are dissipated by a double reversal of strong magnetisation of soft iron, it is not difficult to show that the consequent rise of temperature, if all the heat is retained in the iron, is ·000284° C., or that some 4,000 reversals would be required to raise the temperature 1° C., even provided all the heat generated is retained in the metal. Hence it follows that any very marked rise in temperature cannot be due to hysteresis.

In connection with this subject it is interesting to touch upon the question whether magnetised iron *per se* represents a store of energy; in other words, is magnetised iron analogous to a bent spring?

It is not disputed that available energy accompanies the magnetisation of a short iron bar, but this is a virtue of free polarity. In consequence of the attraction of opposite poles, if a magnetic bar were flexible the two poles would bend round to meet each other, and when this operation was finished there would be no longer any work to be got out of the bar.

In the case, however, of a ring, the magnetisation, though strong, represents no available energy. It requires energy to be applied to demagnetise the iron, and for all practical purposes magnetised iron *per se* cannot be regarded as a source of energy.‡ It requires work to be done to displace the magnetic particles from their positions, and work also to be done to push them back.

The operation of magnetising iron is not analogous to the stretching of a spring, but rather to the bending of an inelastic wire, such as a lead wire, in which work has to be done in twisting the wire to make the several sections shear over each other, though the operation when finished represents no available work.

* Prof. D. E. Hughes "On the Cause of Evident Magnetism in Iron," *Proc. Soc. Tel. Engineers*, May 24, 1883, p. 3.

† See Joule's "Scientific Papers," Vol. I, p. 123, on the calorific effects of magneto-electricity, and on the mechanical value of heat. Also *Phil. Mag.*, series 3, Vol. XXIII., p. 263.

‡ Lord Rayleigh on "The Energy of Magnetised Iron," *Phil. Mag.* August, 1886.

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In addition to the *static hysteresis*, experiments by Prof. Ewing and others also indicate the existence of *viscous hysteresis*. There is evidence of a true *time lag* in magnetisation, especially in the earlier stages of magnetisation. The iron requires time for a given magnetising force to produce its effect, and this sluggishness does not appear explicable as an effect either of induction in the iron or to self-induction in the magnetising circuit. The result of this magnetic viscosity is to augment the value of $-\int I\,dH$ in any rapidly performed cycle, and, consequently, to increase the dissipation of energy into heat. When we come to consider the question of induction transformers it will be seen that this viscous hysteresis has to be taken into account in establishing the full theory.

With respect to this *time lag* of magnetisation Prof. Ewing says:* "I repeatedly observed that when the magnetising current was applied to long wires of soft iron there was a distinct *creeping up* of the magnetometer deflection after the current had attained a steady value."†

If this is so it would seem that a sufficiently rapid reversal of magnetising force would render such force inoperative in magnetising the iron. Just as the self-induction of a circuit operates to make a certain delay in the appearance of the current corresponding to the application of a given electromotive force, and hence renders a circuit apparently a worse conductor for rapidly reversed electromotive forces, so the magnetic lag would introduce a sort of *magnetic self-induction* or retardation in the appearance of the magnetisation corresponding to a given magnetising force.

This time lag appears to be most manifest in the softest iron, and to be especially noticeable near the beginning of the steep part of the magnetisation curve.

In an investigation on the magnetisation of iron under feeble magnetic forces, Lord Rayleigh has also drawn attention to the fact that the settling down of iron when very soft or annealed the into a new magnetic state is far from instantaneous.‡ If strength of the earth's horizontal magnetic field is called h, Lord Rayleigh has shown that for unannealed iron and steel magnetising forces ranging from $\frac{1}{5}h$ to $\frac{1}{10000}h$ call forth proportional magnetisation. In other words, the susceptibility is constant over this range, and the value of the corresponding permeability is from 90 to 100, and that this small proportional magnetisation takes place independently of what may be the actual magnetisation of the iron provided it is not very near the condition usually called saturation.

The moment, however, that the magnetising force is pushed beyond these limits the phenomena of hysteresis and retentiveness make their appearance. According to Prof. Ewing (*loc. cit.*) the following group or constellation of hypotheses has to be made in order to approximate to a mechanical explanation of the magnetisation of iron:—

1. An elastic tendency on the part of the magnetic molecules to recover their primitive position when displaced.
2. A static frictional resistance to their displacement and to their return removable largely by vibration.
3. A limit for each such that if the displacement of the molecule exceeds it a permanent displacement not removable by vibration results.
4. Probably a viscous resistance to the displacement and return of the molecules.
5. An unequal distribution amongst the molecules of the frictional resistance, such that in some of the molecules it is, perhaps, very small.

Aided by these suppositions we might proceed to build up, in imagination, a mechanical model, which should imitate, under the application of certain stresses, the behaviour of iron under magnetising force, but it is certain that the result would not be practically of much value; and it must still be left to future research to collect and analyse the necessary facts before the mystery of the magnetisation of iron is fully unraveled.

* *Phil. Trans.*, Part II., 1885, p. 569.

† See also Mr. T. Blakesley "On Magnetic Lag," *Phil. Mag.*, July, 1888, p. 34, in which it is shown that, by means of three dynamometers, the lag due to viscous hysteresis may be measured.

‡ Lord Rayleigh "On the Behaviour of Iron and Steel under the Operation of Feeble Magnetic Forces," *Phil. Mag.*, March, 1887, p. 225.

HERTZ'S RESEARCHES ON ELECTRICAL OSCILLATIONS.

BY G. W. DE TUNZELMANN, B SC.

H. Hertz has been engaged for some time past in a series of researches on electrical oscillations, which have led to results of very exceptional interest, as was pointed out by Prof. Fitzgerald in his inaugural address to Section A of the British Association last week; and as these results throw considerable light on the nature of electrical action, it will be of interest to readers of *The Electrician* to have a connected account of the investigations, to which I therefore propose to devote a short series of papers.

In Hertz's first Paper on the subject, viz., "On Very Rapid Electrical Oscillations" (Wied. *Ann.*, Vol. XXXI., page 421, 1887), he refers to a Paper by Colley, "On some New Methods for Observing Electrical Oscillations, with Applications" (*ibid.*, Vol. XXVI., page 432), who calls attention to the fact that Sir William Thomson in 1853 first showed the possibility of producing electrical oscillations by the discharge of a charged conductor, and gives references to all the investigations in the same direction which were known to him.

For the benefit of readers who may wish to pursue the subject further the list is reproduced below:—

Sir W. Thomson, "Mathematical and Physical Papers," Vol. I., page 540.

Feddersen, Poggendorff's *Annalen*, Vol. CIII., page 69, 1858; Vol. CVIII., page 497, 1859; Vol. CXII., page 452, 1861; Vol. CXIII., page 437, 1861; Vol. CXV., page 336, 1862; Vol. CXVI., page 132, 1862.

Kirchhoff, "Gesammelte Abhandlungen," page 168, containing remarks on, and corrections of some of Feddersen's results.

von Helmholtz, "Gesammelte Abhandlungen," Vol. I, page 531.

von Oettingen, Poggendorff's *Annalen*, Vol. CXV., page 115, 1862; and Jubelband, page 269, 1874.

Bernstein, Poggendorff's *Annalen*, Vol. XIII., page 142, 1828.

Schiller, Poggendorff's *Annalen*, Vol. CLII., page 535, 1872.

L. Lorenz, Wiedemann's *Annalen*, Vol. VII., page 161, 1879.

Mouton, Thèse, Paris, 1876. *Journal des Physique*, Vol. VI., pages 5 and 46, 1876.

Kolacek, Beiblätter zu Wiedemann's *Annalen*, Vol. VII., p. 541, 1883 (Abstract of a Paper published in the reports of the Bohemian Scientific Society in 1882).

Olearsky, Verhandlungen der Academie von Krakau, Vol. VII., p. 141, 1882.

Oberbeck, Wiedemann's *Annalen*, Vol. XVII., pp. 816 and 1,040, 1882; Vol. XIX., pp. 213 and 265, 1883.

Bichat et Blondlot, *Comptes Rendus*, Vol. XCIV., p. 1,590, 1882.

According to these investigations, the electrical oscillations produced in an open circuit by means of an induction coil are measured by ten thousandths of a second, while in the case of the oscillatory discharge of a Leyden jar they are about a hundred times as rapid, as was shown by Feddersen.

According to theory, still more rapid oscillations should possible in an open circuit of wire of good conducting material, provided its ends are not connected with conductors of any considerable capacity; but it is not possible to determine from theory whether measurable oscillations are actually produced. Some observations of Hertz's led him to believe that under certain circumstances oscillations of this kind were produced, and his researches show that this is so, and that the oscillations are about a hundred times as rapid as those observed by Feddersen; so that their periods are measured by hundred millionths of a second, and, therefore, they occupy a position intermediate between acoustic and luminous vibrations.

Preliminary Experiments.—It is known that if in the secondary circuit of an induction coil there be inserted, in addition to the ordinary air space, across which sparks pass, a Riess spark micrometer, with its poles joined by a long wire,

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the discharge will pass across the air space of the micrometer in preference to following the path of least resistance through the wire, provided this air space does not exceed a certain limit, and it is upon this principle that lightning protectors for telegraph lines are constructed. It might be expected that the sparks could be made to disappear by diminishing the length and resistance of the connecting wire; but Hertz finds that though the length of the sparks can be diminished in this way, it is almost impossible to get rid of them entirely, and they can still be observed when the balls of the micrometer are connected by a thick copper wire only a few centimetres in length.

This shows that there must be variations in the potential measureable in hundredths of a volt in a portion of the circuit only a few centimetres in length, and it also gives an indirect proof of the enormous rapidity of the discharge, for the difference of potential between the micrometer knobs can only be due to self-induction in the connecting wire. Now the time occupied by variations in the potential of one of the knobs must be of the same order as that in which these variations can be transmitted through a short length of a good conductor to the second knob. The resistance of the wire connecting the knobs is found to be without sensible effect on the results.

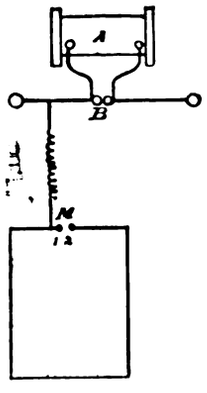

FIG. 1.

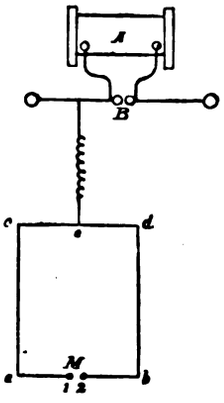

FIG. 2.

In Fig. 1, A is an induction coil and B a discharger. The wire connecting the knobs 1 and 2 of the spark micrometer M, consists of a rectangle, half a metre in length, of copper wire 2 millimetres in diameter. This rectangle is connected with the secondary circuit of the coil in the manner shown in the diagram, and when the coil is in action sparks, sometimes several millimetres in length, are seen to pass between the knobs 1 and 2, showing that there are violent electrical oscillations, not only in the secondary circuit itself, but in any conductor in contact with it. This experiment shows even more clearly than the previous one that the rapidity of the oscillations is comparable with the velocity of transmission of electrical disturbances through the copper wire, which according to all the evidence at our disposal is nearly equal to the velocity of light.

In order to obtain micrometer sparks some millimetres in length, a powerful induction coil is required, and the one used by Hertz was 52 centimetres in length and 20 centimetres in diameter, provided with a mercury contact breaker, and excited by six large Bunsen cells. The discharger terminals consisted of brass knobs 3 centimetres in diameter. The experiments showed that the phenomenon depends to a very great extent on the nature of the sparks at the discharger, the micrometer sparks being found to be much weaker when the discharge in the secondary circuit took place between two points, or between a point and a plate, than when knobs were used. The micrometer sparks were also found to be greatly enfeebled when the secondary discharge took place in a rarefied gas, and also when the sparks in the secondary were less than half a centimetre in length, while, on the other hand, if they exceeded 1½ centimetres the sparks could no longer be observed between the micrometer knobs. The length of secondary spark which was found to give the best results, and which was, therefore, employed in the further observations, was about three-quarters of a centimetre.

Very slight differences in the nature of the secondary sparks were found to have great effect on those at the micrometer, and Hertz states that after some practice he was able to determine at once from the sound and appearance of the secondary spark whether it was of a kind to give the most powerful effects at the micrometer. The sparks which gave the best results were of a brilliant white colour, only slightly jagged, and accompanied by a sharp crack.

The influence of the spark is readily shown by increasing the distance between the discharger knobs beyond the striking distance, when the micrometer sparks disappear entirely, although the variations of potential are now greater than before. The length of the micrometer circuit has naturally an important influence on the length of the spark, as the greater its length the greater will be the retardation of the electrical wave in its passage through it from one knob of the micrometer to the other.

The material, the resistance, and the diameter of the wire of which the micrometer circuit is formed have very little influence on the spark. The potential variations cannot, therefore, be due to the resistance, and this was to be expected, for the rate of propagation of an electrical disturbance along a conductor depends mainly on its capacity and coefficient of self-induction, and only to a very small extent on its resistance. The length of the wire connecting the micrometer circuit with the secondary circuit of the coil is also found to have very little influence, provided it does not exceed a few metres in length. The electrical disturbances must therefore traverse it without undergoing any appreciable change. The position of the point of the micrometer circuit which is joined to the secondary circuit is, on the other hand, of the greatest importance, as would be expected, for if the point is placed symmetrically with respect to the two micrometer knobs the variations of potential will reach the latter in the same phase, and there will be no effect, as is verified by observation. If the two branches of the micrometer circuit on each side of the point of contact of the connection with the secondary are not symmetrical, the spark cannot be made to disappear entirely; but a minimum effect is obtained when the point of contact is about half-way between the micrometer knobs. This point may be called the null point.

Fig. 2 shows the arrangement employed, *e* being the null point of the rectangular circuit, which is 125 centimetres long by 80 centimetres broad. When the point of contact is at *a* or *b*, sparks of from 3 to 4 milimetres in length are observed, when it is at *e* no sparks are seen; but they can be made to reappear by shifting the point of contact a few centimetres to the right or left of the null point. It should be noted that sparks only a few hundredths of a milimetre in length can be observed. If when the point of contact is at *e* another conductor is placed in contact with one of the micrometer knobs the sparks reappear.

Now, the addition of this conductor cannot produce any alteration in the time taken by the disturbances proceeding from *e* to reach the knobs, and, therefore, the phenomenon cannot be due simply to single waves in the directions *c a* and *d b* respectively, but must be due to repeated reflection of the waves until a condition of stationary vibration is attained, and the addition of the conductor to one of the knobs must diminish or prevent the reflection of the waves from that terminal. It must be assumed, then, that definite oscillations are set up in the micrometer circuit just as an elastic bar is thrown into definite vibrations by blows from a hammer. If this assumption is correct, the condition for the disappearance of the sparks at M will be that the vibration periods of the two branches *e* 1 and *e* 2 shall be equal. These periods are determined by the products of the coefficients of self-induction of these conductors into the capacities of their terminals, and are practically independent of their resistances.

In confirmation of this, it is found that if when the point of contact is at *e* and the sparks have been made to reappear by connecting a conductor with one of the knobs, this conductor is replaced by one of greater capacity, the sparking is greatly increased. If a conductor of equal capacity, is connected with

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the other micrometer knob the sparks disappear again; the effect of the first conductor can also be counteracted by shifting the point of contact towards it, thereby diminishing the self-induction in that branch. The conclusions were further confirmed by the results obtained when coils of copper wire were inserted into one or other, and then into both of the branches of the micrometer circuit.

Hertz supposed that as the self-induction of iron wires is, for slow alternations, from eight to ten times that of copper wires, therefore a short iron wire would balance a long copper one; but this was not found to be the case, and he concludes that, owing to the great rapidity of the alternations, the magnetism of the iron is unable to follow them, and therefore has no effect on the self-induction.

(To be continued.)

MANUFACTURE OF LIGHT.*

BY DR. OLIVER LODGE, F.R.S.

The conclusions at which we have arrived, that light is an electrical disturbance, and that light-waves are excited by electric oscillations, must ultimately, and very shortly, have a practical import.

Our present systems of making light artificially are wasteful and ineffective. We want a certain range of oscillation, between 7,000 and 4,000 billion vibrations per second; no other is useful to us, because no other has any effect on our retina; but we do not know how to produce vibrations of this rate. We can produce a definite vibration of one or two hundred or thousand per second; in other words, we can excite a pure tone of definite pitch, and we can command any desired range of such tones continuously by means of bellows and a key-board. We can also (though the fact is less well known) excite momentarily definite ethereal vibrations of some millions per second, as I have at length explained; but we do not at present seem to know how to maintain this rate quite continuously. To get much faster rates of vibration than this we have to fall back upon atoms. We know how to make atoms vibrate; it is done by what we call "heating" the substance, and if we could deal with individual atoms unhampered by others, it is possible that we might get a pure and simple mode of vibration from them. It is possible, but unlikely; for atoms, even when isolated, have a multitude of modes of vibration special to themselves, of which only a few are of practical use to us, and we do not know how to excite some without also the others. However, we do not at present even deal with individual atoms; we treat them crowded together in a compact mass, so that their modes of vibration are really infinite.

We take a lump of matter, say a carbon filament or a piece of quicklime, and by raising its temperature we impress upon its atoms higher and higher modes of vibration, not transmuting the lower into the higher, but superposing the higher upon the lower, until at length we get such rates of vibration as our retina is constructed for, and we are satisfied. But how wasteful and indirect and empirical is the process. We want a small range of rapid vibrations, and we know no better than to make the whole series leading up to them. It is as though, in order to sound some little shrill octave of pipes in an organ, we were obliged to depress every key and every pedal, and to blow a young hurricane.

I have purposely selected as examples the more perfect methods of obtaining artificial light, wherein the waste radiation is only useless, and not noxious. But the old-fashioned plan was cruder even than this; it consisted simply in setting something burning, whereby not only the fuel but the air was consumed, whereby also a most powerful radiation was produced in the waste waves of which we were content to sit stewing, for the sake of the minute, almost infinitesimal, fraction of it which enabled us to see.

Everyone knows now, however, that combustion is not a pleasant or healthy mode of obtaining light; but everybody does not realise that neither is incandescence a satisfactory and unwasteful method which is likely to be practised for more than a few decades, or perhaps a century.

Look at the furnaces and boilers of a great steam engine driving a group of dynamos, and estimate the energy expended; and then look at the incandescent filaments of the lamps excited by them, and estimate how much of their radiated energy is of real service to the eye. It will be as the energy of a pitch pipe to an entire orchestra.

It is not too much to say that a boy turning a handle could, if his energy were properly directed, produce quite as much real light as is produced by all this mass of mechanism and consumption of material.

There might, perhaps, be something contrary to the laws of Nature in thus hoping to get and utilise some specific kind of radiation without the rest; but Lord Rayleigh has shown in a short communication to the British Association at York* that it is not so, and that therefore we have a right to try to do it.

We do not yet know how it is true, but it is one of the things we have got to learn.

Anyone looking at a common glow worm must be struck with the fact that not by ordinary combustion, nor yet on the steam engine and dynamo principle, is that easy light produced. Very little waste radiation is there from phosphorescent things in general. Light of the kind able to affect the retina is directly emitted, and for this, for even a large supply of this, a modicum of energy suffices.

Solar radiation consists of waves of all sizes, it is true; but then solar radiation has innumerable things to do besides making things visible. The whole of its energy is useful. In artificial lighting nothing but light is desired; when heat is wanted it is best obtained separately, by combustion. And so soon as we clearly recognise that light is an electrical vibration, so soon shall we begin to beat about for some mode of exciting and maintaining an electrical vibration of any required degree of rapidity. When this has been accomplished, the problem of artificial lighting will have been solved.

* Extract from "Modern Views of Electricity," *Nature*, August 30] by kind permission of the author.

ON RECENT DEVELOPMENTS OF THE COWLES' ALUMINIUM PROCESS.†

BY R. E. CROMPTON.

It is unnecessary to again describe the earlier stages of the Brothers Cowles' invention of the electric furnace. I confine myself to a description of such parts of the new plant which has been recently put down at Milton, near Stoke-upon-Trent, that I think will be of general scientific interest.

The experience in America at the works at Lockport, Ohio, showed conclusively that great economies were to be expected from increasing the size of the furnaces and the strength of the electric currents employed to work them; but no current larger than 3,000 amperes had been used up to the time that the Milton Works were planned.

Mr. Eugene Cowles came over to England to ascertain whether English makers of dynamo machines were prepared to supply one 60 per cent. larger than Mr. Brush's "Colossus," which had been made specially for them in America, and which was then the largest direct-current machine in the world. He prepared his specification for a dynamo to give a current of 5,000 amperes at 60 volts, and eventually Messrs. Crompton's designs and tender were accepted.

The works were built near the Milton Station on the North Staffordshire Railway; the boilers for generating the steam required are of the Babcock-Wilcox type, and are provided with mechanical stokers; the steam engine is of 600 horse-power, and is a compound condensing horizontal tandem, made by Messrs. Pollit and Wigzel, of Sowerby Bridge; it is furnished with an exceedingly perfect centrifugal governor, which maintains the speed accurately at seventy-six revolutions in spite of very great fluctuations in the load. The electrical

* B. A. Report, 1881, p. 526

† Paper read before the British Association meeting (Section G), at Bath, September, 1888.

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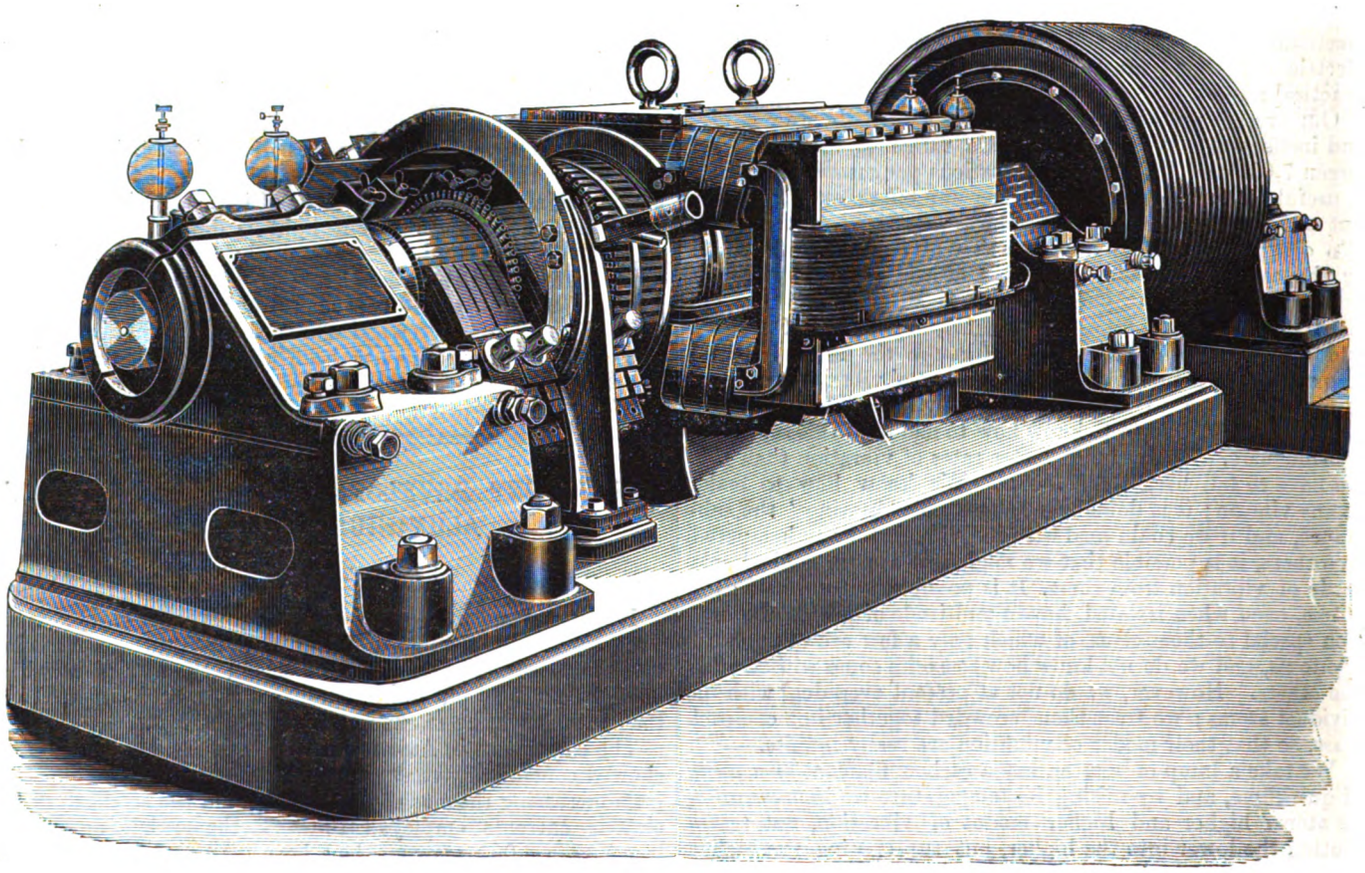
means of stopping the engine have been provided in the shape of Tate's electrical stop valve, which may be described as an electro-magnet arrangement, with the ordinary pushes for completing its circuit, which actuates a steam relay piston set to close the main stop valve. The fly-wheel of this engine is 20ft. in diameter, and weighs 30 tons, and is geared to the pulley of the dynamo, so that the latter makes five revolutions for each revolution of the engine by rope driving gear consisting of eighteen ropes.

This engine is an extremely fine specimen of a modern steam engine; it works so silently that a visitor standing in the engine room with his back to the engine railings at the time the engine is being started cannot tell whether it is in motion or not. The dynamo at first sight seems very small when compared with the steam engine driving it, the fact being that it is dwarfed by the enormous fly-wheel of the engine; it is only when one stands close to the plummer block bearings that one realises the great size of the spindle, and of all the parts required to transmit the power to the armature coils.



GENERAL VIEW OF 400 H.-P. CROMPTON DYNAMO.

The author was still aware when designing this machine that the mechanical strains on the spindle, core attachments, and winding were likely to be of an extraordinary nature. The following precautions were therefore adopted, and as events have turned out they have been more than justified. The spindle is of steel, 18ft. long, with three bearings, one being placed on either side of the driving pulley. The diameter is 7in. in the bearings and 10in. in the part within the core. This part in the original forging was 14in. diameter, and was planed longitudinally so as to leave four projecting ribs or radial bars on to which the core discs are driven, each disc having four key-ways corresponding to these ribs. There are about 900 of these discs, the external diameter being 20in., and the total length of the core 36in. Originally this core was provided with 32 driving teeth made of steel, each both riveted to sockets attached to eight of the core discs. It may here be mentioned that as the working has shown the strain on these driving teeth was perilously near their factor of safety, their number has been doubled, so that now the tangential strains are borne by a very considerable percentage of the core discs.

The armature winding consists of 128 copper bars, each seven-eighths of an inch deep measured radially by three-eighths wide. These 128 bars are coupled up so as to form thirty-two conductors only. This arrangement has been adopted to avoid the heating from Foucault currents which, with one and a-half inch conductors, would have been very considerable. The bars are coupled at the ends of the core across a certain chord according to an arrangement patented by the author and Mr. Swinburne, which consists of crescent shaped bars so formed that the whole surface is thoroughly exposed to the current of air passing through the armature; they are also somewhat shorter than those usually employed on drum-wound armatures. The bars are insulated by a covering of "fiburite," a material which has been recently introduced by Messrs. Crompton, and which will stand a temperature of 160° C. for long periods without the least discoloration, softening or alteration of its mechanical and insulating properties.

The commutator is 20in. long, has 64 parts, and in addition to the usual tightening nuts at the two ends, is provided with a third tightening ring at the centre to prevent the tendency of such long commutator strips to spring when worn down thin. The current is collected by eight brushes mounted on a separate ring placed concentric to the commutator, and the current is led away from these brushes by a large number of thin bands of sheet copper, strapped together into convenient groups.

The field-magnets are of the horizontal double type, and were adopted by the author and Mr. Swinburne, after a careful series of experiments, which convinced them that the fashionable single magnet form was very unsuitable for this kind of machine.

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As this machine is virtually a series-wound machine, the magnet coils each consist of a few turns only of forged copper bars, one and a-half inch wide by one inch thick, forged to fit the magnet cores; there is no insulation, other than mica wedges, to keep the bars from touching the core.

The armature is ventilated by a current of air from a Schiele fan, driven by a belt from the armature spindle. At 380 revolutions the armature can give 5,000 amperes at 60 volts, and temperature of the hottest part, which is at the end plates next the commutator, never rises beyond 70° C. Although this machine was designed to give only 5,000 amperes, yet, electrically speaking, it is capable of doing very much more, and in actual practice it has frequently to stand a current of 8,000 amperes for short periods; but, as will be shown later, when the furnaces are employed to produce ferro-aluminium, there are frequently violent oscillations in the current, which would make it unsafe to employ an average current much in excess of 5,000. In fact, as has been stated above, it has been found necessary already to increase the number of driving-teeth, in order to provide against the driving strains at the times of maximum current. When the machine was first tried the main circuit was unprovided with a cut-out, and there is no doubt that at this time the armature stood the test more than once of temporary currents exceeding 16,000 amperes. Since that time a safety cut-out has been provided calculated to fuse at 8,000 amperes; this, probably the largest one that has ever been designed, consists of a framework carrying 12 lead plates, and these fuse at the calculated point in a most satisfactory manner, without any undue detonation or scattering of the molten lead.

Next to the cut-out comes the current indicator, which is simply a solenoid of nine turns, through which the whole current passes; the core is attached by chain gear to the pointers, of which there are two mounted on one spindle, one pointer and dial is placed in the engine room, and the other in the furnace room; the gearing of this spindle is calculated so that the range of the instrument up to 8,000 amperes extends over the entire circle of 360°. The construction of the solenoid for this indicator is somewhat novel. It is cut out of a cylinder of cast copper by means of a parting tool in a screw-cutting lathe.

There are two furnace rooms, each containing six furnaces, and the conductors after leaving the current indicator pass right across the two rooms at a height somewhat above the attendant's heads. The current is supplied to the furnaces as follows:—

Each furnace pit consists of a long trough built of fire brick, the ends being closed by cast-iron pipes through which carbon electrodes are arranged so that they can be moved lengthways to and fro by the attendant in charge. It will be remembered that one of the main features of the Cowles invention is the use of limed charcoal as a lining for their furnace; they thus obtain a highly refractory nonoxidising lining, which is also a non-conductor of electricity, as the lime prevents the particles of carbon fusing together, and thus forming a continuous conductor, which would otherwise short-circuit the furnace and be consumed under the action of the current, instead of the latter performing its proper duty of maintaining the furnace contents at the required high temperature. The electrodes, each of which consists of nine carbon rods attached to a cast-iron head mounted on a copper rod passing through the above-mentioned cast-iron pipes, are each provided with flexible copper wire cable connections, having an attachment sliding along the conductors passing overhead and somewhat behind them. When it is desired to supply the current to any one furnace the attachments are slid into position opposite it and clamped fast to the conductors; to start the furnace the electrodes are brought together so as to touch and then separate, until the whole of the contents of the furnace between them is an incandescent mass at the required high temperature.

The working of a charge in the furnace is carried out as follows:—The bottom of the empty furnace is covered with limed charcoal, the electrodes are brought into position, and a former, or iron box without top or bottom, and of a size determined by the space to be occupied by the charge, is placed in the furnace; the ends of this sheet-iron box are arched out, so that it can be dropped over the electrodes, the furnace lining of limed charcoal is then rammed up in the space between the iron former and the furnace walls, the space inside the box is filled with the furnace charge, which, when ferro-aluminium is to be produced, consists of a mixture of charcoal, bauxite, and iron turnings, but when the cupro-aluminium is required granulated copper is substituted for the iron turnings. When the furnace lining and contents are brought up to the proper level, the iron former is carefully lifted, much as a moulder draws a pattern from the sand, the cover is then lifted on to the furnace, and it is then ready for the electric current.

This at first is kept down to 3,000 amperes, but as soon as the charge is thoroughly warmed through, and the furnace contents become incandescent throughout, the current is increased to 5,000 amperes, and in about one hour's time the reduction is complete.

The reduced aluminium trickles through the furnace contents, and collects at the bottom below the electrodes, from which in the furnaces last constructed it can be tapped out continuously. Mr. Cowles believes that the temperature of the centre of the furnace is so high that both the reduced aluminium and the metal with which it is to be alloyed are vapourised, and combine as a chemical compound, when in this condition being condensed in the upper and cooler part of the furnace, and from thence passing down the sides to the bottom.

The working of the furnace when cupro-aluminium is to be produced leaves nothing to be desired; the current can be steadily increased towards the commencement, and towards the end of the reduction the current is extremely constant, so that the load on the boilers, engine, and dynamo is fairly steady throughout; but when making ferro-aluminium, the conductivity of the furnace contents varies through very wide limits, and this brings heavy strains on both the steam engine and dynamo, which must be met by correspondingly increased strength of parts. The chief feature of the process which strikes a visitor to Milton Works is the small number of men necessary to work the process. Two men in the engine and dynamo room, one man at the boilers, and one boy to manipulate the electrodes of the furnaces are all that are required for the active part of the operation. Two labourers can easily charge and reline the furnaces, and the remaining staff required for melting down, standardising, and casting into ingots the various classes of furnace products is correspondingly small.

From the experience already gained the author sees no difficulty in designing and constructing engines and dynamos to supply currents of 15,000 or even 20,000 amperes, if such be required, for Cowles furnaces of enlarged size. The electrical difficulties met with in the construction of this large machine have been comparatively small, whereas the mechanical strains have been unexpectedly great, and must be provided for by extreme solidity and massive construction.

Recent investigations made in America by Mr. W. J. Keep have shown that the use of ferro-aluminium is likely to be enormously extended when its properties in relation to cast iron are thoroughly understood and appreciated by the engineering world. Mr. Keep is a gentleman who is well known in America, and his statements are entitled to be received with the utmost respect. We already knew in this country that the addition of ferro-aluminium to cast steel or to ingot iron in such proportion that the finished castings will contain not more than one-thousandth part of aluminium produced extraordinary effects, in some cases reducing the melting point 300° C., and in all cases imparting great fluidity to the metal, thus giving us sharp castings free from blow-holes; but it has remained for Mr. Keep to show us that the addition of an infinitesimally small percentage of aluminium to cast iron insures perfect castings, freedom from blow-holes, and almost all the ills to which the ironfounder is subject. Mr. Keep's report is so very full that it is impossible to give any *résumé* of it here. I only call attention to it to show the extreme importance that ferro-aluminium is likely to assume in future engineering, and that as far as we know at present the perfected Cowles furnace is capable of producing the desired material in any quantity, and at a moderate cost.

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THE COMPARATIVE DANGER OF ALTERNATING VERSUS DIRECT CURRENTS.*

BY DR. P. H. VANDER WEYDE.

It is only a few days ago that I received the flattering invitation to appear before this meeting of the most eminent electricians of the United States, and present a Paper containing my conclusions about the comparative danger to life lurking in the alternate and direct dynamo currents. I do so readily, as I have lately had the opportunity to become acquainted with the arguments made on both sides of the question. I was not prepared to do so when, a few weeks ago, I attended a meeting of the New York Board of Electrical Control, where several Papers were read, most of them in opposition to Mr. Harold P. Brown, who had expressed himself in opposition to the use of the alternate-current system, the introduction of which has lately been commenced. When the president of that meeting asked me to express my opinion I was compelled to decline, stating that my appearance there was solely as a listener to arguments upon the subject, about which I desired full information.

As some of the Papers read there were written in such a spirit as to compel Mr. Brown to defend himself, I made up my mind to attend his expected defence, especially as it might give me an opportunity to hear what powerful arguments and facts would be brought out by the person who has put himself forward as the champion of the enemies of the alternate-current system. . . .

A great portion of the Paper read by Mr. Brown consisted in complaints about the personal attacks made upon his capability as soon as he asserted in print that the alternate electric currents were more dangerous to life than the direct currents, namely, that a current of the electromotive force of, say, 300 volts alternate current would be more likely to destroy life than double or treble that strength of a direct current. One feature was prominent in the reading of the Paper as well as in the lecture and experiments. It was evident that the purpose was not so much to exhibit what was the truth in the matter as to show that he was right in what he had asserted. He attempted to prove this by experimenting upon a large dog, which, when subjected to a direct current, stated to be 300 volts, set up a short howl; 600 volts produced a longer howl and frantic efforts to escape from the cage, while a current of some 900 volts paralysed the dog, who kept up a laboured breathing. Then a representative of the New York Society for the Prevention of Cruelty to Animals interfered and forbade further trials of this kind, so that Mr. Brown was compelled to give the dog the *coup de grace* by applying the alternate current, which he said was of the strength of only 300 volts.

Unfortunately for Mr. Brown this proved nothing, as the dog was already half dead by the previous successive and increasing direct-current doses of 300, 600, and 900 volts respectively. Another dose of 300 or 600 volts direct current might in all probability have ended his life just as well. But what is more, his statement that the alternating current was nearly 300 volts was not proved, as he himself had stated previously that reliable instruments for measuring alternate currents were difficult to obtain, and confessed that he had only a voltmeter for this purpose, but no ammeter. After the lecture I examined the voltmeter, and found that, according to the statements of Mr. Brown himself, its operation was based upon indications of rise in temperature.

Now, it is well known that voltmeters based on this principle are based on false premises. Rise of temperature is not produced by electromotive force, but by amount of current; one Wollaston plunge battery cell, of one square metre acting surface, having, of course, the electromotive force of only one single volt, will produce far more heat than a series of 24 freshly prepared cups of a Leclanché battery of 40 volts electromotive force. This pretended voltmeter was, in fact, a kind of ammeter. . . . .

Mr. Brown stated that the quantity of the direct current he used was only a fraction of one ampere. This induced me to examine also the ammeter after the lecture, when I found that the ammeter and voltmeter were coupled together in series in the same single circuit. Now every experienced electrician knows that in order to measure the capacity of a dynamo current in amperes we must not place any other resistance in the circuit, much less the high resistance of a voltmeter, which may be 500 ohms, as then the indication of the ammeter may drop down 90 per cent. of the original indication; in fact, the ammeter indicated actually two-thirds of an ampere, as had been stated by Mr. Brown when he was asked during the lecture.

The manner in which the ammeter and voltmeter were used was considered by me in connection with the fact that, if really a current of only two-thirds of an ampere had been obtained, it would render the dynamical value of the three currents used only equal to 200, 400, and 600 watts respectively, which was incompatible with their effect on the dog. This caused me to go to the dynamo plant of Columbia College to inquire. I found that the direct-current machine used was an Edison municipal dynamo of 15 amperes and 1,200 volts. This dynamo did not belong to the Columbia College plant, but it was furnished by Mr. Edison for the occasion, as well as an alternate-current dynamo. Both were removed after Mr. Brown finished his experiments, which, it appears, he continued privately for a few days after the lecture.

One of the dynamos used belonged to the college plant; it was an incandescent light dynamo, of which the capacity was stated by the engineer to be 125 amperes and 110 volts. This dynamo was employed to obtain the alternate currents, by using it to feed the field-magnets of a Siemens-Halske alternate-current machine, after the usual manner.

The kind of apparatus which was used and the nature of their arrangement for the production of the alternate current makes it very unlikely that it would produce a current of only 300 volts, especially when we take into consideration that the current developed must represent some kind of equivalent for the horse-power required: firstly, to drive the 125-ampere incandescent light dynamo; next, that required to drive the alternate-current dynamo. The latter must have considerable power, as the 125-ampere current was more than sufficient to saturate the great number of its stationary electro-magnets. According to the statement of the engineer, the engine driving the 125-ampere dynamo requires 36 horse-power, that of the alternate dynamo 36 horse-power—together 72 horse-power, which, at 746 watts per horse-power, gives 54,712 watts. If the amperes of such a current had been measured after the method employed by Mr. Brown for the direct current, it would have resulted in 54,712, divided by two-thirds of an ampere, or 82,063 volts.

Of course, this is an exaggerated estimate, but sufficient to show the worthlessness of all the figures as given by Mr. Brown. In order to come to correct conclusions it would be necessary to measure, by means of indicator diagrams, the engine-power utilised, and measure the currents obtained by proper instruments, properly used and conscientiously observed. One thing is certain, namely, that the dynamos used were not of such a defective quality as to warrant the supposition of such an enormous loss of the power applied, as would be the case if only an electromotive force of 300 volts had been obtained.

There was added on the lecture room table another important additional (however small) contrivance, for the right understanding and use of which I will have to make a short introductory explanation. I do this, also, because I have been especially requested to do so by several parties who have become interested in the operation of this, to them, very novel device.

Notwithstanding electricity is not a fluid like water, it behaves, however, also in this case, in a similar manner. At the moment a uniform electric current is suddenly interrupted a current of greater electromotive force (more pressure) is developed in the conductor, and will show itself as a spark at the break of contact, and as a shock through the body when the hands have hold of the wires when the contact is broken.

As it may be desirable for special purposes to eliminate these currents, an apparatus has been invented, which operates like a very sensitive relay, and then leads these extra currents off, or shunts them into another channel after the manner of lightning protectors. Such an apparatus was on the table during the experiments with the dog, and appeared to be intended to protect the animal against the effect of these extra currents. I must confess not to see why this was done except for the purpose to annul the most powerful and most dangerous item connected with the direct current. Therefore, I consider the addition of this contrivance improper if we wish to arrive at the truth in regard to the comparative danger of the alternate and direct currents, because in case of accidental exposure of person there is rarely such a safeguard enclosed in the circuit, and the person struck by the current must submit to the extra current as well.

In order to arrive at the truth of the matter we must also, above all, be able to make definite statements about the voltage and the volume of current, based on precise measurements, which, in regard to the alternate currents, could not be furnished, but was only guessed at.

Finally, as far as I can judge about the matter, guided by the present state of knowledge (especially in regard to some, in many respects, still unexplained peculiarities in the behaviour of alternate currents), I should say that their true voltage must be quite high. They do not behave like currents of low voltage (say 300 or 400), as they can be, and practically are, conducted over much longer lines and thinner wires than is the case with the direct current of, say, 1,000 volts. This fact is acknowledged as well by the enemies as by the friends of the alternating-current system. Experiments made by converters, especially with a new and very peculiar one of my own construction, appear also to show that there must be considerable voltage in the alternate currents so as to account for the generation of the enor-

* Abstract of Paper read before American Electric Light Convention at New York.

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mous volume of current into which the electromotive force is converted; in other words, for the thousands of amperes obtained by the conversion of the volts of the primary current, and for which amperes there is no ammeter yet to measure them, but their volume shows itself in the capacity to perform operations requiring the highest temperatures, such as welding iron, fusing the most refractory substances, &c.

Surely no dynamo could be constructed directly generating a current of such volume, as it would destroy itself by the heat of its own current; it is only by alternating-current machines of high voltage, assisted by proper converters, that currents of such great volume and high caloric capacity can be obtained.

After all, we must not lose sight of the main object of this controversy, which is the comparative danger lurking in the two systems. When it is found by experience that actually the danger of being killed is greater by the use of alternate currents, it does not make any difference if the voltage which does the killing is 300 or 1,300.

When, however, we consider that statistics show that the loss of life by the direct-current system is continually increasing in proportion that the system is extending, the probabilities appear to be that both systems will furnish their equal quota of victims, and the labour of comparing the relative danger of both systems, and especially the discussion about their comparative voltage, appears to become an idle occupation.

BOOKS, &c., RECEIVED.

"*Transactions* of the American Institute of Electrical Engineers." Vol. V., No. 10. (New York.)

"Price List of Electrical, Testing and other Scientific Instruments." (Nalder Brothers and Co., Westminster.)

"Eleketrische Apparate, Maschinen und Einrichtungen." By W. E. FEIN. (Stuttgart: Julius Hoffmann.)

"Calender for the Sixth Session, 1888-89." University College, Dundee. (Dundee: John Leng and Co.)

"Designing Wrought and Cast Iron Structures." Part V. By HENRY ADAMS. (London.)

A NEW ELECTRIC DOG CART.

MESSRS. IMMISCH AND CO.'S NEW ELECTRIC DOG CART FOR THE SULTAN OF TURKEY.

We illustrate this week a new electric dog cart, which has been constructed by Messrs. Immisch for the Sultan of Turkey at a cost of £200. We had the opportunity of inspecting the vehicle on Wednesday at the Camden Town Skating Rink. In appearance it is similar to an ordinary four-wheeled dog cart, but, of course, has no shafts, the fore carriage being modified to carry a toothed rack, which engages with a pinion attached to a shaft passing upward through the footboard and terminating in a handle, by means of which the carriage can be guided with the greatest facility. The carriage is provided with an ordinary foot brake. It is constructed of walnut and light wood, bright varnished; the cushions of brown cloth are embroidered with the Turkish Imperial crest. The power is stored in 24 small accumulators of special type, which contain a charge sufficient to propel the vehicle for about 5 hours at a speed of 10 miles.

The motor is Messrs. Immisch and Co.'s one horse-power type, using in this case a current of 20 amperes, with an electromotive force of 48 volts. When the vehicle is running at a speed of ten miles an hour the motor makes 1,440 revolutions per minute, and develops ¾ horse-power. The weight of the accumulators is about 7cwt., and the weight of the carriage complete 11cwt.

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The Electrician.

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Owing to the increase in the number of pages of "The Electrician," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months.
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	... 12 6	... 24 0
„ Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	... 14 6	... 28 0
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"THE ELECTRICAL WORLD" IN THE UNITED KINGDOM.

Arrangements have been made by which "The Electrical World" of New York can be obtained from "The Electrician" Office, 1, Salisbury-court, Fleet-street, London, E.C.

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Similarly, "The Electrician" can be obtained in America at the Offices of "The Electrical World," 168 to 177, Potter-building, New York.

"The Electrician" can also be obtained from D. Van Nostrand, *23, Murray-street, and 27, Warren-street, New York.*

The Rate of Subscription for American Subscribers (payable in advance) is $6 per annum.

THE POSTMASTER-GENERAL'S REPORT.

Although the annual Reports of the present Postmaster-General are devoid of those features of popular interest which used to adorn the Blue Books issued by some of his predecessors, he has no reason to be ashamed of the work performed by the Department of which he is now the Parliamentary head. His Report for the financial year 1887-8, frigidly formal and business-like as it is, discloses a remarkable growth in those two branches of the public service most closely identified with the commercial and social well-being of the country. Of the postal branch we need say no more than that the results would astound us if we had not been gradually trained to regard them as a matter of course and the profits arising from them as a source of unfailing revenue. The early struggles of the Post Office were by no means so uniformly cheering; and in

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its efforts to meet the popular demands for cheapness it had to encounter many obstacles and to undergo many vicissitudes from which it is now wholly exempt. In the Telegraph service, however, which was added as a subsidiary branch of its business in 1870, the Post Office has repeated its earlier experiences, and from causes over which it has had no control, or for which it is not directly responsible, the business of the Telegraphs has been an uphill one from the first, and has still some ground to recover before it will rank, like the Post Office proper, as a revenue earning department of the State.

One of the causes of its financial shortcomings is the fact that the Telegraph system was purchased from private companies, who were carrying on a flourishing business, and had to be liberally compensated for its extinction. When, however, we remember that a business of £550,000 per annum has increased in the hands of the Post Office to £1,959,406, and the number of messages dealt with from 6,000,000 to 53,403,425, the twenty years' purchase money which was paid for it cannot be considered excessive. The business acquired on these conditions was then being rapidly developed, and unlike some businesses which have recently changed from private to public hands it continued to increase, and has had an uninterruptedly prosperous career. This at least may be said of it, measured by the standard of ordinary commercial undertakings. But, as a matter of fact, since its transfer to the State, the Telegraph service has been conducted not on commercial but on popular, and in some respects, it may be said, on political lines. In the first instance the tariff was extravagantly liberal; it reduced the price by more than half in compliance with public demands, but missed a golden opportunity of correcting the abuse of free addresses which the companies themselves had found unbearable. The result was, as many competent judges predicted it would be, that the shilling tariff did not pay its way. Not until the year 1881 did the net revenue yield sufficient to pay the interest on the original purchase money. This interest amounts to £326,417 per annum, and we believe that 1881 was the last as well as first year in which that charge was covered by profits.

Here we come to another of those hindrances to financial success which the Telegraphs of this country have encountered. No sooner did there appear signs of prosperity than demands arose for a still cheaper tariff; and the expenses incurred in anticipation of acceding to these demands, coupled with continued depression of trade and the necessarily increased charges of a service which had by this time attained dimensions far beyond expectations, soon converted a small surplus into a considerable deficit, which has lately been getting bigger every year, until the present, when it stands at £325,399. That is to say, the interest on capital swallows up what would otherwise be a small margin (£1,018) of profit, and leaves over £325,000 unpaid. The accumulated total of this annual arrears of interest now reaches several millions; and if the accounts were rendered on commercial principles this sum ought to be added to the capital account. A more reasonable ground for complaint, however, is that the outlay upon fresh works has always been charged against the revenue for the year in which they have been executed, instead of being, as they ought to be, placed to capital account bearing the usual interest. Mr. FAWCETT in his report for 1880-1 pointed out that by this system of account "the net profit in any particular year does not accurately measure the results of Telegraph business for that year, regarded from a commercial point of view;" and by way of illustrating his meaning he showed that the revenue for that year would have paid a dividend of 4·17 per cent. on the aggregate amount of capital invested down to date.

If Mr. RAIKES were to furnish a balance-sheet down to the present date framed on the same principles we rather fancy the figures would be not less satisfactory; and in that case the complaints of those who demur to the "deficit" column remaining a standing reproach to the Telegraph service would be amply justified. Retaining the present system of accounts, however, the revenue, advancing as it does by tremendous bounds, will speedily overtake the annual charge for interest, and we may confidently look forward, if the present sixpenny tariff remain undisturbed, to the Telegraphs soon paying their way and earning a handsome profit. In the years ending 31st March, 1883 and 1884, the revenue was increasing at the rate of twenty thousand per annum; in 1885 it fell five thousand below the year preceding; and in 1885-6, during six months of which the sixpenny tariff had been in operation, there was an increase of only three thousand pounds. But for the two years following, the increase has averaged one hundred thousand pounds, whilst, the working expenses seem to have reached a maximum, which at all events has not been exceeded in the year just expired. The process of extension is, however, not yet completed. During the past year 257 new offices were opened; and of course the expenditure on the staff of operators and officers must increase with their augmented responsibilities. One item of charge the metropolitan public will certainly not begrudge, namely that for placing the wires underground. Of the 1,745 lines of wire now entering the Central Office in London not one is overhead. In many cases the wires are conducted underground for distances of 12 to 22 miles from the office. If this example is not very welcome to the Telephone Companies, they have no ground for complaining of Post Office competition in their own line of business. The total number of subscribers to Postal Telephone Exchanges all told is only 1,370.

OBITUARY.

PROFESSOR EDLUND.

We learn with much regret that Prof. E. Edlund, who has for many years occupied the Chair of Physics at the Swedish Royal Academy of Sciences, died at Waxholm, near Stockholm, on the 10th of August, at the age of 69.

Prof. Edlund has done a considerable amount of valuable work in physics, and we have noted some fifty Papers which he has published in the scientific journals.

By far the greater number of these appeared in the *Transactions* of the Swedish Academy, and being written in the Swedish language could be studied in the original by only a very limited number of physicists.

Most of his more important Papers, however, were translated either into English or German, and appeared in the *Philosophical Magazine*, and in the *Annalen der Physik und Chemie* and other German journals. Some of his earlier Papers were devoted to the consideration of "Fluid Motion," the "Polarisation of Light During a Total Eclipse," the "Thermal Phenomena Accompanying Changes in Volume of Solid Bodies, and the Corresponding Mechanical Work," and other questions respecting heat and light. He, however, very soon turned his attention to electricity, and carried out a number of researches of some practical as well as of considerable theoretical value. In 1855 he described a method of simultaneously transmitting messages in opposite directions along the same telegraph wire, and a translation of the Paper was published in Dingler's *Polytechnisches Journal* for the following year.

Among other electrical Papers, we may mention the fol-

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lowing: "Heat Disengaged by Induction Currents, and the Relation between the Disengagement of Heat and the Mechanical Force Employed to Produce Them;" "Experimental Demonstration of the Elongation of a Wire, Independently of Heat Effects, by the Passage of an Electric Current through It." An abstract of this Paper was published in the *Philosophical Magazine*. Some very interesting Papers, translated in the *Philosophical Magazine*, contained accounts of a series of researches on the electric arc, viz.:—"Investigation of the Electric Light;" "Least E.M.F. by which a Galvanic Luminous Arc can be Produced;" "The New E.M.F. in the Voltaic Arc;" and "The Resistance of the Voltaic Arc." Another interesting Paper contains an account of researches into the cause of the Peltier effect.

He also published some investigations on the "E.M.F. of Contact of Different Metals," on the "Discharge of Electricity through Gases," and on the "Thermal Phenomena of the Galvanic Pile." His theories respecting the nature of electrical actions, especially as applied to unipolar induction, have excited a good deal of interest among physicists. He attempted to obtain an explanation of atmospheric electricity from his theory of unipolar induction, which he defended with vigour, but not, in our opinion, with success, against the attacks of numerous physicists. This subject has lately been treated at some length in our columns, and Prof. Edlund's theories have led to a considerable number of interesting investigations.

IMPROVEMENTS IN THE TELEPHONE SYSTEM OF GLASGOW AND THE WEST OF SCOTLAND.

By D. Sinclair, Engineer, National Telephone Company.

(Continued from page 564.)

I have said that the multiple switch-board is the best within our experience, and the fact that they are being adopted all over the world shows how much they are appreciated; but that they are perfect, or that they fulfil all that a perfect switch-board should do, is not the case. The chief point in which they are deficient is, that when two subscribers are joined together they have only what at best can be called a partial ring-off system. There have been several attempts to fulfil the requirements of the ring-off. One of these is what is known as the "Law" system, which is a loop wire circuit, starting from the exchange, entering into, say, 50 subscribers' offices, and returning to the exchange, and this circuit is used for speaking to the exchange only, each subscriber having an additional wire to the exchange in the ordinary way.

A modification of this system is at work in the National Telephone Company's Centre in Dundee, being a single wire, not a loop, and a connection from it is taken into, say, fifty offices in passing, and is used entirely for calling the exchange. This plan works with very marked success. It gives what is undoubtedly a great advantage to subscribers, but at the same time it causes a very considerable expense to the company. A little consideration will show that while a subscriber is using his call wire his other wire is idle, so that what is wanted is such switching facilities as will enable the subscriber to use his ordinary wire either as a call wire or as an ordinary wire at pleasure, and thus to do away with the trouble and cost of the circuit wire.

After working at the subject for some considerable time, I had an arrangement set up to do this work, the details of which are shown on Fig. 7, and is called "Sinclair's Automatic Ring-Off System." Its main points may be briefly stated as follows:—

In the subscriber's office is placed a commutated magneto, with a small two-way switch on it—one way exchange and the other subscriber—so that either a continuous or intermittent current can be sent from it. Now, as a continuous current will not ring a magneto bell, and will attract the armature of an indicator with that degree of tension upon it which prevents it being affected by an intermittent current, it is only necessary to use the switch to have the power to ring the subscriber without causing any effect in the exchange. When the exchange is wanted, a continuous current is sent which does not ring the subscriber's bell, and does cause the tongue of the indicator to be affected so as to automatically put it in connection with the operator's telephone. Instantaneous attention is the result, and in the same way, as with the "Law" system, the subscriber can say what is wanted. If then connected with any other subscriber, the operator puts the indicator into normal position, clearing her telephone, and leaving the subscribers free to talk privately until either of them wishes to get the exchange, when, as has been said, a continuous current will put his line automatically in connection with the operator's telephone in a moment.

When we can have this system at work with the "multiple" boards there will be no need for description of getting a telephone exchange connection such as *Punch* made so much of; nor will there be any necessity for the use on the part of telephone subscribers of so many adjectives not generally included in the Queen's English.

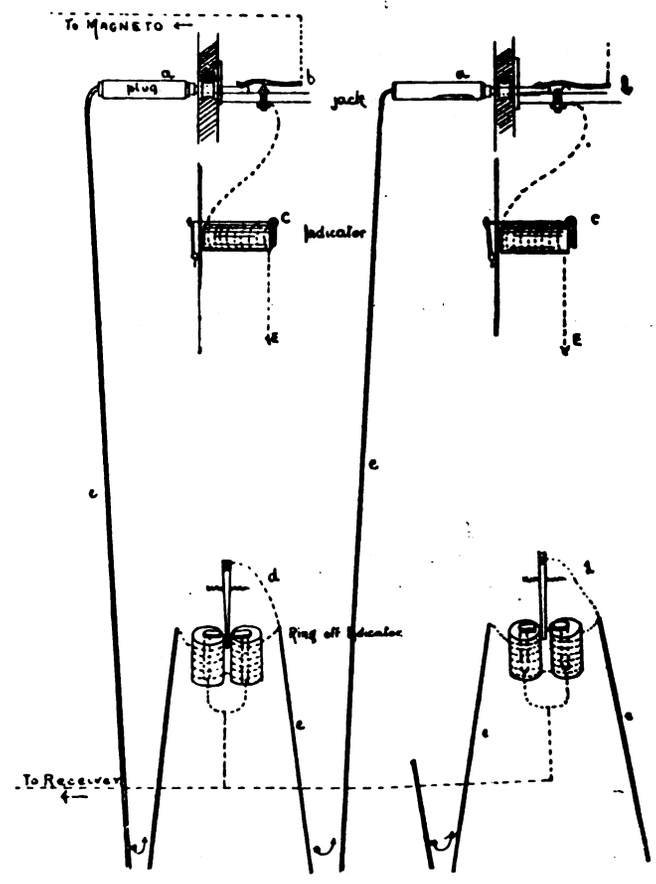

Fig. 7.

In Glasgow, as in other places, we have opened several branch exchanges in the town; they are six in number. At one time the perfect working of these seemed to be a great difficulty, but as they have now been arranged this has entirely disappeared. The wires connecting these branch exchanges we call "junction" wires, to distinguish them from "trunk" wires. At the Central Exchange we have a special operator and table set apart for working these wires. This we call our "junction wire exchange table," and from this table to each of the branch exchanges we have a wire used entirely for speaking between the operators. A plan of the connections is given on Figs. 8A and 8B.

The operating is extremely simple and quick, as it is but the work of a moment for the branch operator to close the circuit wire and tell the junction operator what is wanted, whether it be to connect with a subscriber in the "Central" or to connect with some other branch exchange.

As there is no ringing or calling attention the number of connections one operator can put through in this way is

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wonderful; any two branch exchange wires can be connected together by the movement of one plug. To meet the requirements of the Central Exchange in getting the branch exchanges, the wires are led through the multiple boards, so that each operator has power to connect her subscribers with these junction wires in the same way as if they had been subscribers' lines. Everything works very quietly and smoothly; there are no indicators, and no ringing on these junction wires. In the figure I have shown all the connections, as I am not aware of this being at work elsewhere.

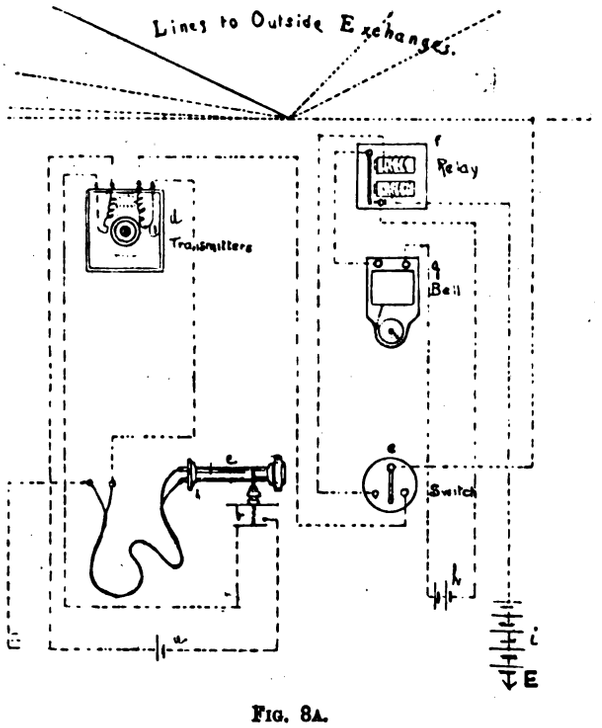

FIG. 8A.

Connections of junction board in Central Exchange. This diagram shows how junction wires are joined up on board; *m*, plug; *k*, jack; *l*, connecting cord.

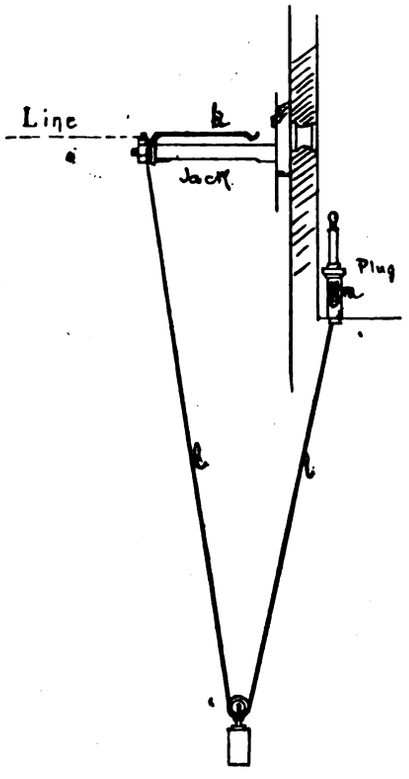

FIG. 8B.

Operator's circuit with lines from outside exchanges meeting on a common line on which connections are asked; *a*, local battery; *b*, receiver rest and battery cut-out; *c*, receiver; *d*, transmitter; *e*, two-way switch to put line direct on to instrument or to introduce relay *f*, bell *g*, and battery *h*; *i*, battery, introduced when switch is to relay and line is put to earth at distant exchange.

As a rule the junction operator keeps the telephone to her ear constantly. If she sets it down the switch puts a bell in circuit, so that any of the branches putting the wire to earth closes the circuit of the relay and bell, and commands immediate attention.

In doing the ordinary work of our Central Exchange it is necessary to ring about 10,000 times each day. This is accomplished by one of the magneto-electric generators of the same kind as used in the ordinary instruments, the apparatus being driven continuously by a small water motor. The amount of water used in this way for driving a generator for each of four exchanges so supplied costs about £5 per annum. The arrangement is fitted up in the basement of the building, and a wire led from the generator there to the central and three of the branch exchanges.

This works well, and gives complete satisfaction to all, unless, indeed, to the lineman who in wet weather catches a wire while the ringing current is on it. The high tension is much more than is agreeable to bear, and I have not been successful in clearing their minds of an idea that this arrangement was devised merely to smarten them up.

I shall next refer to "Sinclair's Automatic Branch Exchange Commutator." It will be readily understood that if six houses placed near each other at a point ten miles distant from London wish to have telephone communication, a wire run to each of them would be very costly, and, at most, would only be required thirty or forty minutes each day.

This instrument provides facilities so that only one wire requires to be run out to the place, and attached to the instrument there, then six branches are taken from it into the different houses. The instrument in this way constitutes a small automatic exchange without an office or operator. The working of the apparatus is as follows:—

When one of the six houses wishes communication the magneto is rung in the ordinary way, which has the effect, at the automatic instrument, of disconnecting the other five lines and connecting the caller's own wire with the main line going into the central exchange. If one of the other five lines on the intrument is wanted, the exchange operator would send a certain number of successive currents, which by an ordinary step-by-step movement puts the pointer to the number wished for, and connects up the wire of that particular subscriber. The two local instruments are now in communication. The exchange disconnects her wire while they are speaking. When finished the instrument is made to perform a complete revolution, thereby putting everything back into normal position, so that any other subscriber may again ring up. When the exchange wishes, say, No. 3, the peg of the "sender" is put in that number, and allows three currents to go out to line, which causes the pointer on the automatic instrument to go round to No. 3. The others, being disconnected, cannot interfere. A magneto current is then used to ring up No. 3, who replies in the ordinary way. As before, when finished the "sender" is allowed to go to zero, which puts the automatic instrument into proper position again. Some of these have been at work in Glasgow with as many as twelve wires, and have given every satisfaction.

I think it is evident that when the time arrives for the telephone enterprise to be freed from patent restrictions and Government royalties then the outside wires which this instrument has been designed to save will have a much higher relative value in the system as a whole; consequently the use of such an instrument will be of greater importance.

(To be continued.)

The Berlin-Breslau Telephone Line.—Telephonic communication was opened on Tuesday between Berlin and Breslau. The line is the longest in Germany, being 360 kilometres. Every word was heard most distinctly.

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THE ELECTRIC TRANSMISSION OF POWER.*

BY PROF. AYRTON, F.R.S.

What is power, and why should we wish to transmit it? Power has one very definite meaning in science, and several rather vague meanings in practice. We speak of a powerful athlete, the power of the law, we sing of the power of love, we say knowledge is power, and so on, using the word in several different senses. Now, in spite of the fact that a general audience feels a little anxious as to what troubles may be in store for it when a lecturer begins by being painfully exact, my telling you that by power an engineer understands the rate of doing work will not, I hope, make you fear that my remarks will bristle with technicalities.

When you walk upstairs you exert power, only, perhaps, the one-twentieth of a horse when you go up slowly talking to other people; but when you run upstairs, because you have forgotten something that you intended to bring down, then your exertions represent, perhaps, the one-tenth of a horse-power. You only get to the top of the stairs in either case, but the breathless sensation of running fast upstairs tells you that the more quickly you go the harder you are working. A person exercises power in the engineer's sense when he exerts himself physically, and the greater the exertion the greater the power. The exercise of power by the ruling classes, however, is unfortunately not necessarily accompanied by any exertion, physical or mental.

Probably, the most familiar example of exerting power at a distance, that is of transmitting power, is pulling a handle and ringing a bell in another room. I pull the handle, exerting myself slightly, and as the result the bell at the other end of the platform rings. Were not this such a very familiar operation I would call it experiment No. 1. You have, doubtless, all of you performed this experiment several times to-day, and what is all important with an experiment, performed it successfully.

And yet it was not until just one hundred years ago that it dawned on people that if one person, A, wanted to attract the attention of another person, B, the place where the bell ought to sound was where B was, and not where A was. Indeed, in many English villages down to the present day the knocker principle of attracting attention is alone resorted to, with the result which you may remember happened when Mr. Pickwick was staying in Bath at lodgings in the Royal Crescent, and Mr. Dowler undertook to sit up for Mrs. Dowler, but "made up his mind that he would throw himself on the bed in the back room and *think*—not sleep, of course. . . Just as the clock struck three there was blown into the Crescent a sedan chair, with Mrs. Dowler inside, borne by one short, fat chairman, and one long thin one. . . They gave a good round double knock at the street door. . . 'Knock again, if you please,' said Mrs. Dowler, from the chair. 'Knock two or three times, if you please.' The short man stood on the step, and gave four or five most startling double knocks of eight or ten knocks apiece while the long man went into the road and looked up at the windows for a light. Nobody came; it was as silent and as dark as ever." But the tall thin man you may remember "kept on perpetually knocking double knocks of two loud knocks each like an insane postman," till Mr. Winkle, waking up from a dream "that he was at a club where the chairman was obliged to hammer the table a good deal to preserve order," met with the catastrophe which the readers of Pickwick will remember.

This episode shows what it is to have plenty of power and no means of utilising it. But if some houses can still dispense with mechanical or other methods of transmitting power, even to ring bells, factories cannot. The looms, the lathes, or whatever the machinery used in the factory may be, must either be worked by hand or foot, in the old style, or it must be connected with the steam, gas, or water engine in the new. On entering a large factory you see lines of rapidly rotating shafting, and a network of rapidly revolving belting, all employed in transmitting power. As a contrast to this, I now throw on the screen a photograph of Sir David Salomons' workshop at Tunbridge Wells, in which every machine is worked by a separate electric motor, thus saving to a great extent the loss of power that usually accompanies the mechanical transmission.

In America there are 6,000 electro-motors working machinery; in Great Britain hardly 100.

But it is not only in transmitting the power from the steam, gas, or water engine of a factory to the various machines working in it that electricity can be utilised. An incredible amount of power is daily running to waste in this and other countries because many of the rapid streams of water are too far away from towns for their power to have been hitherto utilised.

The holiday tourist when admiring the splashing water dashing over the stones hardly realises that the money loss is as if the foam were composed of flakes of silver.

If we take as a low estimate that a large well-made steam engine burns only 2lb. of coal per horse-power per hour, the coal consumption which would be equivalent to the waste of power at Niagara would exceed 150 millions of tons per annum, which, at only 5s. or 6s. per tons, means some 40 millions pounds sterling wasted. And descending from big things to small, the River Avon flowing through Bath, which, so far from being a roaring cataract, especially in dry weather, pursues its course with only a respectable orderly swish, still represents a certain amount of loss power. It has been estimated that from 25 to 130 horse-power runs to waste at the Bathwick Weir behind the Guildhall, depending on the season. If we take as an all-round average that the fall of this weir represents 50 horse-power, and that a steam engine producing this power burns 150lb. of coal per hour, it follows that with steam coal at 16s. per ton, the price at Bath, the waste at Bathwick Weir represents an income of £450 per annum—not a princely fortune, it is true, but too large to be utterly thrown away, as at present.

This state of things will, I hope, however, be shortly remedied, for, as you will see from the large map on the wall, it is proposed to put up 81 electric arc lamps throughout the streets of Bath, and to supply the 50 horse-power required for these lamps by the fall of the Bathwick Weir, supplementing the fall with a steam engine at dry seasons.

The next large diagram shows the use that Lord Salisbury has made of the River Lea to electrically light Hatfield House and to supply electric motive power to the various machines working on his estate; and the following diagram shows the course of the Portrush Electric Railway (see *Electrician*, April 21, 1883, p. 545; October 27, 1883, p. 566), 6½ miles long, which is worked by the Bushmill Falls, situated at about one mile from the nearest point of the railway; and, lastly, this working model on the table, kindly lent me by Dr. E. Hopkinson, as well as the diagram on the wall, represent the Bessbrook and Newry Electric Tramway, a little over three miles in length, which is also worked entirely by water-power, the turbine and dynamo which convert the water-power into electric power being at about three-quarters of a mile from the Bessbrook terminus. [Model of electric tramway shown in action.]

The newspapers of last week contained a long account of the spiral electric mountain railway that has just been opened to carry people up the Burgenstock, near Lucerne, and worked by the River Aar, three miles away, so that we see electric traction worked by distant water-power is extending. But splendid as are these most successful uses of water-power to actuate distant electro-motors, it is but a stray stream here and there that has yet been utilised, and countless wealth is still being squandered in all the torrents all over the world.

The familiarity of the fact makes it none the less striking that, while we obtain in a laborious way from the depths of the earth the power we employ, we let run to waste every hour of our lives many, many times as much as we use.

It is also a well-established, time-honoured fact that large steam engines can be worked much more economically than small ones, and that, therefore, if it were possible to *economically* transmit the power from a few very large steam engines to a great number of small workshops, there would be a great saving of power, as well as a great saving of time, from the workmen in these many small workshops having only to employ this power for various industrial purposes, instead of having to stoke, clean, repair, and generally attend to a great number of small, uneconomical steam engines.

When delivering the lecture which I had the honour to give at the meeting of the British Association at Sheffield nine years ago, I entered fully into Prof. Perry's and my own views on this subject, and, therefore, I will not enlarge on them now. You can all realise the difference between the luxury of merely getting into a train instead of having to engage post horses, of being able to send a telegram instead of employing a special messenger, or being able to turn on a gas tap and apply a match when you want a light, instead of having to purchase oil and a wick and trim a lamp. Well, a general supply of power to workshops is to the manufacturer what a general supply of light or a general supply of post office facilities is to the householder; it is all part of the steady advance of civilisation that leads the man of to-day to go to the tailor, the shoemaker, the baker, the butcher, instead of manufacturing his own mocassins and lassoing a buffalo for dinner. And in case any of you may be inclined to think that we have gone far enough in these new-fangled notions—and we are all, perhaps, prone to fall into this mistake as we grow older—let me remind you that while each age regards with justifiable pride the superiority of its ways to those of its ancestors, that very age will appear but semi-civilised to its great grandchildren. Let us accept as an undoubted fact that a general distribution of power would enable the wants of civilised life to be better satisfied, and therefore would greatly benefit industry.

There are four methods of transmitting power to a distance:—

1. By a moving rope.
2. By air compressed or rarefied at one end of a pipe operating an air motor at the other end.
3. By water forced through a pipe working a water motor.
4. By electricity.

* Delivered at the Drill Hall, Bath, Friday, Sept. 7, 1888.

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We have an example of the transmission of power through a short distance by an endless belt or rope in the machines geared together by belts on this platform, and in the rotatory hairbrushes at Mr. Hall's establishment in the Corridor, Bath. At Schaffhausen, and elsewhere in Switzerland, the principle is employed on a large scale. Spain and other countries use it in connection with the mining operations, and lastly, wire ropes replace horses on many hilly tramways. Do not look, however, for the wire rope of the Bath Cable Tramways, for cable is only to be found painted on the sides of the cars.

For short distances of a mile or so there is no system of transmitting power in a *straight line* along the open country so cheap to erect, and so economical of power as a *rapidly* moving endless rope; but the other systems give much greater facilities for distributing the power along the line of route, are much less noisy, and far surpass wire rope transmission in economy, when the rope must move somewhat slowly, as in tramway traction, or when the distance is considerable over which the power is transmitted, or when the line of route has many bends.

In the same sense that an ordinary house bell man be considered as a crude example of the transmission of power by a moving rope, the pneumatic bell at the other end of the hall, which I now ring by sending a puff of air through the tube, is a crude example of the transmission of power by compressed air. [Pnuematic bell rung.] Compressed air is employed to work from a distance the boring machines used in tunnelling; the continuous vacuum brakes used on many of the railways are also probably familiar to you, and the pneumatic system of transmitting power to workshops is shortly to be tried on a fairly large scale at Birmingham.

But distribution of power by water pressure is the plan that has hitherto found most favour in this country. That little water motor at the other end of the platform rapidly revolves when I work this garden syringe, and serves as a puny illustration of the transmission of water pressure. [Experiment shown.] Pressure water has been employed for years on a large scale at Hull for distributing power; also by Mr. Tweddle as a means of communicating a very large amount of power through a flexible tube to tools that have to be moved about, but the grandest illustration of this principle is the vast system of high-pressure mains that has been laid throughout London, as you will see from the photograph that I now project on the screen of the map kindly lent me by Mr. Ellington.

The economy of this system is so marked, and the success that has attended its use so great, that, did I not feel sure that electricity offers a grander system still, it would be with fear and trembling that I should approach the subject of this evening, the "Electric Transmission of Power." *Punch* drew six years ago the giant steam and the giant coal looking aghast at the suckling babe, electricity, in its cradle. That babe is a strong boy now. Let the giant water look to its laurels ere that boy becomes a man, for the electric transmission of power even now bids fair to surpass all other methods in

1. Economy in consumption of fuel.

2. More perfect control over each individual machine, for see how easily I can start this electric-motor and how easily I can vary its speed. [Experiment shown.]

3. Ability to bring the tool to the work instead of the work to the tool. This rapidly rotating polishing brush, with its thin flexible wires conveying the power, I can handle as easily as if it were a simple nail brush.

4. In greater cleanliness, no small benefit in this dirty, smoky age.

5. And, lastly, there is still one more advantage possessed by this electric method of transmitting power that no other method can lay claim to—the power which during the daytime may be mainly used for driving machinery can, in the easiest possible way, be used during the night for driving light. I turn this handle one way and the electric current, coming by one of these wires and returning by the other, works this electro-motor; now I turn the handle the other way and the current, which comes and returns by the same wires as before, keeps this electric lamp glowing. [Experiment shown.]

It might be said that the transmission of power by coal-gas, which I have omitted from my list, fulfils the condition; but so also does the transmission of power by a loaded coal waggon. In both these cases, however, it is fuel itself that is transported, and not the power obtained by burning the fuel at a distant place.

Let us study this electric transmission a little in detail. I pull this handle, and the bell at the other end of the room rings, but in this case there is no visible motion of anything between the handle and the bell. [Electric bell rung by an electric current produced by pulling the handle of a very small magneto electric machine.] Whether I ring the bell by pulling a wire, or by sending an air puff, or by generating an electric current by the exertion of my hand, the work necessary for ringing the bell is done by my hand exactly as if I took up a hand bell and rung it. In each of the three cases I put in the power at one end of the arrangement and it produces its effect at the other. In the electric transmission how does this power travel? Well, we do not know; it may go through the wires, or through the space outside them. But although we are really quite in the dark as to the mechanism by means of which the electric power is transmitted, one thing we do know from experience, and that is this—given any arrangement of familiar electrical combinations, then we can foretell the result.

Our knowledge of electrical action in this respect resembles our knowledge of gravitation action. The only thing quite certain about the reason why a body falls to the ground is that we do not know it; and yet astronomical phenomena can be predicted with marvellous accuracy. I mention the analogy since some people fancy because the answer to that oft-repeated question "What is electricity?" not only cannot be given exactly, but can only be guessed at in the haziest way, even by the most able, that therefore all electric action is haphazard. As well might the determinations of a ship's latitude at sea be regarded as a mere game of chance because we have not even a mental picture of the ropes that pull the earth and sun together.

This power of producing an action at a distance of many yards, or it may be many miles, by the aid of electricity without the visible motion of any substance in the intervening space is by no means new. It is the essence of the electric telegraph, and electric transmission of power was employed by Gauss and Weber when they sent the first electric message. I am transmitting power electrically whether I now work this small model needle telegraph instrument, or whether I turn this handle and set in motion that little electric fan. [Experiment shown.]

But until about ten years ago the facility that electricity gave for producing signals almost instantaneously at a great distance was the main thing thought of. The electric power consumed for sending the telegraphic messages was so small, the amount of power lost *en route* comparatively so valueless, that the telegraph engineer had no need to trouble himself with those considerations that govern us to-day, when we are transmitting power large enough to work a factory or an electric tramway. Although there are as many as 22,560 galvanic cells at the Central Telegraph Office, London, which cost some thousands annually to keep in order, what is that compared with the salaries of all the 3,089 superintendents, assistants, telegraph clerks, messengers, and the maintenance of the 1,150 telegraph lines that start from the central office?

In all last three of the systems on my list, some form of power, such as flowing water or the potential energy stored up in coal, wood, zinc, or other fuel, has initially to be utilised; this power is given to some form of air, water, or electric pump, which transfers the air power to the air, water, or electricity, by which it is conveyed to the other end of the system. There it is re-converted into useful mechanical power by means of an air, water, or electro motor.

You will observe that I class together air, water, and electricity; by that I do not mean to imply that electricity is a fluid, although in many respects it acts like a fluid—like a fluid of very little mass, however, or, odd as it may seem, like a fluid moving extremely slowly, for electricity goes round sharp corners with perfect ease, and without any of the phenomena of momentum possessed by rushing water. But what I particularly wish to impress on you by classing air, water, and electricity together is that electricity is not, as some people seem to think, a something that can be burnt or in some way used up and so work got out of it. Electricity is no more a source of power than a bell wire is; electricity is a marvellously convenient agent for conveying a push or a pull to a great distance; but it is not by the using up of the electricity that electric lights burn or that electro-motors revolve. It is by the electricity losing pressure, exactly as water loses head when turning the miller's wheel as it flows down hill that work is done electrically.

This model shows, in a rough, symbolical way, what takes place in the transmission of power, whether by air, water, or electricity. [Model shown.] The working stuff, whichever of the three it may be, is first raised in pressure and endowed with energy, symbolised by this ball being raised up in the model; it then gradually loses pressure as it proceeds along the tube or wire which conveys it to the other end of the system, the loss of pressure being accompanied by its giving up power to the tube or wire and heating it.

This is shown in the model by the ball gradually falling in its course. At the other end there is a great drop of pressure corresponding with a great transference of power from the working stuff to the motor, and finally it comes back along the return pipe or wire, losing, as it returns, all that remains of the pressure given to it initially by the pump. The ball has, in fact, come back to its original level.

The problem of economically transmitting power by air, water, or electricity is the problem of causing one or other of these working stuffs—air, water, or electricity—to economically perform the cycle I have described.

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In each of the four stages of the process :—

1. Transference of power to the working substance at the pump,
2. Conveyance of power to the distant place,
3. Transference of power from the working substance to the motor at the distant place,
4. Bringing back the working substance,

there is a loss of power, and the efficiency of the arrangement depends on the amount of these four losses. The losses may be shortly called—

1. Loss at the pump.
2 and 4. Loss on the road.
3. Loss at the motor.

Until 1870 the pump most generally employed for pumping up electricity and giving it pressure was the galvanic battery, a scientifically and extremely efficient converter of the energy in fuel into electric energy, only unfortunately the only fuel a battery will burn is so expensive. A very perfect fireplace, in which there was very complete combustion, and very little loss of heat, but which had the misfortune that it would only burn the very best wax candles, would be analogous with a battery. The impossibility of using zinc as fuel to commercially work electro-motors has been known for the last half century, and the matter was very clearly put in an extremely interesting Paper, "On Electro-Magnetism as a Motive Power," read in 1857 by Mr. Hunt before the Institution of Civil Engineers, a copy of which has been kindly lent me by Dr. Silvanus Thompson. Prof. William Thomson (Glasgow)—I quote from the discussion on the Paper—put the matter very pithily by showing that even if it were possible to construct a theoretically perfect electro-motor, the best that could be hoped for, if it worked with a Daniell's battery, would be the production of a 1 horse-power by the combustion of 2lb. of zinc per hour, whereas with a good actual steam engine of even thirty years ago 1 horse-power could be produced by the combustion of exactly the same weight of the much cheaper fuel, coal. This argument against the commercial employment of zinc to produce electric currents is irresistible unless—and this is a very important consideration which is only beginning to receive the attention it deserves—unless, I say, the compound of zinc formed by the action of the battery can he reduced again to metallic zinc by a comparatively inexpensive process, and the zinc used over and over again in the battery. If the compound of zinc obtained from the battery be regarded as a waste product, then it would be much too expensive to work even theoretically perfect electro-motors if they were existent by consuming zinc. Suppose, however, a process be devised by means of which burnt zinc can be unburnt with an expenditure comparable with the burning of the same weight of coal, then it might be that although coal would still form the basis of our supply of energy, the consumption of zinc batteries might be an important intermediary in transforming the energy of coal economically into mechanical energy.

While, then, some experimenters are aiming at possibly increasing the working power of a ton of coal to eight times its present value by earnestly seeking for a method of converting the energy it contains directly into electric energy without the intervention of a wasteful heat engine, it should not be forgotten that in the cheap unburning of oxidised metal may lie another solution.

The solution of this latter problem is quite consistent with the principles of the conservation and dissipation of energy, since the heat required to theoretically unburn 1lb. of zinc is only one-seventh of that given out by the burning of 1lb. of coal. Further, it involves no commercial absurdity like that found in the calculations given in the prospectuses of many primary battery companies which are based on zinc oxide, a material used in the manufacture of paint, maintaining its present price even if thousands of tons were produced. Unless all those who use primary batteries on this expectation intend to have the painters doing up their houses all the year round, they will find themselves possessed of the stock-in-trade of an oil and colourman on a scale only justified by a roaring business in paint.

Now about waste No. 3, the waste of power at the motor. That also is gone into fully in the discussion in Mr. Hunt's Paper, and Mr. Robert Stephenson concluded that discussion by remarking :—"That there could be no doubt from what had been said that the application of voltaic electricity in whatever shape it might be developed was entirely out of the question, commercially speaking. . . . The power exhibited by electro-magnets extended through so small a space as to be practically useless. A powerful electro-magnet might be compared for the sake of illustration to a steam engine with an enormous piston, but with an exceedingly short stroke. Such an arrangement was well known to be very undesirable."

And this objection, made with perfect justice against the electro-motors of thirty years ago, might also have been made to all the machines then existing for the mechanical production of electric currents. I have two coils of wire at the two sides of the platform joined together with two wires. I move this magnet backwards and forwards in front of this coil, and you observe the magnet suspended near the coil begins to swing in time with my hand. [Experiment shown.] Here you have in its most rudimentary form the conversion of mechanical power into electric-power and the re-conversion of electric power into mechanical power ; but the apparatus at both ends has the defects pointed out by Mr. Hunt and all the speakers in the discussion on his Paper—the effect diminishes very rapidly as the distance separating the coil from the moving magne increases.

As long as electro-motors as well as machines for the production of electric currents had this defect the electric transmission of power was like carrying coals to Newcastle in a leaky waggon. You would pay at least 16 shillings for your coals in Bath, lose most of them on the way, and sell any small portion that had not tumbled out of the waggon for, say, two shillings a ton at Newcastle, a commercial speculation not to be recommended.

A very great improvement in electro-motors was made by Pacinotti in 1860, but although his new form of electro-motor was described in 1864, it attracted but little attention, probably because any form of electro-motor, no matter how perfect, was commercially almost useless until some much more economical method of producing electric currents had been devised than the consumption of zinc and acids. Pacinotti's invention removed from motors that great defect that had been so fully emphasised by the various speakers at the reading of Mr. Hunt's Paper in 1857. When describing his motor in the *Nuovo Cimento*, in 1884, he pointed out that his principle was reversible, and that it might be used in a mechanical current generator. This idea was utilised by Gramme in 1870, who constructed the well-known Gramme dynamo for converting mechanical into electric power, a machine far more efficient than even Pacinotti had contemplated, and gave the whole subject of electrical engineering a vigorous forward impulse. Every subsequent maker of direct-current dynamos, or motors, has followed Gramme's example in utilising the principle devised by Pacinotti, which was as follows :—In all the early forms of dynamos or motors there were a number of magnets and a number of coils of wire, the magnets moving relatively to the coils, or the coils relatively to the magnets, as you see in this rather old specimen of alternate-current dynamo. To produce magnetism by a large number of little magnets is not economical, and Pacinotti's device consisted in arranging a number of coils round a ring in the way shown in the large wooden model [model shown] so that they could all be acted on by one large magnet. Instead of frittering away his magnetism, Pacinotti showed how it could be concentrated, and thus he led the way to dynamos and motors becoming commercial machines. Pacinotti's science, engineered by Gramme, not only made electric lighting commercially possible, but led to electricity being used as a valuable motive power. It was in their work that the electric transmission of power in its modern sense sprang into existence.

Quite recently an improvement in the same direction has been introduced into alternate-current dynamos by Mr. W. N. Mordey, for he has replaced the many magnets of the ordinary alternate-current dynamos with one large magnet, and so with his alternator weighing 41cwt., which you see in this hall, he has succeeded in obtaining at a speed of 650 revolutions per minute an output of 53·6 horse-power with a high efficiency.

It may be convenient to mention at this stage the valuable work that has been done by the Drs. Hopkinson, Mr. Crompton, Mr. Kapp, and others in the improving dynamos and motors by applying scientific principles in the construction of these machines. Were I lecturing on dynamos and motors instead of on the electric transmission of power, I would explain to you how, by putting more iron into the rotating armature, as it is called, and less wire on it, by shortening the stationary magnet, and generally by concentrating the magnetic action, these constructors have raised the commercial efficiency of these machines to actually as high as between 93 and 94 per cent. ; further, how by recognising the force of the general principles laid down by Prof. Perry and myself as to the difference that should exist in the construction of a motor and a dynamo, Messrs. Immisch have succeeded in constructing strong, durable electro-motors, weighing not more than 62lb. per effective horse-power developed.

The subject is so entrancing to me, the results commercially so important, that I am strongly tempted to branch off, but the inexorable clock warns me that I must concentrate my remarks as they have concentrated the magnetic action.

Eighty-seven and a-half per cent. of the power put into an Edison-Hopkinson dynamo has actually been given out by the motor spindle when 50 horse-power was being transmitted. How does this compare with the *combined* efficiencies of an air pump and an air motor, or of a water pump and a water motor ? I understand that in either of these cases 60 per cent. is considered a very satisfactory result. As far, then, as the terminal losses are concerned, electric transmission of power is certainly superior to air or water transmission.

The next point to consider is the loss of power on the road

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between the dynamo at the one end and the motor at the other. This problem was perhaps seriously attacked for the first time in the discussion of a Paper read by Messrs. Higgs and Brittle, at the Institution of Civil Engineers, in 1878, and that problem was considered in some detail theoretically and experimentally at the lecture I gave during the meeting of the British Association in Sheffield in the following year. It was then shown that, since the power developed by the generator and motor depended on the product of the current into the electric pressure, while the loss when power was transmitted through a given wire depended on the square of the current and was independent of the electric pressure, the economical transmission of power by electricity on a large scale depended on the use of a very large electric pressure and the small current, just as the economic transmission of much power by water depended on the use of a very large water pressure and a small flow of water. At that time it was not thought possible to construct a small dynamo to develop a very large electric pressure, or potential difference as it is technically called, and therefore it was proposed to join up many dynamos in series at the one end, and many lamps or electro-motors in series at the other, and to transmit the power by a very small current which passed through all the dynamos and all the lamps in succession one after the other.

You have an example to-night of the realisation of this principle in the 15 arc lamps that are all in series outside this Drill Hall, and are worked with a small current of only 6·8 amperes, and a further example in the 30 arc lamps at the Bath Flower Show, which are also all worked in series with the small current passing through them; but it is known now how to produce a large potential difference with a single dynamo, so that a single Thomson-Houston dynamo belonging to Messrs. Laing, Wharton and Down supplies the current for each of the two circuits.

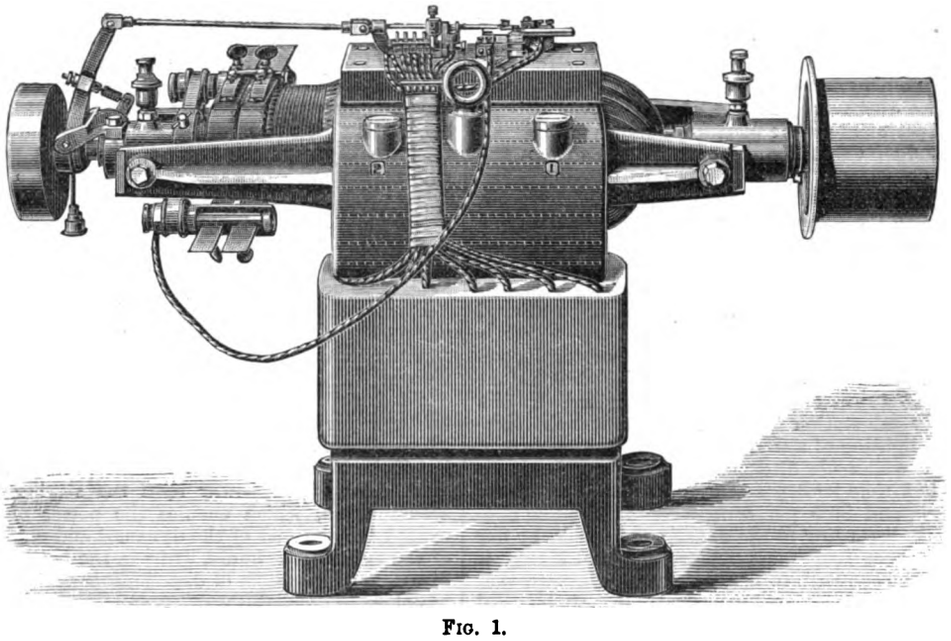

Fig. 1.

The electric pressure, or potential difference, between the terminals of any arc lamp is not high, but it is between the main wires near the dynamo as well as between these wires and the ground. How far does this lead to the risk of sparks or unpleasnt shocks? That is a point that can be looked at in a variety of ways. First, there is the American view of the matter, which consists in pointing out to people exactly what the danger is, if there be any, and training them to look out for themselves. Let ordinary railway trains, say the Americans, run through the streets, and let horses learn to respect the warning bell. Next, there is the semi-paternal English system, which cripples all attempts at street mechanical locomotion, because we are conservative in our use of horses, and horses are conservative in the way of looking at horseless tramcars. Lastly, there is their foreign paternal system, which, carried to its limit, would prohibit the eating of dinners because some people have at some time choked themselves, and would render going to bed a penal offence because it is in bed that most people have died.

We laugh a good deal at the rough and ready manner adopted on the other side of the Atlantic. The Americans, no doubt, are very ignorant of the difficulties that properly-minded people would meet with, but it is a blissful ignorance where it is folly to be wise. Every English electrician who has travelled in America comes back fully impressed with their enterprise and their happy-go-lucky success. They have twenty two electric tramways, carrying some four million passengers annually, to our four electric tramways at Portrush, Blackpool, Brighton, and Bessbrook. Why, New York city alone, Mr. Reckenzaun tells me, possesses 300 miles of ordinary tramway track, and Philadelphia city 430 miles, so there are more tramway lines in these two cities than in the whole of the United Kingdom put together. Now, there would be no difficulty in proving to anyone unfamiliar with railway travelling that to go at 50 miles an hour round a curve, with only a bit of iron rail between him and eternity, would be far too risky to be even contemplated. And yet we do go in express trains, and even 80 miles an hour is beginning to be considered not to put too great a demand on the funds of life insurance companies. The American plan of basing a conclusion on experience rather than on anticipations is not a bad one, and if we follow that plan, then taking into account that there are 75,000 arc lights alight every night on the Thomson-Houston high-potential circuits throughout the world, and the comparatively small number of people that have suffered in consequence (not a single person, I am assured, outside the companies' staffs), we are compelled to conclude that high potential now is what 30 miles an hour was half a century ago—uncanny rather than dangerous.

But it is possible to use a very large potential difference between the main wires by means of which the electric power is economically conveyed a considerable distance and transformed into a very small potential difference in the houses where it is utilised. An electric transformer is equivalent to a lever, or wheel and axle, or any other of the so-called mechanical powers. You know that a large weight moving through a small distance can raise a small weight through a large distance, there is no gain in the amount of work, but only a transformation of the way in which the work is done. A large weight moving through a small distance is analogous with a high potential difference and a small current, while a small weight moving through a large distance is analogous with a small potential difference and a large current; and an electric transformer is for the purpose of effecting the transformation with as little loss as possible, so that what is lost in potential difference may be all gained in current.

Electrical transformation may be effected by—

1. Alternate-current transformers.
2. Motor-dynamos.
3. Accumulators, or secondary batteries.
4. Direct-current transformers.

Of these apparatus, the eldest by far is the alternate-current transformer, as it is merely the development of the classical apparatus invented by Faraday in 1831, and familiar to many of you as the Ruhmkorff or induction coil. A combination of a motor and dynamo was suggested by Gramme in 1874. Accumulators are the outcome of Planté's work, while direct-current transformers are quite modern, and not yet out of the experimental stage.

After studying the literature on this subject, it appears, as far as I have been able to judge, that the first definite proposal to use a high-potential difference in the street mains and transform down to a low-potential difference in the houses was made in the lecture given by me at the meeting of the British Association in Sheffield in 1879, on which occasion I explained and showed in action the motor-dynamo principle suggested by Prof. Perry and myself. The apparatus on the platform is not unlike that shown on the former occasion. An Immisch motor (Fig. 1), working at 500

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volts, and with a current of 6·8 amperes, is geared direct to a Victoria Brush dynamo giving five times that current, and we will now use this larger current to produce an electric fire. [Experiment shown.] Messrs. Paris and Scott have combined the motor and dynamo into one machine, which they have kindly lent me, and by means of which we are now transforming about 700 volts and 6·8 amperes into 100 volts, and about 40 amperes used to light that group of incandescent lamps and work these motors. [Experiment shown.]

Lastly, here is a working illustration of the double transformation proposed by MM. Deprez and Carpentier in 1881 by means of which, while the potential difference between the mains may be two or ten thousand volts if you like, not merely is the potential difference in the house so low that you could hardly feel anything if you touched the wires, but, in addition, there is the same security against shocks in the dynamo room. This alternate-current machine is producing about 50 volts, which is transformed up to 2,000 volts by means of this transformer. At the other end of the platform by means of a similar transformer the 2,000 volts is transformed down again to 50 volts employed to light that cluster of low voltage incandescent lamps. I have to thank the Anglo-American Brush Company for the loan of this apparatus. [Experiment shown.]

In this experiment there is, as a matter of fact, still more transformation than that I have yet mentioned, because whereas in actual practice the alternate-current dynamo, as well as the small dynamo used to produce the current for magnetising the electromagnets in the alternate-current dynamo, would be worked by a steam, gas, or water engine, I am working them both by electromotors, since a steam engine or a water wheel would be an unsuitable occupant of the Drill Hall. Practically, then, a steam engine on the land belonging to the Midland Railway Company on the other side of the Lower Bristol road is driving a Thomson-Houston dynamo; this is sending a small current working these high-voltage constant-current Immisch motors. The motors being geared with low-voltage dynamos the potential difference is transformed down, the first alternate-current transformer tranforms it up again, and the second alternate-current transformer transforms it down again, so that there are, in fact, three transformations taking place in this experiment on the platform before you (Fig. 2). A vast district in London, extending from Regent's Park on the north to the Thames on the south, from the Law Courts on the east to Hyde Park on the west, has over 20,000 incandescent lamps scattered over it, all worked from the Grosvenor Gallery in Bond-street, by means of alternate-current transformers, which convert the 2,000 volts maintained between the street mains into 100 volts in the houses; and this London electric supply company have arranged for a vast extension of this system to be worked from Deptford.

In America alternate-current transformers are, due to the remarkable enterprise of Mr. Westinghouse, used to light 120,000 incandescent lamps in 68 towns; in fact, the electric lighting of a whole town from a central station begins to excite less astonishment than the electric lighting of a single house did ten years ago.

The efficiency of a well-made alternate-current transformer is very high, being no less than 96·2 per cent. when the transformer is doing its full work, and 89·5 per cent. when it is doing one-quarter of its full work, according to the experiments made by our students. It certainly does seem most remarkable, and it reflects the highest praise on the constructors of electrical machinery, that motor power can be converted into electrical power, electrical power at low pressure into electrical power at high pressure, or electrical power at high pressure into electrical power at low pressure; or, lastly, electrical power into motor power—in each case with an efficiency of 94 per cent.

As a further illustration of the commercial importance of this electric transformation I will show you some experiments on electric welding, one of the latest developments in electrical engineering. To weld a bar of iron one square inch in section requires a gigantic current of some 13,000 amperes. To convey this current even a few yards would be attended with a great waste of power, consequently while an enormous current is passed through the iron to be welded, only a comparatively small current is transmitted along the circuit from the dynamo to the welding apparatus. Mr. Fish, the representative of Prof. Elihu Thomson, of America, to whom this apparatus is due, will be so kind as to first show us the welding together of two bars of square tool steel, the edge of each bar being three-quarters of an inch, and the operation is, as you see, entirely completed in some 15 seconds. For this experiment an alternate current of 20 amperes will be produced by the dynamo at the other side of the Lower Bristol-road, and this current will be converted by the transformer on the platform into one of 9,000 amperes, large enough for 12,000 of those incandescent lamps if these were placed in parallel and the current divided among them. He will next try welding some thicker bars; and, lastly, he proposes welding together two pieces of aluminium, which it is extremely difficult, if not impossible, to weld in any other way. The bars, as you see, are in each case pressed together end on, and, in consequence of the electric resistance of the very small gap between the bars being much higher than that of the bars themselves, the current makes the ends of the bars plastic long before it even warms the whole bar, so that I can, as you see, take hold of the iron or steel two or three inches away from the weld without its feeling hot. The temperature of the weld can be adjusted with the most perfect nicety so as not to burn the steel, and the ends of the bars to be joined are softened to the centre, consequently a very good weld indeed can be made electrically by simple end pressure.

We have to thank Mr. Fish, not only for showing us the welding, but also for the very valuable assistance he has given us in supplying the electric power for the experiments on transformers and for the electric lighting for the outside of the Drill Hall. That "go-a-head" which is so characteristic a feature of his countrymen has been ever present in my mind while we have been working together during the last few days.

To Mr. Albion Snell, the representative of Messrs. Immisch and Co., we must also give our best thanks for so generously devoting some days of hard work to the arrangement of his high-voltage constant-current motors, used in driving the alternate-current machine and the small dynamos employed to magnetise the magnets of the former.

This ingenious telpher model, to which I shall refer later on, is Mr. Bourne's handiwork, and, considering that it has been hastily taken to pieces and hastily erected again, it is most creditable to him that it automatically blocks as well as it does. A watch, for example, is a very trustworthy piece of mechanism, but if one hurriedly took it all to pieces and hurriedly put it together again, one would not be surprised if it lost a little; indeed, if you or I did it, we should not be surprised if it refused to go at all, and were only right twice in twenty-four hours.

For the arangement of the smaller illustrations, and the careful execution of several of the diagrams, I have to thank Mr. Raine.

Did time allow I should like to describe to you to what perfection the system of economical distribution with accumulators—originally proposed by Sir William Thomson in 1881, and shown in its very simplest form in the wall diagram—has been brought by Mr. King, the engineer to the Electrical Power Storage Company; how the cells, when they are fully charged, are automatically disconnected from the charging circuit, and electrically connected with the discharging circuit; how the electric pressure on the discharging, or house mains, is automatically kept constant, so that the brightness of the lamps is unaffected by the number turned on, and how cells that are too energetic have their ardour automatically handicapped, and not allowed to give more current than is being supplied by the less active ones.

During the last few months fierce has been the battle raging among the electricians, the war cry being alternate-current transformers *versus* accumulators, while the lookers on, with that better view of the contest that they are proverbially said to possess, have decided that the battle is a drawn one. Neither system is the better under all circumstances; if the district to be lighted be a very scattered one use alternate-current transformers by all means, but if the houses to be lighted are clustered together at a distance from the supply of power then the storing property possessed by accumulators, which enables the power of electric power to far exceed the capacity of the dynamos and engines in the busiest part of the twenty-four hours, will win the battle for accumulators. Any direct-current system of distribution such as is furnished by accumulators has also the very great advantage that it lends itself to the use of the very efficient electro-motors which I have been using this evening. Alternate-current motors do exist, but they are still in the experimental stage, and are not yet articles of commerce.

Secondary batteries have caused much heartburning for their uses from the apparent fickleness of their complex chemical action, yet but imperfectly understood. But we have at length been taught what is good and what is bad treatment for them, and after years of brave persevering application on the part of the Electrical Power Storage Company, that forlorn hope, the secondary battery, has become one of the most useful tools of the electrical engineers; and secondary cells, some of which, thanks to the kindness of that company, I am using here to-night to supply power for lamps and motors, may now be trusted to have a vigorous long life. That company, I learn, undertake henceforth to keep their cells in order, when used for central station work, for 12½ per cent. per annum, and I understand that they have such confidence in them that they anticipate making no little money by incurring this insurance office responsibility. It is not, then, surprising that the Chelsea Supply Company have decided to use secondary batteries on a large scale for the economical distribution of light and power in their district.

Oliver Goldsmith said, more than 100 years ago, in his "Life of Richard Nash, Esq.:—"People of fashion at Bath . . . . when so disposed attend lectures on the arts and sciences, which are frequently taught in a pretty superficial manner, so as not to tease the understanding, while they afford the imagination some amusement." I want not to be superficial, yet I must not tease

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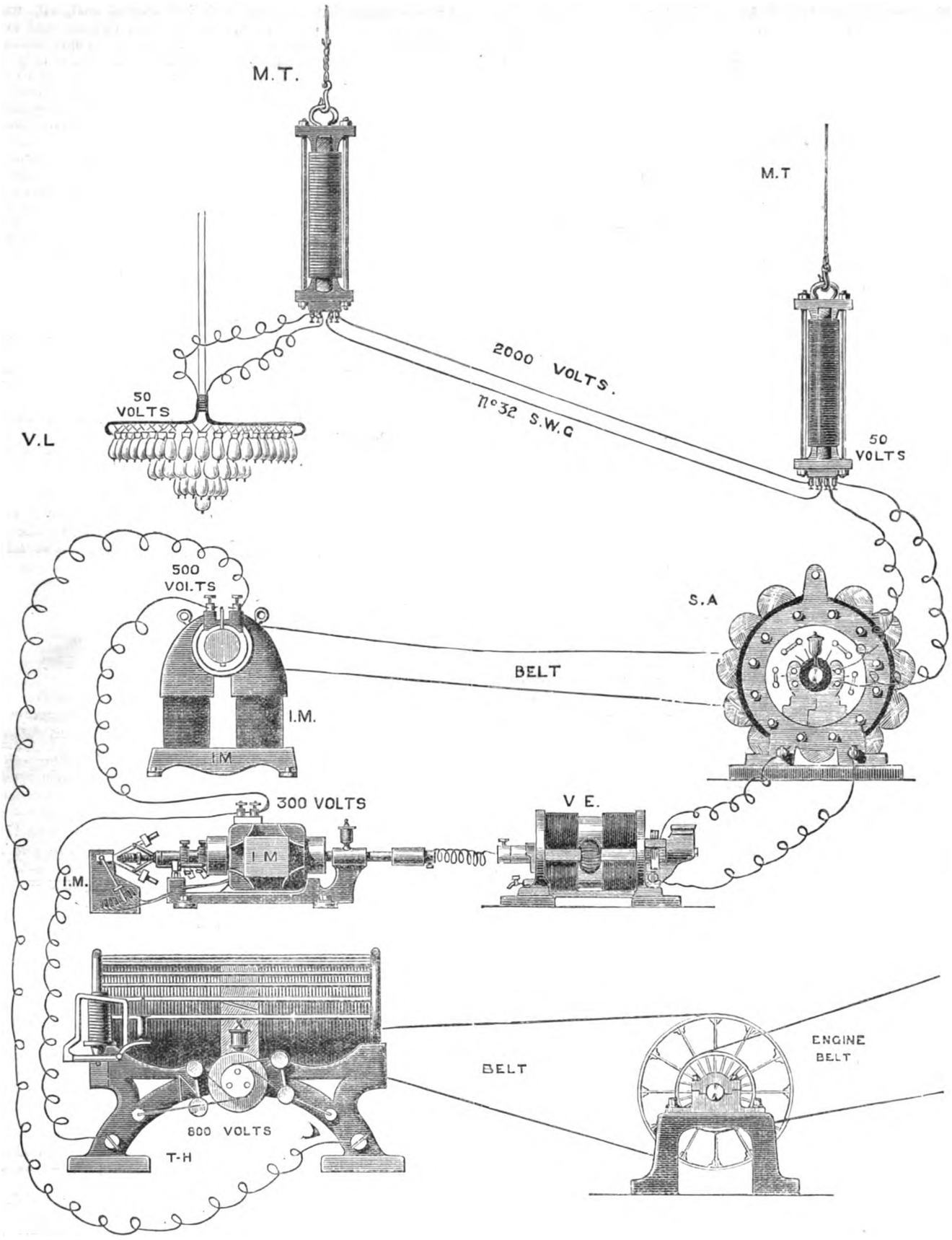

FIG. 2.

T.-H Thomson-Houston Dynamo
I. M. Immisch Constant-Current Motors with Governors.
V E Victoria Exciter.
S. A. Siemens Alternator.
M. T. Mordey Transformers.
V. L. Victoria Lamps (forty-five of 10 candle-power.

your understanding, and so we will not lose ourselves in technical details. If, however, my remarks have led you to appreciate the vast economical importance of using very large electric pressures, and to grasp that by substituting 2,000 volts for 50 volts when transmitting a certain amount of electric power the current can be reduced to the one-fortieth part, and the waste of power when transmitted along a given length of a given wire to the one-fortieth of the one-fortieth—that is, to the 1-1,600th part—your imagination will have been kindled as well as amused.

With a loss on the road of only 11 per cent. M. Deprez has, by using 6,000 volts, transmitted 52 horse-power over a distance of about 37 miles through a copper wire only one-fifth of an inch in dia-

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meter (see *Electrician*, 27th August, 1886, p. 318). A piece of the actual conductor he employed I hold in my hand ; the copper wire is coated with an insulated material and then with a leaden tubing, so that the outside may be touched with perfect impunity, in spite of the high potential difference employed. M. Deprez's dynamo and motor were not nearly as efficient as he could make them now, so that his terminal losses were unnecessarily great, and the efficiency of the whole arrangement, wonderful as it was, not so startling as it would otherwise have been. I have told you that the loss in dynamo and motor has actually been reduced to only 12½ per cent., so that if a dynamo and motor of this efficiency had been used by M. Deprez the total loss in the whole transmission over thirty-seven miles would have been under 25 per cent. Indeed, by using only 1,250 volts, Mr. Brown has sueceeded in transmitting 50 horse-power supplied by falling water at Kriegstetten to Solothun in Switzerland, five miles away, with an entire loss in the dynamo, motor, and the five miles of going and returning wire of only 25 per cent., so that three-quarters of the total power supplied by the water at Kriegstetten were actually delivered to machinery at Solothun, five miles away.

In less than twenty years, then, from Gramme's practical realisation of Pacinotti's invention, we have power transmitted over considerable distances by electricity, with only a total loss of 25 per cent., whereas the combined loss in an air pump and air motor or in a water pump and water motor is 40 per cent., irrespective of the additional loss by friction or leakage that occurs *en route*. We cannot help feeling that we are rapidly arriving at a new era, and that it will not merely be for the inauguration of the quick transmission of our bodies by steam, or the quick transmission of our thoughts by telegraph, but for the economical transmission of power by electricity that the Victorian age will be remembered.

I showed you a little while ago an electric fire. Was that a mere toy, or had it any commercial importance ? To burn coal, to work dynamos, and to use the electric current to light your houses and your streets is clean and commercial ; to use the current to warm your rooms is clean but wasteful, on account of the inefficiency of the steam engine. But when the dynamos are turned by water power which would otherwise be wasted the electric current may be economically used, not merely to give light but also to give heat. And when the electric transmission of power becomes still more perfect than at present, even to burn coal at the pit's mouth where it is worth a shilling a ton may, in spite of the efficiency of the steam engine being only one.tenth, be the most economical way of warming distant towns where coal would cost 20s. a ton. Think what that would mean—no smoke, no dust, a reform effected commercially which the laws of the land on smoke prevention are powerless to bring about, a reform effected without the intervention of the State, and, therefore, dear to the hearts of Englishmen.

I am aware that this idea of burning coal at the pit's mouth and electrically transmitting its power has quite recently been stated to be commercially impracticable. But is that quite so certain, for in 1878 it was stated that, although telephones might do very well for America, they certainly would never be introduced into Great Britain, as we had plenty of boys who were willing to act as messengers for a few shillings a week ? The phonograph was also declared to be worked by a ventriloquist, and electric lighting on a large scale was proved to be too expensive a luxury to be ever carried out.

To-day the electric current is used for countless purposes ; not only is it used to weld, but by putting the electric arc inside a closed crucible smelting can be effected with a rapidity and ease quite unattainable with the ordinary method of putting the fire outside the crucible. If one had pointed out a few years ago that it was as depressing, scientifically, to put a fire outside a crucible when you wanted to warm the inside, as Joey Ladle, the cellarman, found it depressing, mentally, "to take in the wine through the pores of the skin, instead of by the convivial channel of the throttle," who would have believed that in 1888 a 500 horse-power dynamo would be actually employed to produce an electric arc inside a closed crucible in the manufacture of aluminium-bronze ? Putting a conservative drag on the wheels is a very good precaution to take when going down hill, but it is out of place in the up-hill work of progress.

But of all the many commercial uses to which the electric cuurent may be put, probably, after the electric light, electric traction has most public interest. The English are a commercial people, but they are also a humane people, and when, as in this case, their pockets and their feelings are alike touched, surely they will be radicals in welcoming electric traction whatever may be their political sentiments on other burning topics of the day. It is not a nice thing to feel that you are helping to reduce the life of a pair of poor tramway horses to three or four years ; it would be a very nice thing to be carried in a tramcar for even a less fare than at present. Now, while it costs 6d. or 7d. to run a car one mile with horses, it only costs 3d. or 4d. to propel it electrically. Indeed, from the very minute details that have recently been published of the four months' expenses of electrically propelling 30 cars at 7½ miles an hour along 12 miles tramway line in Richmond, Virginia, it would appear that the total cost, inclusive of coal, oil, water, engineers, firemen, electricians, mechanicians, dynamo and motor repairers, inspectors, linemen, cleaners, lighting, depreciation on engine, boiler, cars, dynamo, and line work, has been only 1½d. per car per mile. That is small enough at any rate, let us hope that it is true. This tramway is no doubt particularly favourable for propelling cars on the *parallel* system (that is, the system in which the current produced by the dynamo is the sum of the currents going through all the motors on the cars) without a great waste of power being produced by a very large current having to be sent a very long distance, because the tramway track is very curved, and the dynamo is placed at the centre of the curve with feeding wires to convey the current from the dynamo to all parts of the track. But even in the case of a straight tramway line with a dynamo only at one end, it is quite possible to obtain the same high econony in working by employing a *large* potential difference, and by sending a small current through all the trains in *series* instead of running the train in *parallel*, as is done on the Portrush, Blackpool, Brighton, and Bessbrook tramways.

This *series* system (see *The Electrician*, April 29, 1887, p. 549) of propelling electric trains was, oddly enough, entirely ignored in all the discussions that have taken place this year at the Institution of Civil Engineers and at the Institution of Mechanical Engineers regarding the relative cost of working tramways by horses, by a moving rope, and by electricity, and yet this series system is actually at work in America, as you will see from an instantaneous photograph, which I will now project on the screen, of a series electric tramway in Denver, Colorado ; and a series electric tramway 12 miles long, on which 40 cars are to be run, is in course of construction in Columbus, Ohio. The first track on which electric trams were run in *series* was the experimental "Telpher Line" erected in Glynde in 1883, under the superintendence of the late Prof. Fleeming Jenkin, Prof. Perry, and myself, for the automatic electric transport of goods. A photograph of this actual line

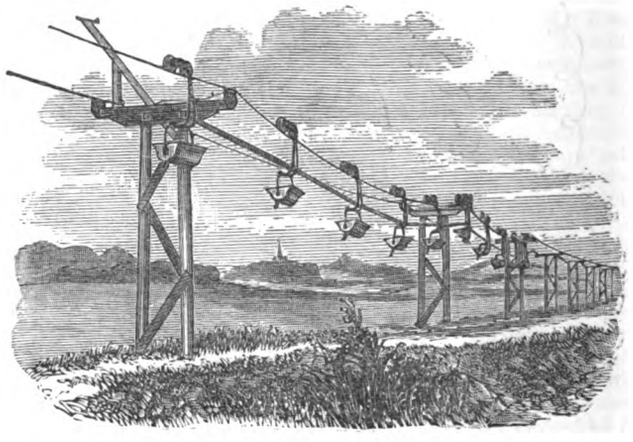

Fig. 3.

is now projected on the screen (Fig. 3). The large wall diagram shows symbolically, in the crudest form, our plan of series working. The current follows a zigzag path through the contact pieces, and when a train enters any section the contact-piece is automatically removed, and the current now passes through the motor on that train instead of through the contact-piece. The Series Electrical Traction Syndicate are now developing our idea, but it has received its greater development in the States, where the Americans are employing it instead of spending time proving, *à priori*, that the automatic contact arrangements could never work.

Mental inertia, like mechanical inertia, may be defined in two distinct ways. Inertia is the resistance to motion—that is the English definition ; but inertia is also the resistance to stopping—that is the American definition.

In addition to the small waste of power and consequent diminished cost of constructing the conductors that lead the current into and out of the passing trains, the series system has another very marked advantage. Some years ago we pointed out that when an electric train was running down hill, or when it was desirable to stop the train, there was no necessity to apply a brake and waste the energy of the moving train in friction, because the electric motor could, by turning a handle, be converted into a dynamo, and the train could be slowed or stopped by its energy being given up to all the other trains running on the same railway, so that the trains going down hill helped the trains going up hill, the stopping trains helped the moving trains. At that time we suggested detailed methods for carrying out this economical mutual aid arrangement, whether the trains were running on the parallel or on the

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series system. But there is this difference, that whereas on the parallel system it is only when a train is running fairly fast that it can help other trains, the series system has the advantage that, when a motor is temporarily converted into a dynamo by the reversal of the connections of its stationary magnet, the slowing train can help all the other trains even to the very last rotation of its wheels. Brakes that save the power instead of wasting it are of purely English extraction, but their conception has recently come across the Atlantic with such a strong Yankee accent, that it might pass for having been born and bred in the States.

Economy is one feature which gives electric traction that right to claim your attention, safety is another. This model telpher line (see *Electrician*, February 19, 1886, p. 286), worked on "the post-head contact" system, is so arranged that no two trains ever run into one another, for in addition to each of the three trains being provided with an automatic governor which cuts off electric power from a train when that train is going too fast, the line is divided into five sections, connected together electrically in such a way that as long as a train is on any Section A no power is provided to the Section B behind, so that if a train comes into Section B it cannot move on as long as the train in front is on Section A (three trains shown running on a model telpher line with four automatic locks). Whenever a train—it may be even a runaway electric locomotive—enters a blocked section it finds all motive power withdrawn from it quite independently of the action of signalmen, guard, or engine driver, even if either of the latter two men accompanied the train, which they do not in the case of telpherage; no fog, nor colour blindness, nor different codes of signals on different lines, nor mistakes arising from the exhausted nervous condition of overworked signalmen can with our system produce a collision. Human fallibility, in fact, is eliminated. While the ordinary system of blocking means merely given an order to stop, and whether this is understood or intelligently carried out, is only settled by the happening or non-happening of a subsequent collision, our automatic block acts as if the steam were automatically cut off; nay, it does more than this, it acts as if the fires were put out in an ordinary locomotive, and all the coal taken away, since it is quite out of the power of the engine driver to restart the electric train until the one in front is at a safe distance ahead.

The photograph now seen on the screen shows the general appearance of the Glynde line, which has recently been much extended in length by its owners, the Sussex Portland Cement Company, and a telpher line, with automatic blocking on the broad principles I have described, is about to be constructed between the East Pool tin mine in Cornwall and the stamps. There will be four trains running, each consisting of 33 skeps containing 3cwt. each, so that the load carried by each train will be about five tons.

It may be interesting to mention that the last difficulty in telpherage, which consisted in getting a proper adhesion between the driving wheels of the locomotive and the wire rope has now been overcome. The history of telpher locomotives is the history of steam locomotives over again, except that we never tried to fit the electric locomotives with legs, as was proposed in the early days for steam locomotives. It is a tedious discouraging history, but it is so easy to be wise when criticising the past, so difficult to be wise when prospecting the future. Gripping wheels of all kinds, even the India-rubber tyres used for the last three years, have all been abandoned in favour of simple slightly loose cheap iron tyres, which wear for a very long time and give a very perfect grip when the bar supporting the electro-motor is so pivoted pendulum-wise to the framework of the locomotive that the weight of the motor no longer makes the locomotive jump in passing the posts, as it did until quite recently. . . .

After several years of experimenting we have in telpherage, I venture to think, at last a perfectly trustworthy and at the same time a most economical method of utilising distant steam or water-power to automatically transport our goods, and in time it may even be our people, over hills and valleys without roads or bridges, and without interfering with the crops or the cattle, or the uses to which the land may be put over which the telpher trains pursue heir snakelike way. We have, in fact, the luxury of ballooning ithout its dangers.

The Gadot Accumulator.—The Gadot accumulator has undergone several important modifications lately; the proportion of active material has been increased to 54 per cent. of the total weight of the plate, and an output of 21·75 ampere-hours per kilogramme of plate has been attained. Owing to the system of double plates adopted by M. Gadot, it is asserted that these improvements have not been obtained at the expense of durability. The plates are 45mm. in thickness, and the discharge takes place at the rate of 1·5 amperes per kilogramme of plate.

A SIMPLE HYPOTHESIS FOR ELECTRO-MAGNETIC INDUCTION OF INCOMPLETE CIRCUITS; WITH CONSEQUENT EQUATIONS OF ELECTRIC MOTION IN FIXED HOMOGENEOUS OR HETEROGENEOUS SOLID MATTER.*

BY SIR WILLIAM THOMSON.

1. To avoid mathematical formulas till needed for calculation consider three cases of liquid† motion, which for brevity I call Primary, Secondary, Tertiary, defined as follows:—Half the velocity in the Secondary agrees numerically and directionally with the magnitude and axis of the molecular spin at the corresponding point of the Primary; or (short, but complete, statement) *half the velocity in the Secondary is the spin in the Primary, and (similarly) half the velocity in the Tertiary is the spin in the Secondary.*

2. In the Secondary and Tertiary the motion is essentially without change of density, and in each of them we naturally, therefore, take an incompressible fluid as the substance. The motion in the Primary we arbitrarily restrict by taking its fluid also as incompressible.

3. Helmholtz first solved the problem—Given the spin in any case of liquid motion, to find the motion. His solution consists in finding the potentials of three ideal distributions of gravitational matter having densities respectively equal to $1/4\pi$ of the rectangular components of the given spin; and, regarding for a moment these potentials as rectangular components of velocity in a case of liquid motion, taking the spin in this motion as the velocity in the required motion. Applying this solution to find the velocity in our Secondary from the velocity in our Tertiary, we see that the three velocity-components in our Primary are the potentials of three ideal distributions of gravitational matter having their densities respectively equal to $1/4\pi$ of the three velocity-components of our Tertiary. This proposition is proved in a moment,‡ in § 5 below, by expressing the velocity-components of our Tertiary in terms of those of our Secondary, and those of our Secondary in terms of those of our Primary; and then eliminating the velocity-components of Secondary, so as to have those of Tertiary directly in terms of those of Primary.

4. Consider now, in a fixed solid or solids of no magnetic susceptibility, any case of electric motion in which there is no change of electrification, and therefore no incomplete electric circuit, or, which is the same, any case of electric motion in which the distribution of electric current agrees with the distribution of velocity in a case of liquid motion. Let this case, with velocity of liquid numerically equal to 4π times the electric current density be our Tertiary. The velocity in our corresponding Secondary is then the magnetic force of the electric current system;§ and the velocity in our Primary is what Maxwell‖ has well called the "electro-magnetic momentum at any point" of the electric current system; and the rate of decrease per unit of time of any component of this last velocity at any point is the corresponding component of electromotive force, due to electro-magnetic induction of the electric current system when it experiences any change. This electromotive force, combined with the electrostatic force, if there is any, constitutes the whole electromotive force at any point of the system. Hence by Ohm's law each component of electric current at any point is equal to the electric conductivity multiplied into the sum of the corresponding component of electrostatic force and the rate of decrease per unit of time of the corresponding component of velocity of liquid in our Primary.

5. To express all this in symbols, let (u_1, v_1, w_1), (u_2, v_2, w_2), and (u_3, v_3, w_3) denote rectangular components of the velocity at time t, and point (x, y, z) of our Primary, Secondary, and

* Paper read before the British Association at Bath, in Section A (Mathematical and Physical Science), September, 1888.

† I use "liquid" for brevity to signify incompressible fluid.

‡ From Poisson's well-known elementary theorem, $\Delta^2 V = -4\pi\rho$.

§ "Electrostatics and Magnetism," § 517 (Postscript) (*c*).

‖ "Electricity and Magnetism," §§ 604, 585.

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Tertiary. We have (§ 1)—

$$u_2=\frac{dw_1}{dy}-\frac{dv_1}{dz},\quad v_2=\frac{du_1}{dz}-\frac{dw_1}{dx},\quad w_2=\frac{dv_1}{dx}-\frac{du_1}{dy}\ .\ (1)$$

$$u_3=\frac{dw_2}{dy}-\frac{dv_2}{dz},\quad v_3=\frac{du_3}{dz}-\frac{dw_2}{dx},\quad w_3=\frac{dv_2}{dx}-\frac{du_2}{dy}\ .\ (2)$$

Eliminating u_2, v_2, w_2 from (2) by (1), we find—

$$u_3=\frac{d}{dx}\left(\frac{du_1}{dx}+\frac{dv_1}{dy}+\frac{dw_1}{dz}\right)-\left(\frac{d^2u_1}{dx^2}+\frac{d^2u_1}{dy^2}+\frac{d^2u_1}{dz^2}\right);\ \&c.\ .\ .\ (3)$$

But, by our assumption (§2) of incompressibility in the Primary

$$\frac{du_1}{dx}+\frac{dv_1}{dy}+\frac{dw_1}{dz}=0\ .\ .\ .\ .\ .\ (4)$$

Hence (3) becomes—

$$u_3=-\nabla^2u_1,\ v_3=-\nabla^2v_1,\ w_3=-\nabla^2w_1\ .\ .\ (5)$$

where, as in Article XXVII. (November, 1846) of my "Collected Papers" (Vol. I.)—

$$\nabla^2=\frac{d^2}{dx^2}+\frac{dy^2}{d^2}+\frac{d^2}{dz^2}\ .\ .\ .\ .\ .\ (6)*$$

This (5) is the promised proof of § 3.

6. Let now u, v, w denote the components of electric current at (x, y, z) in the electric system of § 4; so that—

$$4\pi u=u_3=-\nabla^2u_1;\ 4\pi v=v_3=-\nabla^2v_1;$$
$$4\pi w=w_3=-\nabla^2w_1;\ .\ .\ .\ .\ .\ (7)$$

which, in virtue of (4), give—

$$\frac{du}{dx}+\frac{dv}{dy}+\frac{dw}{dz}=0\ .\ .\ .\ .\ .\ (8)$$

Hence the components of electromotive force due to change of current, being (§ 5)—

$$-\frac{du_3}{dt},\quad -\frac{dv_3}{dt},\quad -\frac{dw_3}{dt},$$

are equal to—

$$4\pi\nabla^{-2}\frac{du}{dt},\quad 4\pi\nabla^{-2}\frac{dv}{dt},\quad 4\pi\nabla^{-2}\frac{dw}{dt};\ .\ .\ (9)$$

and therefore if Ψ denote electrostatic potential, we have, for the equations of the electric motion (§ 5)—

$$u=\frac{1}{\kappa}\left(\nabla^{-2}\frac{du}{dt}-\frac{d\Psi}{dx}\right);\quad v=\frac{1}{\kappa}\left(\nabla^{-2}\frac{dv}{dt}-\frac{d\Psi}{dy}\right);$$
$$w=\frac{1}{\kappa}\left(\nabla^{-2}\frac{dw}{dt}-\frac{d\Psi}{dz}\right)\ .\ .\ .\ (10)$$

where κ denotes $1/4\pi$ of the specific resistance.

7. As Ψ is independent of t, according to § 4, we may conveniently for a moment put—

$$u+\frac{d\Psi}{\kappa\,dx}=\alpha;\ v+\frac{d\Psi}{\kappa\,dy}=\beta;\ w+\frac{d\Psi}{\kappa\,dz}=\gamma\ .\ (11)$$

and so find as equivalents to (10)—

$$\frac{d\alpha}{dt}=\nabla^2(\kappa\alpha);\ \frac{d\beta}{dt}=\nabla^2(\kappa\beta);\ \frac{d\gamma}{dt}=\nabla^2(\kappa\gamma);\ (12)$$

The interpretation of this elimination of Ψ may be illustrated by considering for example a finite portion of *homogeneous* solid conductor of any shape (a long thin wire with two ends, or a short thick wire, or a solid globe, or a lump of any shape, of copper or other metal homogeneous throughout), with a constant flow of electricity maintained through it by electrodes from a voltaic battery or other source of electric energy, and with proper appliances over its whole boundary, so regulated as to keep any given constant potential at every point of the boundary; while currents are caused to circulate through the interior by changing currents in circuits external to it. There being no *changing electrification* by our supposition of § 4, Ψ can have no contribution from electrification within our conductor; and therefore throughout our field—

$$\nabla^2\Psi=0\ .\ .\ .\ .\ .\ .\ .\ (13)$$

which, with (8) and (11), gives—

$$\frac{d\alpha}{dx}+\frac{d\beta}{dy}+\frac{d\gamma}{dz}=0\ .\ .\ .\ .\ .\ .\ (14)$$

Between (12) and (14) we have four equations for three unknown quantities. These, *in the case of homogeneousness* (κ constant), are equivalent to only three, because in this case (14) follows from (12), provided (14) is satisfied initially and proper surface condition is maintained to prevent any violation of it from supervening. But unless κ is constant throughout our field, the four equations (12) and (14) are mutually inconsistent; from which it follows that our supposition of unchangingness of electrification (§ 4) is not generally true. An interesting and important practical conclusion is that when currents are induced in any way in a solid composed of parts having different electric conductivities (pieces of copper and lead, for example, fixed together in metallic contact), there must in general be changing electrification over any interface between these parts. This conclusion was not at first obvious to me; but it ought to be so by anyone approaching the subject with mind undisturbed by mathematical formulas.

8. Being thus warned off heterogeneousness until we come to consider changing electrification and incomplete circuits, let us apply (10) to an infinite homogeneous solid. As (8) holds through all space according to our supposition in § 4, and as κ is constant, (13) must now hold through all space, and therefore $\Psi=0$, which reduces (10) to—

$$u=\frac{1}{\kappa}\nabla^{-2}\frac{du}{dt}\quad v=\frac{1}{\kappa}\nabla^{-2}\frac{dv}{dt}\quad w=\frac{1}{\kappa}\nabla^{-2}\frac{dw}{dt}.\ (15)$$

These equations express simply the known law of *electromagnetic* induction as we have it, and all we know about it from direct experiment. Maxwell's equations (7) of § 783 of his "Electricity and Magnetism" become in this case—

$$\mu\left(4\pi C+K\frac{d}{dt}\right)\frac{du}{dt}=\nabla^2u,\ \&c.\ .\ (15')$$

which cannot be right, I think (???), according to any conceivable hypothesis regarding electric conductivity, whether of metals, or stones, or gums, or resins, or wax, or shellac, or gutta percha, or India-rubber, or glasses, or solid or liquid electrolytes; being, as seems (?) to me, vitiated for complete circuits, by the curious and ingenious, but, as seems to me, not wholly tenable, hypothesis which he introduces, in § 610, for incomplete circuits.

9. The hypothesis which I suggest for incomplete circuits and consequently varying electrification, is simply that the components of the electromotive due to electro-magnetic induction are still $4\pi\nabla^{-2}du/dt$, &c. Thus for the equations of motion we have simply to keep equations (10) unchanged, while not imposing (8), but instead of it taking—

$$\text{"}v\text{"}^2\left(\frac{du}{dx}+\frac{dv}{dy}+\frac{dw}{dz}\right)=\frac{d}{dt}\nabla^2\Psi.\ .\ .\ .\ (16)$$

where "v" denotes the number of electrostatic units in the electro-magnetic unit of electric quantity. This equation expresses that the electrification of which Ψ is the potential increases and diminishes in any place according as electricity flows more out than in, or more in than out. We thus have four equations (10) and (16) for our four unknowns, u, v, w, Ψ; and I find simple and natural solutions with nothing vague, or difficult to understand, or to believe when understood, by their application to practical problems, or to conceivable ideal problems; such as the transmission of ordinary or telephonic signals along submarine telegraph conductors and land-lines, electric oscillations in a finite insulated conductor of any form, transference of electricity through an infinite solid, &c. This, however, does not prove my hypothesis. Experiment is required for informing us as to the real electro-magnetic effects of incomplete circuits, and as Helmholtz has remarked, it is not easy to imagine any kind of experiment which could decide between different hypotheses which may occur to anyone trying to evolve out of his inner consciousness a theory of the mutual force and induction between incomplete circuits.

* Maxwell, for quaternionic reasons, takes ∇^2 the negative of mine.

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ON THE IMPEDANCE OF CONDUCTORS TO LEYDEN JAR DISCHARGES.*

BY DR. OLIVER LODGE.

Among other experiments which I made in connection with lightning conductors were some on what I call "the alternative path." These gave some surprising results, showing that iron and copper acted equally well as conductors, and that sometimes the iron was better than copper; also that thickness of conductor and ordinary conductivity mattered very little.

Since then I have more completely applied the theories of Clerk-Maxwell and Lord Rayleigh concerning the impedance of conductors to very high frequencies of alternation, and have been able to arrive at a complete understanding of all, or nearly all, the alternative path results. I bring forward these experiments, therefore, as a verification of Lord Rayleigh's modification of Maxwell for extremely high frequencies.

Impedance being defined as

$$\sqrt{R'^2+p^2L'^2} \quad \frac{I}{pL'} \quad R'$$

Rayleigh develops an expression of Maxwell's for E.M.F. into expressions for R′ and L′, which take the form, when p is infinitely great,

$$R' = \sqrt{\tfrac{1}{2} p l \mu_0 R}$$

$$L' = L + \frac{R'}{p},$$

these being the limits of a Bessel function series; where L refers only to the medium outside the substance of the wire, and μ_0 is the magnetic permeability of the material of the wire, l being its length.

Wherefore, $$I = \sqrt{(pL+R')^2+R'^2}.$$

$$= pL\sqrt{1+\frac{2m}{\sqrt{p}}+\frac{2m^2}{p}},$$

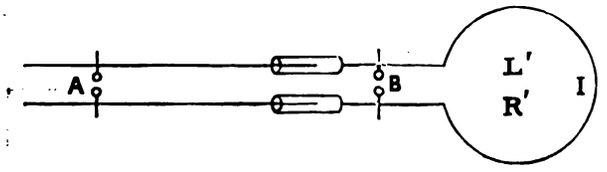
where $$m = \frac{\sqrt{\frac{1}{2} l \mu_0 R}}{L}.$$

L depends on the size and shape of the conductor but not at all on its material, and it only depends slightly on its thickness; m depends on the conducting substance, and increases with both μ and R. R is the ordinary resistance of the wire.

At very high frequencies the first term of those under the root in the expression for I alone matters, and therefore all substances which conduct at all behave in the same way. At less frequencies the terms involving R and μ begin to be of importance.

All this is borne out by the experiments, and the theoretical impedance is found to be very nearly proportional to the observed difference of potential needed to drive a given charge through any given conductor.

The experiment is conducted thus:—



Two jars are arranged to be charged and discharged at A. The circuit is completed either by an air gap at B, or by the conductor to be experimented on. The conductor is arranged in the form of a circle and connects the B knobs so as to afford an alternative path. The experiment consists in adjusting the B knobs until the spark jumps the air jet just about as often as it misses and chooses the conductor, the size of the jars, the length of the A spark, and the position of A on the two wires connected to the inner coatings being the things varied in successive series experiments. A whole lot of circular conductors, I, are tried one after the other with each adjustment.

* Paper read before the British Association Meeting (Section A) at Bath, September, 1888.

The length of spark B measures the E.M.F. needed to effect discharge through the conductor.

This is found proportional to the theoretical impedance for

No. 2 Iron,	No. 5 Copper,	No. 2 Brass,
No. 18 Iron,	No. 18 Copper,	No. 24 Brass,
No. 25 Iron,	No. 23 Copper,	
	No. 40 Copper,	

with frequencies varying in different experiments from 12 million vibrations per second to a quarter million vibrations per second.

The current amplitude during the discharge was 3,000 amperes, sometimes more, sometimes less.

The impedance of a conductor 2½ metres long bent into a circle was

180 ohms for thick wire, No. 2 } at 12 millions per
300 ohms „ thin „ „ 40 } second,

the ordinary resistance being ·004 ohms and 2·6 ohms respectively.

43 ohms for thick ..... } at 3 millions.
78 ohms „ thin..... }

At a quarter million vibrations the material just begins to matter, and iron has a trace more impedance than copper; but even now they are practically equal, being about 4 ohms for thick and 6 ohms for extremely thin wire.

These are the results of the latest experiments. In some of the older experiments iron came out distinctly better than copper—even thin iron better than thick copper.

Theory does not, so far as I see, throw any light upon this, and I am going to repeat those experiments in something like their original form, so as either to confirm or to modify these few anomalous results.

The main point established is that for frequencies comparable to a million per second, such frequencies as occur in jar discharges and probably in lightning, the impedance of all reasonably-conducting materials is the same, both by theory and by experiment, independently of their magnetic properties as well as of their conductivity; and that even the sectional area of a conductor only affects its impedance in a minor degree, so that a change to $\frac{1}{1000}$ the area scarcely doubles the impedance.

MEASUREMENT OF ELECTRO-MAGNETIC WAVE LENGTH.*

BY PROF. OLIVER J. LODGE, F.R.S.

When returning thanks for the reception of his address yesterday morning, our President thought fit to disclaim too much share in the suggestion of an oscillatory Leyden jar circuit as a practicable source of radiation of moderate wave length. But such a disclaimer he must not be allowed to make. He mentioned as coming before himself the names of Feddersen and other German experimenters on these alternations. But to them belongs not this credit, but another. What they accomplished was the experimental verification of the existence and the counting of the frequency of these already predicted oscillations. Prior credit must therefore be put further back. As is very well known, Helmholtz in 1847 suggested that a Leyden jar discharge must be oscillatory in a circuit of small dissipation, and Sir William Thomson in 1858 calculated out the whole details of the process and gave its equation; an equation which, though we now write it down glibly enough, was at that date unintelligible and difficult of comprehension to all but a very few—perhaps to all without exception—not the mere equation, of course, but the coefficient A which it contained, the electro-dynamic capacity of the discharger, or, as we now call it, the self-induction or inductance of the circuit. Every important detail of this prediction has now been verified by the labours of the German experimenters, Feddersen, Schiller and others. But any idea that radiation was propagated through the ether by such oscillations I am sure had never occurred to them. I remember the history of

* Paper read before the British Association meeting (Section A) at Bath, September, 1888.

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the thing pretty well, because I had been thinking much myself on the direction of how directly to manufacture light, *i.e.*, how to construct an electrical oscillator of a given and sufficient frequency. In fact, a year or so before the Southport meeting I suggested to this section a plan whereby I fancied it might be done. That particular plan I saw soon afterwards to be incapable of working, and the suggestion has therefore no merit. But it made me able to clearly appreciate the suggestion, or rather the certainty, which was expressed by Prof. Fitzgerald at Southport, that the oscillations in a discharging Leyden jar circuit were just the things that would be practicable, and which would generate light of some measurable, though no doubt still considerable, wave length.

More recently Lord Rayleigh showed at a Friday evening discourse in the Royal Institution some remarkably beautiful interference experiments in sound, whereby inaudible sound waves could be detected, measured, converged, and, in fact, treated in just the same manner as one is accustomed to treat light waves.

Putting the two things together, I was hopeful of being able to attack the problem experimentally and to prove the existence of radiation with measurable wave lengths from a Leyden jar circuit by interference experiments conducted after the model of Lord Rayleigh's. Meanwhile I happened to be experimenting on lightning conductors, and somewhat to my surprise, as an outcome from those experiments, I hit on an arrangement which, without any thought or scheming at all, gave me evidence of the very waves I had been thinking so much about, and enabled me to measure their lengths, though not in a previously planned-out way. I described these experiments quite hastily and briefly in the midst of other matter, in a lecture to the Society of Arts last March on lightning conductors, as "the experiment of the recoil kick."

I continued the experiments after the lecture, and proved the existence of ether waves of various lengths, the shortest wave that I obtained distinct evidence of being three yards. I intended to describe those experiments at this meeting with a reference to the Southport suggestion of Prof. Fitzgerald, quite unknowing at the time that we should have the pleasure of seeing him in the chair. However, when going away from Liverpool on a holiday I read in the train the July number of Wiedemann's *Annalen*, and there found that Dr. Hertz had obtained much better and more striking evidence of these electro-magnetic waves, and had measured their length by an interference experiment exactly like one of those used by Lord Rayleigh for sound.

I hasten to acknowledge the superiority of Hertz's method of demonstration to my own; and so far as evidence of the waves is concerned a description of my experiments is now superfluous. Nevertheless, the mode of propagation of the pulses and their mode of reflection is different in my experiments from what they are in those of Hertz, and although mine is not so good a method, yet it may have some interest as confirming the view taught us by Poynting and others concerning the mode of propagation of energy through the ether, and the theory of Kirchhoff and Heaviside concerning the rate of transmission of signals by a telegraph wire.

The theory of the experiment is given in my Paper in the August number of the *Philosophical Magazine*.

The velocity of a pulse along a wire is $\frac{1}{\sqrt{l_1 s_1}}$,

where $l_1 = 4\mu \log \frac{b}{a} + \frac{r_1}{\mu}$, and where $r_1 = \sqrt{\frac{1}{2} p \mu_0 \mathrm{K}_1}$

$$s_1 = \frac{\mathrm{K}}{4 \log \frac{a}{b}}.$$

So velocity of pulse along a wire $= \frac{1}{\sqrt{\mu \mathrm{K}}}$, the same as in free space.

Now take an oscillatory Leyden jar circuit and apply Thomson's theory to it.

$$p = \frac{1}{\sqrt{\mathrm{L S}}}$$

Now, if this circuit emits waves of velocity V, their length in free space is $\lambda = \frac{2\pi \mathrm{V}}{p} = 2\pi \sqrt{\frac{\mathrm{L}}{\mu} \frac{\mathrm{S}}{\mathrm{K}}}$.

Along two parallel wires they go at the same pace, and therefore have the same length. Hence combine the two things, (Fig. 2), and we have waves of known length propagated along the wires.

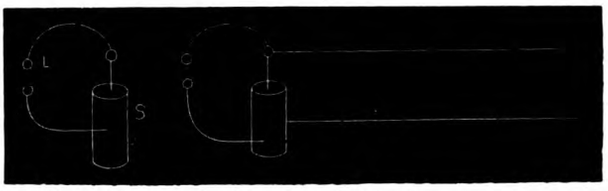

Fig. 1.

Fig. 2.

Now take the wires of infinite length. At the free ends we shall have reflexions, a sort of recoil or kick evidenced by a brush discharge or spitting off from the ends of the wire, and in the dark the far ends of the wires glow. Supply these with knobs, and we get surprisingly long sparks.*

When may we expect to get the longest sparks? When the period of oscillation of the circuit and of the appendages to it are the same. This will be when the length of each wire is half a wave length, or some multiple of half a wave length. The two will then vibrate together like a resonant column.

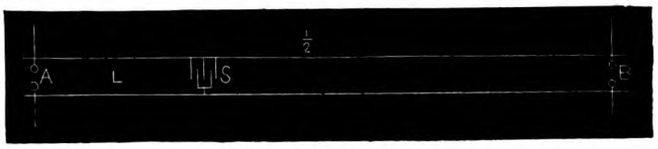

Fig. 3.

My experiment consisted, then, in so varying the current or the resonant wire that the recoil kick is a maximum.

The results of varying L are shown by some such curves as this, where horizontal distance represents distance of A knots from jars, and where vertical ordinates represent length of B spark (Fig. 4), and are such as entirely to confirm the theory so far as the accuracy of the experiments go.

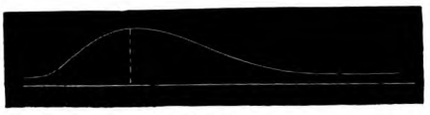

Fig. 4.

It is much easier to get good measurements with fairly big condensers, and therefore long waves, else the energy is not sufficient to give very marked results. With very long wires arranged out of doors on a dark night I hope to get evidence of modes by the periodic glow.

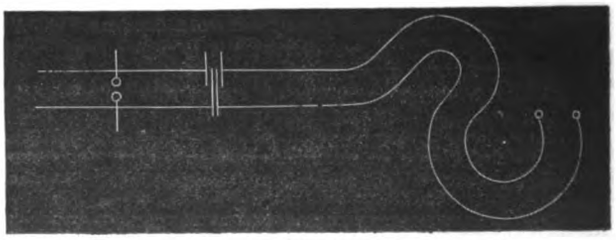

Fig. 5.

The experiments with shorter waves were made with an adjustable tube condenser, various lengths of which could be used (Fig. 5); and on the shortest waves with a mere coated disc condenser the size of a penny.

* For instance, A = 4·4; B = 15. (Fig. 3.)

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To get frequencies of the rapidity of visible light the linear dimensions of the circuit must be something comparable to 10^{-6}, and so electric oscillations in atoms will give rise to ultra violet rays.

[ABSTRACT.]

The author has been endeavouring to manufacture light by direct electric action without the intervention of heat, utilising for the purpose Maxwell's theory that light is really an electric disturbance or vibration. The means adopted is the oscillatory discharge of a Leyden jar, whose rate of vibration has been made as high as 1,000 million complete vibrations per second. The waves so obtained are about three yards long, and are essentially light in every particular except that they are unable to affect the retina. To do this they must be shortened to the hundred-thousandth of an inch. All that has yet been accomplished, therefore, is the artificial production of direct electrical radiation, differing in no respect from the waves of light except in the one matter of length. The electrical waves travel through space with the same speed as light, and are refracted and absorbed by material substances according to the same laws. It only wants to be able to generate waves of any desired length in order to entirely revolutionise our present best systems of obtaining artificial light by help of steam engines and dynamos, which is a most wasteful and empirical process.

THE MEETING OF THE BRITISH ASSOCIATION.

The following is a complete list of the Papers dealing with Electricity which were read during the 1888 meeting of the British Association :—

SECTION A.

SIR W. THOMSON, F.R.S.—"A Simple Hypothesis for Electromagnetic Induction of Incomplete Circuits: with Consequent Equations of Electric Motion in fixed Homogeneous or Heterogeneous Solid Matter."

SIR W. THOMSON, F.R.S.—"On the Transference of Electricity within a Solid Conductor."

LORD RAYLEIGH, F.R.S.—"Is the Velocity of Light in an Electrolytic Liquid Influenced by an Electric Current in the Direction of Propagation ?"

PROF. OLIVER J. LODGE, F.R.S. — "On the Measurement of Electromagnetic Wave-Lengths."

PROF. OLIVER J. LODGE, F.R.S.—"On the Impedance of Conductors to a Leyden Jar Discharge."

PROF. J. A. FLEMING.—"On a Form of Standard Resistance Coil."

PROF. J. A. FLEMING.—"On a Form of Commutator for Charging a Condenser and Discharging it at a Known Rate."

PROF. H. A. ROWLAND.—"On Maxwell's Equations for Electromagnetic Waves."

W. H. PREECE, F.R.S.—"On C.-G.-S. Units of Measurement."

R. T. GLAZEBROOK, F.R.S.—"On Standards of Electrical Resistance."

PROF. W. STROUD AND W. H. HALDANE GEE.—"Electro-calorimetry."

A. TANAKADATÉ.—"On the Magnetisation of Soft Iron Bars of Different Lengths in a Uniform Field."

W. LANT CARPENTER.—"Comparison of Gassner's Dry Cells with Leclanché's."

PROF. W. M. HICKS, F.R.S.—"A Vortex Analogue of Static Electricity."

FRIESE GREENE.—"On a Photographic Image of an Electric Arc Lamp, probably due to Phosphorescence in the Eye, and on some Photographs of an Eclipse of the Moon."

J. BROWN.—"On Figures produced by Electric Action on Photographic Dry Plates."

DR. ANTHONY TRAILL.—"Note on the Burning of Coils on the Generating Dynamo at the Waterfall on the Bush River, co. Antrim, belonging to the Giant's Causeway and Portrush Electric Railway and Tramway Company."

DR. J. JANSSEN, For.Memb.R.S.—"Analyse Chronométrique des Phénomènes Electriques Lumineux."

Report of the Committee on Electrical Standards.

REPORT OF THE COMMITTEE ON ELECTROLYSIS.

PROF. G. F. FITZGERALD, F.R.S., and F. TROUTON.—"Further Examination of Ohm's Law in Electrolytes."

DR. J. H. GLADSTONE, F.R.S., and W. HIBBERT.—"On the Conduction of Alloys and Solid Sulphides."

PROF. H. E. ARMSTRONG, F.R.S.—"On the Purification of Selenium."

DR. FRANZ RICHARZ.—"On the Electromotive Force of Polarisation with small Electrodes."

DR. ARRHENIUS.—"On Dissociation in Electrolytes."

SECTION G.

W. ANDERSON.—A 20-ton Travelling Crane worked by Electricity.

R. E. CROMPTON.—Cowles's Process of Electric Smelting.

G. FORBES.—Electric Lighting in America.

H. EDMUNDS.—Edmunds's System of Electrical Distribution.

W. LOWRIE.—The Measurement of Electricity in a House-to-House Supply.

R. P. SELLON.—Suez Canal Lighting.

F. BRAIN.—Electricity as applied to Mining.

N. WATTS.—Miners' Electric Safety Lamps.

J. W. SWAN.—An Automatic Fire-damp Indicator.

In addition to the above Papers there was a joint discussion in Sections A and G on lightning conductors, which was opened by Mr. W. H. Preece, F.R.S., and Prof. Oliver Lodge, F.R.S.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *September 1st*, 1888.

The well-known superiority of wrought iron over cast iron for the cores of magnets of dynamos has led to their almost general adoption, but the yoke pieces connecting the limbs are still usually made of cast iron, its bulk being increased to make up for the lack of magnetic permeability as compared with wrought iron. There is evidently more or less of a magnetic resistance introduced into the circuit by the presence of a joint between the wrought and the cast iron ; and, indeed, unless they are carefully surfaced there is apt to be considerable of this resistance. In order to overcome this difficulty the Baxter motor, which has been recently modified, is now made with a perfect weld or joint between the wrought iron of the core and the cast iron of the pole-piece. We are not informed as to the exact manner in which this process is accomplished, but it points to the recognition of a difficulty which is sometimes the cause of poor performance in a machine.

By the reports from all quarters, the utmost activity prevails in electric railway circles, and new roads are reported as being contracted for in all parts of the country. I have already reported to you that Boston and Cleveland are to have electric roads, and it now seems likely that the fine city of Minneapolis will also have one. Omaha is to have a road two miles long, and new roads have just gone into operation at Framingham, Mass. ; Dayton, O. ; and Merriden, Ct. Active measures for the installation of roads are being taken at Kansas City, Brockton, Mass.; Seattle, Washington Territory ; Bangor, Maine ; Scranton, Pa. ; North Adams, Mass. ; Danvers, Mass. ; Desmoines, Iowa ; Davenport, Iowa ; Columbus, Ind. ; Springfield, Mo. ; and St. Joseph, Mo. ; and several other places. All the roads now in operation are reported to be doing a very large business, and are increasing at such a rate that they would keep the companies fairly busy, even if there were no new lines to construct. As it is, it looks as though there were more activity almost to-day in electric railway circles than in electric lighting, and yet in the latter department the growth is something tremendous.

With regard to stationary motors, the same progressive state of affairs may be reported, and the demand, if anything, exceeds the supply. It is reported, for example, that in this city alone there are over 300 "C. and C." motors running. This handy little motor has already been described in your columns, and I am not surprised to find it so popular. These

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300 motors are distributed in nearly 120 different installations, and range in size from ⅛ horse-power up to 5 horse-power.

As might be expected, the recent experiments of killing dogs by continuous and alternating currents have revived the discussion on the desirability and feasibility of conducting executions by electricity. The law requiring such executions comes into effect on the 1st of January next; but up to the present no definite plan or arrangement seems to have been selected by the authorities for the purpose. The question which is now agitating the public and the press is whether electrical executions can be carried out without mutilating the objects of them. It is quite clear that although the public may be willing to approve of electrical executions, provided they are instantaneous and do not mutilate the criminal, there would be a great howl of indignation if it should be found that the body was burnt or injured.

A very interesting meeting has been held during the past week at Chicago of the United States Military Telegraph Corps and of the Old Timers' Association. These two bodies comprise in their membership a large number of the pioneer telegraphers in this country, including such men as Mr. James D. Reid, who was an intimate friend of Prof. Morse, and also has the distinction of being the first telegraph superintendent in the world. Mr. Reid is a well-preserved Scotchman, who, instead of making place for the young men, as he well might be excused for doing, is the soul and life of all gatherings in which he takes part, contributing speech or song as the occasion may need. It is an interesting fact that Andrew Carnegie, our great millionaire ironmaster, with his magnificent residences in this country and his castles in Scotland, was at one time Mr. Reid's messenger boy in Pittsburg. There are a great many other men with a history in these two associations, and when they get together you may depend upon it that the reminiscences of old times that are exchanged are of the most interesting character. Most of the Old Timers are members of the Military Corps, which is composed of men, many of them now of prominence and influence in this country, who served as operators during the Civil War. While our great national struggle was in progress, there were 15,000 miles of wire in use by the Union Army for military operations, and over 13,000,000 messages were sent. About 1,200 operators were employed, of which number nearly 300 were killed or wounded, or captured on the field of battle, or were lost, and now lie buried in nameless graves in the far South. The Military Telegraph Corps has received glowing tributes as to the value of its services from Generals Grant, Sherman, Sheridan, and others, and it now awaits from Congress a substantial recognition, which it fully deserves. The body has been striving to obtain for the old war operators some provision for pensions, and it is hoped that in an instance like this where the pensions have been so thoroughly earned, Congress will soon do justice. Of course, a number of the men are, as I have said, in good positions of life, many of them being at the front in telegraphic and electrical matters, but there are others to whom a little pecuniary help would be a great boon, and this it is that the corps seeks to obtain for them. The meeting at Chicago last week was of a very enjoyable nature, and the reception which was given to these veterans in the electrical field by the citizens of Chicago showed that their services had not been forgotten.

A noteworthy shipment of apparatus to South America has recently been made by the Ball Electric Light Company of this city. The plant is intended for the city of Quezaltenango, in the State of Guatemala, and the remarkable feature about it is that the place to which it is to be transported is 90 miles distant from either railroad or water communication. The weight of the plant is put at about 70,000 pounds, and the various pieces will have to be carried by a large number of natives by paths running across precipitous mountains at heights of 8,000ft. Fortunately, engines will not be required to run this plant, as the cost of transportation would in that event have been materially added to, and it is doubtful whether fuel could have been obtained cheaply. There is, however, an ample water supply, and this will be utilised to drive the dynamos. There are now a large number of electric light plants from this country scattered all over Central and South America, and from the fact that special efforts have been made in that line of export lately it seems likely that the number will be very largely increased. Another example of this is found in the plant of 100 arc lights which the Thomson-Houston Company has just sold for San José, the capital of Costa Rica, also, like Guatemala, a Central American station.

Note was made not long since by the papers of the use of artesian-well power at St. Augustine, Fla., to drive some of the dynamos there of the Edison plant, in the Ponce de Leon Hotel. This was looked upon as a unique installation, but attention is now called to another plant of similar character at Yankton, Dakota. There the United States dynamos of the Yankton Electric Company are driven by a well. It is one hundred feet deep. The water comes up through a 6in. casing, passes into an old boiler which catches the stones and *débris* sometimes shot up by the well, and then passes by a pipe to a 12in. turbine with a fall of 30ft. The turbine is controlled automatically by an electric governor. The pressure in the boiler is 71b. under full head, and 57lb. to the square inch when the well is closed. So successful has the plant proved that the present 30 horse-power is inadequate to meet the demand for lights, and a second well is to be sunk.

NOTES FROM PARIS.

(FROM OUR OWN CORRESPONDENT.)

September 11th, 1888.

The experiments on the electrical tramway I spoke of in my last letter have been successful, and the line will be open to the public by the 15th inst. The employment of accumulators is every day becoming more general in electric light installations, and the three firms who manufacture them in this country are unable to meet their orders. The Société pour le Travail Electrique des Métaux, which manufactures the Laurent-Cély accumulator, are about to open their works at St. Ouen, close to Paris, where the manufacture of these accumulators will be carried out on a very large scale. Accumulators are not only employed in the lighting of theatres, but it is proposed to erect an important public lighting station based on working accumulators in series. The Gadot accumulator also has undergone several important modifications lately; the proportion of active material has been increased to 54 per cent. of the total weight of the plate, and an output of 21·75 ampere-hours per kilogramme of plate has been attained. Owing to the system of double plates adopted by M. Gadot, it is asserted that these improvements have not been obtained at the expense of durability. The plates are 45mm. in thickness, and the discharge takes place at the rate of 1·5 ampere per kilogramme of plate. The recent improvements made in their manufacture have greatly increased their efficiency and durability, and the time is certainly not far off when accumulators will be sold with the same guarantees as other electrical machinery.

Tenders will in a very short time be received for the municipal electric lighting station at the Halles Centrales. There will be separate tenders for electricity and motive power, the total expenditure amounting to one million of francs:—Works and motive power, 565,000fr.; electric machinery, 192,000fr.; wiring, 221,300fr.; sundries, 21,700fr. The lighting of the Halles will only absorb 512 incandescent lamps and 168 arc lamps; the remainder of the plant, as I have mentioned before, will be devoted to private lighting. Part of the lighting will be done with 115-volt compound-wound dynamos, and part with transformers and 2,000-volt alternating dynamos.

Private installations in this city are rather numerous, the motive power being either steam or gas, and their number increases daily in view of the impossibility of foreseeing the time when central stations will be at work. The new printing works, Imprimerie de la Presse, Rue du Croissant, are lit with 500 incandescent lamps, and the works on the other side of the same street, in which about twenty papers are daily printed, will soon be lighted with 2,000 incandescent, and some twenty arc lamps.

NOTES FROM VIENNA.

(FROM OUR CORRESPONDENT.)

The reconstruction of the Central Electric Lighting Station of the Imperial Continental Gas Association, from which the Opera House is lighted, and which will also light the new Court Theatre, has just been completed. It will be remembered that one of your

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contemporaries published some time ago a description, with illustrations, of this station. Anyone who had formed an idea of the place by this would not believe that the present station is the one there referred to, so entirely has it been reconstructed—it is not too much to say that really a new station has been built. How difficult the work must have been may be guessed by the fact that during the whole time this reconstruction was going on, involving as it did the taking up of the whole plant, removing and refixing it, the electric current has been supplied, and no interruption caused in the lighting of the Opera House. Numerous temporary makeshifts had to be resorted to, and to appreciate the difficulty of the task it is necessary to have seen the station as it was and as it now is. This new central station, as it may truly be called, was built entirely to the designs and under the superintendence of the company's able resident engineer, Mr. T. W. W. Melhuish, Assoc. M. Inst. C.E., who deserves great credit for the successful carrying out of a most difficult task. The new dynamo room, a splendid airy and well-lighted hall, is now full. It contains five 72-unit dynamos, three 100-unit dynamos, and four 7-unit dynamos by Crompton and Co. These are all coupled direct to Willans engines. The steam is supplied by eight Babcock and Wilcox boilers, each having 1,306 square feet heating surface. The boiler house is most conveniently arranged. The work has been done in a most thorough and substantial manner, showing that the engineer knew what he was about, and that he wanted to make this central station one of the best, if not the best in Europe.

NOTES FROM COPENHAGEN.

(FROM OUR CORRESPONDENT.)

The electric lighthouse at the Copenhagen Exhibition is now completed, and has been lighted for a couple of weeks. It is an exhibit of exceptional importance, and one which has probably never been exhibited before in its entirety. This is only another example of the trouble taken and the large expense incurred by the Danish Government and public institutions in connection with this Exhibition. It is intended for the Hanstholm, and is not only the first electric lighthouse in Denmark, but is one of the, or perhaps the, most powerful in Europe. Its power is no less than 20 million candles, or about 300 times more powerful than any other lighthouse on the west coast of Jutland. In clear weather only one-fourth of the light will be employed. The large and well known firm of Barbier, of Paris, has supplied the lenses; De Meritens, of the same city, has supplied the magneto-electric machines; the steam engines, &c., hail from the Elsinore Shipbuilding and Engineering Company Works at Elsinore; Messrs. Kemp and Lauritzen, electrical engineers, of Copenhagen, have supplied the air motor, dynamos and electro-magnets for the sirens; the latter are made by the firm of Tuxen and Hammersch, of Copenhagen. The electric lamp can be changed in the course of a few seconds, and should the electric light fail, a petroleum lamp can be instantaneously substituted without altering the character of the lighthouse, and a light twice as powerful as the Scaw lighthouse can be maintained. The lenses are of very large dimensions, allowing an admirable distribution of the light; they have been constructed in accordance with drawings from the chief engineer for the Danish lighthouses. The result is that a large portion of the light, which would otherwise fall within a few miles of the lighthouse, is sent to the horizon. There are two foghorns at the Hanstholm Lighthouse, which are both being worked by electricity, through the medium of a small motor, with dynamos at the lighthouse, and electro-magnets at the foghorns, by which these are actuated through a system of valves. The light of the Hanstholm Lighthouse is so powerful that people have been able to read by it at a distance of 24 miles from the exhibition.

The telephone line between Stockholm and Vesteros (Sweden) was opened on Wednesday, August 29th. The length is 10½ Swedish miles, and the wire is copper wire, of two millimetres in diameter. There are no intermediate stations between Stockholm and Vesteros. The business of the large Stockholm Telephone Company is increasing to such an extent that they have again been obliged to extend the premises occupied by them.

A very curious story comes to hand from Sillevorde, Jutland:—"On Monday, August 27th, a farmer and his wife were returning from a visit to some friends, it being close upon midnight, when, within a short distance of home, it suddenly appeared as if the horse had to use all its power to pull the carriage, although it was going down hill. At the same moment some fire was discovered at the front wheels. As to what happened next both the farmer and his wife are ignorant, as they became insensible. The man came to first, and found that the horse was gone and the trap was shattered. The seat was lying in one place, the cushions in another, and the cover was found in a cornfield. The farmer's wife was lying insensible some distance from the carriage. When the farmer and his wife finally arrived home the horse was standing with its nose against the stable door."

SWEDISH NOTES.

(FROM OUR CORRESPONDENT.)

STOCKHOLM, *Sept.* 7, 1888.

In Stockholm the question of a large central station for electric light appears to progress somewhat slowly, and more time is likely to elapse before any definite decision is arrived at than was at one time anticipated. In lieu of a plan which the gasworks submitted to the Corporation as early as December, 1886, and which comprised the erection of a central station for 4,000 incandescent lamps, entailing a cost of 585,000kr., the directors of the gasworks applied for and obtained leave to lay another proposal before the Corporation. The gasworks authorities then invited tenders from five foreign firms for the erection of a central station. The tender preferred was that of Messrs. Siemens and Halske, Berlin, it being the cheapest of the lot. Upon this basis a fresh plan was worked out by the gasworks, and brought before the Corporation; the cost had risen to 623,000kr., but the capacity of the station had been doubled, and was now calculated at 8,000 incandescent lamps. As this number of lamps was not excessive, the second plan was consequently far cheaper than the former. In order to ascertain the probable requirements of that part of the town for which the central station was in the first instance intended, people wanting electric light were requested to state the number of lamps they wanted, and in less than a fortnight 4,092 incandescent and nine arc lamps were asked for. The second plan of the gasworks has been before the Corporation for some ten months without any reply having been given. In the meantime, the Corporation appointed a committee, which was to look into the matter of the fixing of wires and cables, and to frame additional regulations in reference to this question. Although this committee was not appointed simply on account of the contemplated central station, but also on account of the rapid growth of telephony in Stockholm, the Corporation will probably await their report before giving the gasworks a reply.

In Sundsvall a comprehensive scheme for lighting the town by electricity has been mooted by the well-known firm of Thomson-Houston, of Boston. This firm has effected a number of important installations in Sweden, among them being those at Gothenberg, Hernösand, &c., and their system has gained many friends in Sweden. They now propose utilising the waterfall of Matfors for the above purpose, and the plan comprises not only the lighting of streets and houses, but it is under contemplation to extend it to electric tramways in the town and neighbourhood. An engineer is at present at Sundsvall, and the proposal meets with a favourable reception. The firm is supposed to be willing to complete the whole installation and submit it to a thorough trial before demanding payment. As the town of Sundsvall has been almost entirely destroyed by fire within the last two or three months, the conditions would appear to be exceptionally favourable.

The installation for the lighting of the town of Vesteros (Sweden) by electricity is nearly completed. The dynamos hail from the Stockholm Elektriska Aktiebalag, and the Motala Engineering Company has supplied the steam engines.

A new limited company for electric light has just been formed at Gothenburg, under the name of "Electran." At a meeting of persons interested in the undertaking, which was held at Statel, Christiania, Gothenburg, on Saturday, September 1st, it transpired that enough shares had already been applied for to leave sufficient funds for the building of a large central station. The directors *ad interim* were authorised to at once proceed with the works, as it was deemed desirable to be able to start as early as November. The money is exclusively Swedish, and a number of consumers of electric light are among the applicants for shares. The prospectus of the new company contains, among others, the following clauses:—"Electric light will be supplied both night and day; the light will be perfectly steady, and to attain this end the company will have a sufficiency (including reserves) of the best possible machines; the light will be supplied at such a price that both business people and private individuals may be able to use it."

CORRESPONDENCE.

UNIPOLAR INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to Mr. Tunzelmann's note in your last issue, suppose any curved figure, A B C D, to represent a conducting circuit, and to be situate in the field of a cylindrical magnet, and fixed in distance from the magnet's axis. The magnetic field being uniform about this axis the number of lines enclosed by the circuit A B C D does not change, whether the lines of force rotate about the axis, everything else being fixed; whether the circuit A B C D alone rotates about the magnetic axis,

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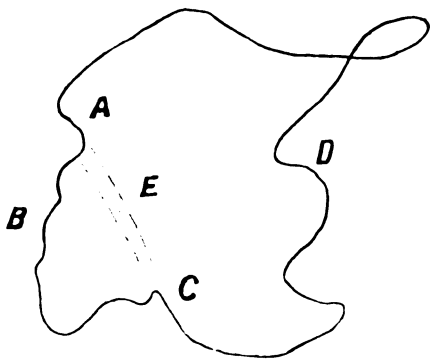
maintaining a constant distance and position relative thereto; or whether both lines and circuit rotate simultaneously either in the same or in contrary directions about the magnet's axis. This is a very obvious fact.

Now, suppose that the part A B C of the circuit be replaced by a metallic cylinder (disc or what not), mounted concentrically with the magnet, and that sliding contacts be provided at the points of junction A and C. The *circuit* is now—whether the



cylinder rotates or whether the conductor A D C rotates—represented by the figure A E C D, A E C (representing the *path* of the diffused current within the cylinder) being fixed relatively to the points A D C. Hence it is perfectly obvious that, since the circuit A E C D is invariable in figure and in size, the number of lines bounded by it can no more vary than in the case of the former circuit A B C D. Surely this is simple enough, and entitles me to write Q.E.D. When the contacts A and C are sliding, owing to the relative rotation of the cylinder and A D C, then the conductor on the line A E C cuts a different number of lines of force to A D C., whatever way the lines be revolving, or if they are stationary. Hence the current, as in Forbes's dynamo.—Yours, &c.,

Staveley, Sept. 7, 1888. R. SNOWDON.

THE LINEFF ELECTRIC TRAMWAY SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your contemporary, the *Electrical Review*, last week published a criticism of a report drawn up by Mr. Gisbert Kapp on my electric tramway system, which report you have published in your issue of 31st ult.

The *Electrical Review*, while criticising Mr. G. Kapp's report, has not printed it, and the readers of that paper cannot be in a position to appreciate the facts of the case, the more so as the Editor himself appears to labour under a misapprehension as regards the distinctive features of my system.

The point raised by the article quoted is, however, of some importance to engineers and electricians generally, and for this reason I trust you will allow me to make a few remarks on it.

The writer of the article seems to take exception to professional reports on the ground that they are based on tests and experiments made on a small scale and extending over a short time. Yet what other course would the author advise to the inventor who has to deal with tramways and railways, where an experiment on a *full-size scale* means an expenditure of many thousands of pounds, and would be the work of years? Is it not a most natural, proper, and, I may say, honourable course for an inventor, after having demonstrated on a small scale the capabilites of his system, to request to have the results thus obtained checked by an independent and thoroughly competent practical man? Surely my critic does not advise the adoption of what I would call the stock-jobbing system of "scientific" display, according to which a new invention is shown to a party of city gentlemen and half a dozen reporters from "friendly" papers, who witness a series of well-rehearsed showy experiments, in order to demonstrate the great "features" of the invention.

The contention of your contemporary that my system is identical with that of Mr. Holroyd Smith and that of Profs. Ayrton and Perry is so absurd that I need not waste your valuable space with details of the many vital points of difference. But let me respectfully ask my sapient critic the following question:—If "the leading feature of the Lineff system was demonstrated years ago by Profs. Ayrton and Perry and Mr. Holroyd Smith," then what is the difference between the two latter systems? Have they both the same leading features?—Yours, &c., ALEX. L. LINEFF.

88, High-road, Chiswick, W., 11th Sept., 1888.

LEA'S HAND-STARTER FOR GAS ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It may be desirable to point out that an identical arrangement was in use here about six years ago, and the lever, with vertical arrangement, is still by me.

We found by experience that turning the wheel of the engine answered better, because at a particular moment a slightly quicker turn of the fly-wheel succeeded in producing the explosion, and this is not easily done with a lever device, as may easily be conceived. If Mr. Lea doubles his ratchet arrangement in a suitable manner so that the backward as well as the forward movement of the lever causes revolution in the same direction, by one of the well-known methods, success will follow. At the same time this arrangement can be made to allow the engine to run free. Rollers or balls are better than ratchets, if expense does not stand in the way.—Yours, &c.,

DAVID SALOMONS.

Broom Hill, Tunbridge Wells, Sept. 8, 1888.

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ELECTRIC STREET LIGHTING AT BARNET.

A correspondent writes from Barnet as follows :—On Saturday, Sept. 1, the streets of Barnet were for the first time lighted by electricity, and the general opinion appeared to be that the result was most satisfactory. The light was brilliant, steady, and well diffused. For many years great dissatisfaction has been felt at the quality and price of the gas supplied by the Barnet District Gas and Water Company, and the Local Board have frequently had under consideration the advisability of lighting the town with oil. The company gradually reduced the price per thousand cubic feet of gas from 6s. to 4s. 6d., but even this was considered far too high, and some few months back negotiations were entered into with Mr. H. F. Joel, C.E., of the firm of Messrs. Joel and Co., of Wilson-street, Finsbury, for the lighting of the town by electricity. This was the signal for a reduction of 3d. per thousand in the price of gas, and when the contract was at length provisionally accepted notice was given of a further reduction to 4s. per thousand. Mr. Joel's original proposal was to supply lamp for lamp with 16 candle-power burners (that being the supposed power of the gas) at a price about 3s. 6d. per lamp per annum less than that paid to the gas company. This proposal was eventually modified, and it was decided to give 32 candle-power lamps, the price still being based on the original offer ; but the Board have arranged to have more than half the number of lamps originally proposed, consequently the price will be slightly in advance of what has been paid for gas, and at the same time the amount of light will be proportionately greater. There are 71 lamps of 32 candle-power each placed in all the streets of the town and fixed on strong ornamental iron posts 12ft. high, each being provided with a powerful reflector by means of which the light is distributed over a large area. The posts have been specially designed for the work, and each is provided with a small door in order that, where necessary, switches may be used for cutting off independently any lamp or lamps. The electricity is conducted over the district by means of about five miles of hard drawn copper wire of 3 strands 17 gauge, supported on the top of the lamp-posts, which are provided with iron hoops for the purpose. The copper wires are attached to short lengths of well-insulated wire supported on cup insulators and then passed down through the globes to the incandescent lamps. Where the wires cross main thoroughfares they are laid underground in creosoted wooden troughs, and insulated with rubber and encased in leaden tubes to preserve them from mechanical injury. The electricity is generated by a dynamo machine fitted with Joel's patent armature, the pressure being 900 volts, with a current of 10 amperes, and the machine revolves at a speed of 800 per minute. The dynamo machine is fitted with Statter constant-current apparatus ;* this allows one lamp or any number of lamps up to 100 to be used, and the current is automatically adjusted in the required proportions. The machine is mounted on slide rails, so that the belt can be adjusted while it is running. The engine now used is an 8 horse-power (nominal), but this is only temporary, while the permanent engine is being erected. The latter will be inverted vertical engines, running at 240 revolutions per minute. The boilers are of the locomotive type, and the feed-water heaters, injectors, &c., are all of special design and in duplicate. The electric light station is at the Hadley end of High Barnet, and the company, who have taken over Mr. Joel's contract, propose at once laying down powerful engines, boilers and electrical machinery for from 1,000 to 5,000 lamps, for use in private houses, places of worship, &c., many orders having been received and promised. Already the enterprising proprietor of the Castle, one of the principal hotels of the town, has adopted the electric light, and the result is satisfactory in the extreme. The whole of the machinery and electrical apparatus has been designed and fitted by Mr. Joel, and the company have many inquiries from other towns anxious to keep pace with the times. The work in this instance has been carried out in an exceptionally short time, and under contract with the Barnet Local Board. We regret to learn that, owing to the excessive heating of a dynamo bearing, the town of Barnet was thrown into darkness for some time on Wednesday night. By 2 o'clock on Thursday morning everything was restored.

* *See The Electrician*, October 21, 1887, p. 497.

THE WOLVERHAMPTON CORPORATION AND THE LIGHTING OF THE BOROUGH.

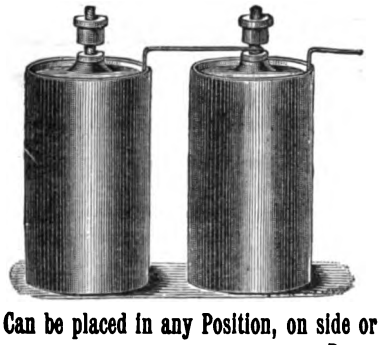
At Monday's meeting of the Wolverhampton Town Council, the Special Gas Committee presented the following report :—

At a special meeting of the Council, held in December last, your committee were re-appointed to consider the question of the supply of artificial light for the use of the inhabitants of this borough, and to obtain such professional advice with reference thereto as they might think fit, and to report thereon to the Council. Your committee deemed it desirable to submit a series of questions to various corporations and gas companies in the country, with regard to their respective gas undertakings ; and a large number of replies have been received. It was also considered necessary to ascertain, as far as possible, to what extent electric light and oil were being used in those places for lighting the public streets. Your committee have to report upon the various points as follows :—

At Eastbourne, Hastings, and Blackpool electric light is used for lighting some of the principal places, streets, and thoroughfares ; but your committee have not sufficient information from those boroughs to enable them to judge as to the relative cost of gas and electric light for the areas supplied. The Corporations of Bristol, Carlisle, and Huddersfield have obtained Provisional Orders for the supply of electric light, but they have not been acted upon ; whilst at Norwich and Middlesbrough electric light has been tried and its use abandoned. The Town Council of Bath have recently decided to light about 50 streets with electric light.

Your committee have consulted Messrs. Elwell-Parker (Limited), of Wolverhampton, with regard to the cost of lighting the streets of the borough with electricity, who cannot at present recommend the Corporation to undertake the lighting of the streets alone, owing to the length of leads necessary to be used for the purpose, and the amount of labour of laying down mains necessary for this comparatively limited amount of lighting. Messrs. Elwell-Parker are of opinion that "if Wolverhampton is lighted by electricity it must be arranged to be done upon the same plan as gas—that is to say, by taking off the mains to light dwellings or shops, or wherever the current could be sold, so as to utilise the cables to the greatest extent." In case of carrying out such a plan of lighting, they have no hesitation "in recommending the Corporation to use electricity, as electrical engineering is sufficiently advanced to make the thing a thorough success, and to give a good return for capital invested at reasonable rates charged. Even in small installations, where not more than 4,000 lights are used, it will compare favourably with gas at 3s. 6d. per 1,000 feet. If a 40,000 lamp installation were entered into, the present price of gas in Wolverhampton could be successfully competed with by electricity."

Your committee find, on comparing the estimate of cost of plant, &c., which they have received from Messrs. Elwell-Parker (Limited) for light-



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ing 60 miles of streets in the borough, and for providing for the probable requirements of the inhabitants, with that of Mr. J. N. Shoolbred, which was submitted to the Council in November, 1882, and which provided for the lighting of a small area in the centre of the town only, that an enormous reduction has been made in the cost of such plant, and there is no doubt that on the further development of electric light, still greater reductions will be made.

Your committee may also here call attention to the Electric Lighting Act, 1888 (51 and 52 Vict., c. 12) amending the Electric Lighting Act, 1882. Under this Act a Provisional Order for the supply of electric light in the district of any local authority is not to be granted, except with the consent of the local authority, unless where such consent is refused the Board of Trade are of opinion that such consent ought to be dispensed with, when they are to make a special report, stating the grounds upon which they have dispensed with such consent. The grant of authority to any undertakers to supply electricity within an area is not to restrict or hinder the granting of a license or Provisional Order to the local authority, or to any other company or person within the same area. The Act also gives local authorities power to purchase the undertakings for the supply of electric light from the undertakers within six months after the expiration of a period of 42 years from the date of the Act confirming the Provisional Order, or the passing of the Special Act, or within six months after the expiration of every subsequent period of ten years, or such shorter respective periods as may be specified in the Provisional Order or Special Act. These periods in the former Act were twenty-one and seven years respectively. The sale is to made without any additional price in respect of compulsory purchase or goodwill, or of any profits which may, or might have been, or be made from the undertaking, or of any similar considerations; but subject to any variation of the terms which may be made by the Board of Trade. It is generally thought that these modifications of the principal Act will have the effect of stimulating and extending the use of the electric light.

The report was of a most exhaustive character. In addition to the above extract, it dealt shortly with the question of oil lamps, and entered very fully into the price and quality of various gas supplies.

The report concluded as follows:—Your committee, in concluding their inquiry, desire to disclaim any suggestion of antagonism to the Gas Company in respect of the steps which they have taken. They have examined in an impartial manner the evidence brought before them, and in view of the facts of the case they are bound to remark that the position occupied by the Gas Company, by virtue of their legal monopoly, as regards the gas consumers, cannot be accepted as satisfactory to the public.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

12,592. C. HAMILTON. Glasgow. An improved means or method of attaching incandescent electric lights to gas brackets or other gas fittings. September 1, 1888.

12,609. W. P. THOMPSON. Liverpool. Improvements in or relating to electrical locks (E. Lémonon, France). September 1, 1888.

12,620. C. MARSON. London. Electric secondary battery plates. September 1, 1888.

12,703. G. T. JOLLAND. London. An improved voltaic battery. September 3, 1888.

12,706. W. P. THOMPSON. Liverpool. Improvements in storage battery plates (C. D. P. GIBSON, United States). September 3, 1888.

12,727. G. STIBBE, acting for E. DUBIED AND CO. Convet. Suisse. The electric brake appliance. September 4, 1888.

12,740. W. FAIRWEATHER. Glasgow. Improved apparatus for electrically indicating variations of water level in rivers, aqueducts, mines and the like (H. C. Spohr, Germany). September 4, 1888.

12,754. H. H. LAKE. London. Improvements relating to electric bells and to indicating apparatus for use in connection therewith (W. Humans, United States). September 4, 1888.

12,759. F. TEAGUE. London. An electric meter or apparatus for recording the passage or consumption of electricity. September 4, 1888.

12,761. A. G. WATERHOUSE. London. Improvements in dynamo-electric machines. September 4, 1888.

12,767. W. H. SCOTT. Norwich. Improvements in dynamo electric machines. September 4, 1888.

12,817. E. DIXON. Hull. Immediately stopping a steam-engine by means of electricity from a distance; may be called "The Electric Engine Stopper." September 5, 1888.

12,828. F. D'ARC. London. Improvements in electric incandescent lamps. September 5, 1888.

12,832. F. V. ANDERSON. London. Improvements in conductors for armatures of dynamo electric machines. September 5, 1888.

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ELECTRIC LIGHTING MACHINERY.

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12,856. C. ZIPERNOWSKI and M. DERI. London. Improved apparatus for converting electrical currents. September 5, 1888.

12,858. C. ZIPERNOWSKI and M. DERI. London. Improvements in the distribution of electrical energy. September 5, 1888.

12,887. R. H. COURTNEY. London. An improvement in voltaic cells. September 6, 1888.

12,907. T. PARKER and W. LOWRIE. London. Improvements in dynamo electric machines. September 6, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

September 8, 1888.

12,437. R. E. B. CROMPTON and J. SWINBURNE. Chelmsford. Improvements in and connected with dynamo electric machines. September 14, 1887.

12,830. W. R LAKE. London. An improved regulating device for use in electric arc lamps, and for other purposes (O. H. L. Lindemann, Germany). September 21, 1887.

12,924. G. Zanni. London. Improvements in the manufacture of incandescent electric lamps and of carbon rods therefor. September 23, 1887.

15,754. W. J. S. BARBER-STARKEY. Manchester. Improvements in the electrolytes of secondary voltaic batteries. November, 17, 1887.

2,516. G. MIST. London. A new or improved apparatus or inductometer for measuring the intensity of a magnetic field. February 20, 1888.

9,991. W. R. LAKE. London. Improvements in magneto-electric apparatus (W. Humans, United States). July 10, 1888.

10,954. E. H. GEIST. London. Improvements in or connected with dynamo-electric machines. July 28, 1888.

11,338. L. KELNER. London. Improvements in telephone line circuits. August 4, 1888.

PATENTS SEALED.

August 31, 1888.

7,185. W. H. AKESTER. London. Improvements in electro-propulsive motors, and in the application thereof to wheeled vehicles or rolling stock. May 17, 1887.

10,177. E. L. MAYER and H. LIEPMANN. London. Improvements in the manufacture or treatment of porous pots, plates, or partitions for electric batteries. July 20, 1887.

11,285. R. HANNAN. Glasgow. Improvements in the manufacture of rubber composition strips used in the manufacture of insulated wires and cables (J. J. C. Smith, United States). August 18, 1888.

11,390. J. S. STEVENSON. South Shields. Improvements in the manufacture of elements or plates for secondary batteries or electrical accumulators. August 20, 1887.

11,417. T. A. GARRETT. London. Improvements in and connected with electrical connections with moving bodies. August 22, 1887.

11,502. E. F. H. H. LAUCKERT. London. Improvements in dynamo-electro and electro-dynamic machines. August 23, 1887.

13,758. A. J. BOULT. London. Improvements in electrical apparatus especially applicable for use in dental operations (E. Smith and F. Kimble, United States). October 11, 1887.

7,536. B. WILLCOX. London. Improvements in galvanic batteries (T. Palmer-Whittier, United States). May 22, 1888.

SPECIFICATIONS PUBLISHED.

13,720, 1887. DE KHOTINSKY, A. Effecting electrical measurements and contacts. (Price 4d.)

15,455, 1887. ROGERS, W. S. Connecting separate electrical conductors to one main conductor. (Price 8d.)

713, 1888. COAD, T. Voltaic batteries. (Price 8d.)

7,619, 1888. WEIR, G. J Primary electric battery. (Price 8d.)

CITY NOTES, &c.

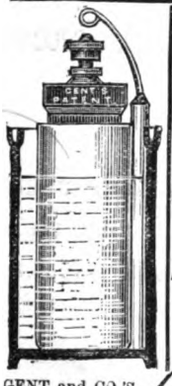
BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended September 7, 1888, amounted to £4,863.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of August was 3 507, estimated to produce £2,800, against 2,983 messages, producing £2,280, in the corresponding month of last year. The traffic receipts for the month of May, estimated at £3,300, realised £3,337.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended September 7th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £4,011.

PATENTS FOR INVENTIONS,
REGISTRATION of TRADE MARKS and DESIGNS in all countries.
SEARCHES made *re* novelty, and opinions given on all matters connected with above.
Full particulars on application to
J. C. CHAPMAN,
Assoc. M. Inst. C.E., M. Inst. M.E., Fel. Inst. Patent Agents.,
70, CHANCERY LANE, LONDON, W.C.

WHOLESALE AGENTS FOR
GASSNER'S DRY CELL.



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Combined Engines, Dynamos, and Projectors for Torpedo Boats, &c., as supplied to H.M. Navy and Foreign Governments.
PLANT ON HIRE FOR CONTRACTORS, &c

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Sept 12, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Sept. 12, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	42 43	3 15 6	Jan., Apr., July, Oct.	42⅞	41
2,614,820	Stock	10/0	Do. Preferred	71 72	3 16 5	,, ,,	72	67½
2,614,820	Stock	nil.	Do. Deferred	15 15½	...	February	15 7/16	14
130,000	£10	3/0	Brazilian Submarine	13 13½	5 5 8	Mar., June, Oct., Dec.	13 5/16	13 1/16
16,000	10	9/0	Cuba Submarine	13½ 14	6 1 5	February and August	14	13⅜
6,000	10	10/0	Do. Preference	18 19	5 5 3	,, ,,	...	...
12,931	5	4%'87	Direct Spanish (£4 paid)	3¾ 4¼	3 15 4	March & September	...	...
6,000	5	5/0	Do. Preference	9⅝ 10⅛	4 15 3	April and October	...	...
60,710	20	2/0	Direct United States	9⅛ 9⅜	4 2 1	Jan., Apr., July, Oct.	...	...
380,000	10	4/6	Eastern	12⅜ 12⅝	4 15 1	,, ,,	12 9/16	12⅜
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜ 15	4 0 0	,, ,,	14 1/16	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	3 18 0	February & August	108¾	...
250,000	10	2/6	Eastern Extension	13 13½	4 18 6	Jan., Apr., July, Oct.	13 5/16	13
22,050	10	8/3	German Union Telegraph and Trust	9 9⅛	7 7 4	January and March	...	...
179,177	10	3/0	Globe Telegraph and Trust	7 7¼	4 16 7	Jan., Apr., July, Oct.	7⅛	6⅞
178,992	10	3/0	Do. 6 per Cent. Preference	14 14½	4 4 3	,, ,,	14¼	14
150,000	10	5/0	Great Northern	13⅜ 14¼	5 5 3	Jan., July, and April	14¼	14 1/16
17,000	25	37/6	Indo-European	37 39	6 8 3	April and October	38½	37½
33,348	10	3/0	London Platino Brazilian	6 6½	...	May and November	...	...
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	...	...
338,225	Stock	13½%	Submarine	130 140	10 7 0	February & August	...	...
30,000	10	6/0	West Coast of America	7¼ 7⅜	6 9 0	January and July	7⅜	7¼
150,000	Stock	8%	Do. Debentures	112 117	6 16 9	June and December	...	...
88,321	10	nil.	West India and Panama	1⅜ 1⅞	...	...	1⅞	1 11/16
34,563	10	*10/0	Do. 1st Preference	12 12½	...	April and October	12⅜	12 5/16
45,181	15	9/0	Western Brazilian	12¼ 12⅜	5 1 3	March & September	12⅜	12 1/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 123	5 13 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	£5 7s. '87	Consolidated Telephone and Maintenance	½ ⅝	5 10 0	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	1/16 1/16	3 9 0	...	...	...
80,000	5	10/0	United	13¼ 13⅜	5 9 0	June and December	13⅜	13 5/16
50,000	5	2/6	United River Plate	5⅜ 5⅝	...	April and October	5 1/16	5⅛
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3 3½	...	...	3 5/16	...
23,692	5	nil.	Do. (fully paid)	4 4¼	...	February & August	...	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2½ 2⅝	...	...	2 5/16	2⅜
312,000	½	5% '86	Maxim-Weston	1/16 1/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39 40	5 19 9	March and July	39⅞	39½
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 3	February & August	17	...

* On account of arrears of dividend.

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 540.—Vol. XXI. FRIDAY, SEPTEMBER 21, 1888. Price 4d.

NOTES.

In another column there will be found a sketch by Prof. Lodge of the Electrical Papers read at the Bath Meeting of the British Association. The author has done well to call attention to the magnification of the engineer at the expense of the scientific investigator by the President of the Association and the President of Section G respectively. The scientific investigator is, from the point of view of practical applications, essentially a pioneer, and we fear that everywhere the pioneer receives very much less credit than he is entitled to. The remarks of the President and of the Sectional President were, however, couched in quite moderate terms compared with those of the extract quoted by the Professor from a technical contemporary.

We would specially call the attention of our non-mathematical readers to Prof. Lodge's excellent *résumé* of two Papers by Sir William Thomson, dealing mathematically with electrical theory, as in their original form they demand a not inconsiderable amount of mathematical knowledge on the part of the reader.

A Paper by Herr Marcher, of Mülheim, which we publish this week, directs attention to a class of dynamo with which very little has hitherto been done, nor do we altogether share our contributor's views as to the probability that the type will establish a permanent foothold. The commutator is undoubtedly the most delicate part of the organism of the dynamo. Other things being equal, a machine without commutator or brushes is undeniably to be preferred to one which possesses those adjuncts. But then at present other things are *not* equal: the increased cost and diminished efficiency of such a machine is too heavy a price to pay for dispensing with a device which after all works, at least in modern machines, with surprisingly little trouble or irregularity. At the same time we think the article will repay perusal, and has a certain historical interest.

An interesting letter from Prof. S. P. Thompson will be found in our "Correspondence" columns this week, referring to a Note in our issue of September 7th. The possibility of practically generating knotted lines of force is novel, and of considerable interest. As we are confined to space of only three dimensions, it would be impossible to produce knots by any inductive action, in lines of force proceeding from a conductor, and equally impossible to remove the "beknottedness." In space of four dimensions a knot, as known to us in our space, could be tied upon or untied from an endless cord, or one with both its ends fixed, without cutting it or detaching an end respectively; and therefore in space of four dimensions a true knot—that is to say, one which cannot be untied from a closed string—is impossible.

The eighth meeting of the National Electric Light Association of America was opened at the Hotel Brunswick at New York, on the 29th August, by an address from the President, Mr. S. A. Duncan, of Pittsburg (Pa). The address contained some interesting statistics relating to the present condition of electrical industry in America, an abstract of which will be found in another column. According to the Secretary's report, the Association now embraces 189 members, which shows a considerable increase upon last year.

The first Paper read at the meeting was by Mr. S. S. Leonard, giving a short account of his practical experience with petroleum fuel. The subject is one of considerable importance to American engineers, owing to the quantity and low price of the crude material, and his Paper therefore attracted a good deal of attention.

On the second morning three Papers were read—by Mr. S. S. Wheeler, on "Overhead and Underground Wires in New York;" by Mr. E. G. Acheson, on "Disruptive Discharges and their Relation to Underground Cables;" and by Mr. A. C. Chenoweth, "Description of an Underground Circuit." Mr. Acheson's Paper will be found in another part of the present issue, and we shall shortly give an abstract of Mr. Wheeler's. The three Papers were discussed together, and gave rise to a long and interesting debate. Dr. Van der Weyde's Paper, which we published last week, was read on the third day, and was followed by a valuable Paper on "Some Methods of Electrical Measurement," by Dr. G. A. Liebig, intended to draw the attention of American engineers to recent methods of exact measurement. We trust they will give it the attention it deserves. The other Papers read at the meeting were on "Electrical Education," by Mr. E. R. Weeks, and on "The Expense of Electro-Motor Service," by Mr. H. F. Lufkin.

Mr. Acheson's Paper on "Disruptive Discharges and their Relation to Underground Circuits" dealt with a subject which has scarcely as yet been forced upon the attention of electrical

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engineers in this country, but which will in all probability assume considerable importance at no distant date. We should be glad to learn how far Mr. ACHESON's experimental results are confirmed by the experience of practical men, and how far the danger indicated is a real one.

IN the course of the discussion on Mr. ACHESON's and the two other Papers dealing with underground conductors, Mr. T. CARPENTER SMITH stated that when working an arc-light circuit containing a couple of Thomson-Houston lightning arresters at the ends, he had observed that when the circuit was opened or closed sparking took place across the lightning arresters, and when the machines were working badly there was a continuous stream of sparks. No explanation of the phenomenon had occurred to him until it had been given in Mr. ACHESON's Paper. Mr. SUNNY, while challenging some of Mr. ACHESON's results, also considered his investigations of great importance. The American technical journals generally express themselves to the same effect.

THE little pamphlet on the Technical Education of Engineers which has just been issued by the Manchester Association of Engineers contains some valuable suggestions as to the best course of study to be pursued by young men engaged in engineering workshops. We cordially endorse the remarks upon the importance of the study of practical geometry, which is usually very much neglected in this country. Its special importance to engineering students, whose knowledge of mathematics is but slender, is pointed out in the pamphlet, and we may add that it is of the greatest value as a preliminary even to the most thorough course of mathematical study, and especially so for engineering students, owing to the great assistance which it will afford them in applying their mathematical knowledge to practical problems. The essential importance to electrical engineers of acquiring a knowledge of applied mechanics, metallurgy, and machine and freehand drawing, is very properly insisted on, and also the value of a knowledge of the principles of steam and of chemistry. We are glad to see that the study of French and German is also strongly advised, as a knowledge of both of these languages is of the utmost value to the electrical engineer to enable him to keep himself abreast of the most recent advances in electrical engineering. The student should also bear in mind that a knowledge of these and other modern languages, such as Spanish and Italian, may often enable him to secure appointments from which he would otherwise be debarred.

THE breakdown at Barnet is all the more annoying because it appears to have been one of those "accidents" which an ordinary degree of prudence might have entirely obviated. To start a machine under a full load of responsibility directly it has been got into place may be "smart," but it certainly is not engineering. We take it that except in a case of the extremest urgency no engineer with a due sense of responsibility would dream of putting a dynamo on central station work without first making a preliminary run to see that the bearings are true. We feel bound to speak plainly and strongly when an incident of this character comes under our notice, for the fact is that the position of central station electric lighting in this country is not sufficiently well assured to withstand these rude buffets at the hands of its would-be exponents.

AS to the impression which Mr. JOEL's performance—apart from the interruption alluded to above—has made upon the public mind at Barnet, we may refer to our Note columns, in which we give an extract from a local journal. Our own views as to the propriety of lighting streets with glow lamps of low candle-power are well-known to our readers, and notwithstanding that our earlier remonstrances induced the Town Council to double the candle-power of the lamps, we are still not in the least surprised to learn that the mutterings of discontent are already heard. We trust the success of Mr. JOEL's scheme for the distribution of current to private consumers will be sufficient to atone as far as may be for the mistaken policy which he has adopted with regard to the public lighting.

WE are glad to notice that the Insurance Offices are beginning to realise the importance of exact electrical knowledge in connection with one branch of their business—the inspection of premises where electricity is employed for industrial or lighting purposes. The Insurance surveyors, according to the *Finance Chronicle and Insurance Circular*, will in future have to be men of "considerable scientific training, or at the least widely read in the sciences of chemistry and natural philosophy, in addition to their knowledge of assurance business." This is rather exacting; but it is better than protesting that there is nothing to learn, or pretending to teach electricians their own business. Electrical engineers as a body have much to gain by the Insurance surveyors becoming competent electricians; for otherwise and in the meanwhile the name and reputation of particular firms must necessarily carry undue weight, sometimes to the detriment of less prominent but equally trustworthy undertakers.

Frankfort.—It has been decided to construct a central station at Frankfort from which to light the streets of the town by electricity.

Paris.—The installation at the Variétés is about to be reorganised. Accumulators are to be employed, and the motive power will be compressed air.

The Telephone at Grimsby.—A telephone exchange, established by the National Telephone Company, was opened at Grimsby on Wednesday last.

University College, Dundee.—The winter session of this college will open on the 8th of October. Further details will be found in our advertisement columns.

Orleansville.—The municipal authorities of Orleansville, Algeria, have invited tenders for the erection and working of a central lighting station in that town.

Telegraphic Communication in Central Asia.—A new line of telegraph will very shortly be laid down in Central Asia, between Khiva and Chardjui, on the Amu Daria.

Dalkeith.—The Dalkeith Police Commission having been informed that the introduction of the electric light would mean an addition to the rates, has abandoned the idea of introducing it.

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Chelmsford.—On the occasion of the festivities connected with the incorporation of Chelmsford, which took place on Wednesday last, the town was illuminated by Messrs. Crompton and Co. with the electric light.

Deutsche Naturforscher und Aerzte.—The sixty-first annual meeting of this society, which was recently announced in our columns, was opened at Cologne on Wednesday, and it is expected that about 1,500 members will attend.

The May Island Electric Light.—Captain Boldt, of the Danish mail steamer "Thyra," reports having sighted the May Island electric light at a distance of sixty-one nautical miles. This is the highest recorded distance at which the reflection of the light has been observed.

Electric Motors in Mines.—The Aspen Mining and Smelting Company (U.S.A.), which has a great number of electric motors for pumping, hoisting and haulage, is about to establish a large central power station to be run by water power, the energy to be transmitted to other mines in the district.

Toulon.—During the French Naval Manœuvres at this port several experiments were made with a view to test the utility of the electric light. According to the *Gaulois* the search lights on shore swept the water so thoroughly that not a single torpedo boat was able to get into the bay unseen.

Telephony in Portugal.—Messrs. Mourlon and Co., of Brussels, have received an order from the Portuguese Government for the erection of a telephone and telegraph line between Oporto and Lisbon, a distance of some 200 miles, similar to those at present existing between Paris and Brussels and Lyons and Marseilles.

Electric Light Installation at Smedley's.—Messrs. T. H. Holmes and Co., of Newcastle, have recently fitted this well-known hydropathic establishment with the electric light. The current is supplied by a 25-unit slow-speed compound "Castle" dynamo, and the fittings all over the building are of a very elaborate character.

The British Association.—The next meeting of the British Association will be held in Newcastle-on-Tyne, commencing on September 11, 1889, and the meeting in 1890 will be held in Leeds, Cardiff, probably, being favoured in 1891. Prof. W. H. Flower was unanimously elected President for the Newcastle meeting next year.

Verity and Sons' Catalogue.—We have just received the new catalogue of electric light fittings manufactured by this firm. The book contains a large number of illustrations of electroliers of various kinds and at various prices. Many of the designs are of exceptional beauty, and the catalogue is very handsomely got up, the designs being reproduced by the phototype process.

The Palais-Royal Central Station.—The plant for this central station will consist of 8,150 horse-power steam engines, each driving an Edison dynamo direct. The Théâtre Français will take 1,000 lamps, the Théâtre du Palais Royal 650 lamps, and various public buildings 1,500 lamps. The eight or ten thousand lamps still available are intended for private consumers.

Compiegne.—The central lighting station erected by MM. Buchin, Tricoche and Cie. commenced work on September 1st. It comprises two boilers, 130 horse-power Farcot steam engine, and two compound-wound 300-light Gramme dynamos. The wires are overhead, and the consumers are charged so much per lamp per annum, meters having been deemed unsatisfactory.

Lightning on a Telegraph Line.—The telegraph line between Wittower and Arkona, in the island of Rügen, was recently struck by lightning some 5 kilometres north of Wittower. Several posts were hurled to the ground and a large length of wire was melted into minute fragments. The lightning then ran along the conductor to Wittower, where it went to earth after shattering the ebonite insulator immediately outside the telegraph office. Some portion of the discharge entered the office, but, thanks to the lightning guard, no damage was done to the instruments.

The Hydrophone.—A submarine telephonic apparatus, called the hydrophone, has recently been submitted to some tests in Brest Bay by order of the Minister of Marine. The sound of a bell weighing 150 kilogrammes, which was struck under water, was heard at the greatest distance permitted by the configuration of the Bay—namely, 5,200 metres (3¼ miles). Excellent results were obtained on board a boat in motion, the bell being distinctly heard 1,400 metres off, as well as the noise of the screw of the tug on board which the sounding instruments were placed.

Use of Electricity in Diseases of the Throat.—Mr. J. Macintyre, M.B., in a Paper bearing this title read at the annual meeting of the British Medical Association last month at Glasgow, after alluding to the expense, and difficulties of arrangement for the various purposes required, when either primary or secondary batteries are employed, suggests that the transformer will probably in the future be generally adopted for this purpose, and expresses the opinion that a cheap and portable transformer suitable for all medical purposes would be of great value to the profession.

A Statue to Ampere.—At the meeting of the Academy of Sciences on Tuesday it was stated that in the beginning of next month a statue would be inaugurated at Lyons to Ampère. The authorities of that city have invited the Academy of Sciences to send a representative to the ceremony, and the President of the Republic has signified his intention to be present. The secretary recalled the various titles which Ampère has to take his place among the greatest men of science in this century. A member of the geometrical section is to be sent to represent the Academy at the inauguration of the monument.

Telephone Statistics.—The Russian Post Office authorities have recently published some statistics relating to the position of telephony in Russia. The total length of telephone lines amounts to 7,440 versts (4,960 miles), the total number of subscribers being 3,250. There are at the present moment 941 subscribers in St. Petersburg, 584 at Moscow, 472 at Odessa, and 365 at Riga. The Swiss Post Office authorities have also issued a similar report relating to Switzerland. The total number of subscribers at the end of 1887 was 5,988, being an increase of 990 since 1886; the total length of wire was 9,460 kilometres, an increase of 2,237 kilometres. The total length of trunk lines at the end of 1887 was 1,140 kilometres.

City and Guilds of London Institute.—The classes at the Technical College, Finsbury, for the Session 1889, will begin on Monday, the 1st October. They are divided into five departments, viz.:—(1) Mathematics and Mechanical Engineering; (2) Electrical Engineering and Applied Physics; (3) Industrial and Technical Chemistry; (4) Applied Art; (5) Special Trade Classes. The classes are conducted both in the day time and in the evening. The entrance examination, for day students, will take place on Wednesday, September 26th, at 10 o'clock a.m. Scholarships of £30 a year each, and the Holl Scholarships of £20 a year, all tenable for two years, will be awarded (in accordance with the several schemes) on the results of the entrance examination.

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The Zanni Shippey Lamps.—With reference to a paragraph in our New York correspondent's letter, dated 7th instant, Mr. Arthur Shippey writes to us from Llandudno a letter, too long for insertion, suggesting that if our correspondent wishes for further and trustworthy information "respecting the new S.S. lamps" he should drop in at the offices of the undermentioned American firms :—The Edison Electric Light Company, the United States Electric Lighting Company, the Julien Electric Company, the Brush Electric Light Company, the Electric Light Accumulator Company, the Columbia Lamp and Lighting Company, the Fort Wayne Jenney Electric Light Company, all of whom, besides others, have been supplied with samples of the lamps. Mr. Shippey also gives the names of a number of learned and influential persons in the States who can testify to the scientific and financial merits of the invention.

An Electrical Time Call Register.—An automatic call-bell arrangement, whereby any number of rooms can be electrically connected with a clock, and called separately or together at any time which may be desired, has recently been designed by Mr. H. Boardman, of Bradford, and is in practical operation at Mr. George Armitage's dye works at Bradford. This arrangement is in use in several private establishments, varying from three circuits upwards. It will probably be of some value in hotels, as each bed room can be electrically connected with the clock, and the occupant called without the intervention of a servant. Mr. Boardman has also devised a method for recording, by electricity, the visits of watchmen to various stations in asylums, prisons, workplaces, and police districts, which will probably be largely adopted. The several stations are so arranged that the watchman must visit the whole of the place or district under his charge when he is on duty.

Electric Light and Power Statistics.—In his presidential address to the National Electric Light Association, Mr. S. A. Duncan gave the following remarkable statistics relating to the present position of electrical industry in America:—There are now 5,351 isolated plants and central stations in the United States, and there are burning every night no less than 192,500 arc lights and 1,925,000 incandescent lights. There are 459,495 horse-power of steam engines devoted to electric lighting, and there has been an increase in the capitalisation of the electric light companies of the United States in the last six months of no less than $42,210,100. There are thirty-four electric railways completed and in operation, having an aggregate of 138 miles of single track, and operating 223 motor cars, and utilising 4,180 horse-power for stationary engines. There are, also, now in progress of construction forty-nine other electric railways, aggregating 189 miles of single track, which will operate 244 motor cars.

A New Telephone.—In a short paper on "A Novel Form of Electro-Magnetic Telephone," Prof. R. B. Fulton, of the University of Mississippi, gave a description of a form of electro-magnetic telephone of his design, in which the ordinary spool electro-magnet and circular diaphragm are replaced by a magnetised tube of thin sheet iron, with the insulated wire wound round the tube. The tube has a rectangular cross section about 2in. square (it may be of any length), and open at one or both ends. It is magnetised by steel magnets, or a current, so as to have the lines of force running parallel to its length. The wire is coiled round those parts of the tube which form vibrating segments when vocal or other sounds are made near an open end of the tube. The lines of magnetic force, the direction of the vibratory motion of the walls of the tube, and the direction of the induced currents are thus each at right angles to the other two. The instrument may be used either as a receiver or transmitter, but seems to work best as a transmitter to a Bell receiver.

The "Rees" Electric Safety Lamp.—A few particulars concerning the "Rees" lamp, which has been very well spoken of by several colliery owners and managers, may be of interest. The body of the lamp is composed of a vulcanite case, measuring 5¼in. by 5in. by 3in. To the lid is attached a small brass cylinder, and on this cylinder is placed an elongated glass dome, ⅛in. thick. The handle is fixed to the vulcanite casing by means of a brass strap, and is so constructed that the lamp may evenly balance when suspended. In the vulcanite case are four cells, filled with a liquid prepared by the inventor. Within the lid is a flat piece of India-rubber covered with paraffin wax, which prevents the liquids from mixing or spilling whilst being carried. Inside the glass dome is the bulb with the incandescent lamp, and the space between the bulb and the dome is filled with compressed air, forced from a small hand-pump. This compressed air forces the bottom of the brass cylinder down, and completes the circuit. The compressed air may be left in for an indefinite time, and the circuit broken by opening the lid alone.

The Axo Battery.—The Axo battery, constructed by the Leclanché Battery Company of America, is an "improved" form of Leclanché, intended to overcome some of the defects of batteries of the porous cup class. The porous cup has a flange which rests on the rim of the jar and forms of itself a cover for the cell. The zinc passes through an independent aperture of its own in the shoulder of the jar. The carbon conductor has inclined sides, increasing in size from the top to the bottom. By gravitation, therefore, the particles of the surrounding mixture are always in perfect and continuous electrical contact with its surface. The carbon itself is provided with ventilating grooves extending along its sides, by which it is much more readily relieved of the bubbles of gas which form on its surface, and retard the electric action, than by the holes usually run through the seal and into the mixture. The well-known lead cap of the carbon is dispensed with, and in its place is used a thimble with thumbscrew, which can be slipped off and replaced in a moment. The battery wire passes through a small hole in the top of the thimble and into a recess in the carbon, against which it is clamped by the thumbscrew.

Mr. Preece's Definition of Electricity.—In *L'Electricien* of 14th September, M. Hospitalier, commenting on Mr. Preece's Presidential Address to Section G, remarks :—"We cannot agree with Mr. Preece's definition of electricity and energy. The disagreement between physicists and engineers is much less important than it looks, and may possibly disappear without inventing new terms, such as 'coulombism' and 'electron.' The confusion to which Mr. Preece calls attention arises simply from the attempts made to define a word which is in reality only a label denoting a series of phenomena called electrical. In former days the common cause of these phenomena was thought to be a mysterious fluid called 'electricity;' but it is now amply proved that this fluid does not exist. It is therefore perfectly idle in the present state of our knowledge to try and define something which does not allow of a definition. We can define electric energy, electromotive force, intensity of current, electric force, and quantity of electricity by applying the fundamental relations connecting the different physical quantities; but electricity, having no existence, cannot be defined. Such is the only answer which can be given to the question, What is electricity ?"

Galvanic Action in Ships.—A curious discovery has just been made in connection with the "Nymphe," one of the ships completing at Portsmouth. The "Nymphe" was laid down

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ou July 5th, 1887, floated out of dock on May 1st last, and is to be completed some time during the present year. She is a composite vessel—that is to say, constructed of iron frames with a wood bottom, which is protected by copper sheathing. Before a ship is launched or floated out of dock it is customary to get the boss pieces on to the end of the steel shaft for the screw blades; but the boss pieces not being delivered in time from the makers of the machinery the "Nymphe" was floated out without them. There was in consequence no protection against galvanic action set up by the water between the steel shaft and the copper and other metal on the ship's bottom. Since leaving the dock in which she was built the "Nymphe" has been in one of the basins; but in order to complete the copper sheathing of her bottom, it was necessary a few days ago to take her into dock again, and then the discovery in question was made. It was found that galvanic action had been for some time proceeding, and that the steel was much eaten into and corroded. The damage is serious; but whether its extent is such as to necessitate the replacing of the shaft is not yet determined, the question being still under consideration.

The Telegraphists' School of Science.—The prize list and prospectus of this school, which was established at the London Central Telegraph Office in September, 1876, and which is, therefore, entering on its thirteenth annual session, has been issued, and a copy is before us. The success which was achieved in 1886-7 has been eclipsed by that of 1887-8, the 41 certificates gained last year being increased to 81 this year, 37 of them being first-class. The total number of registered students was 72. Thirteen out of the 16 candidates in mathematics were successful, and in the magnetism and electricity examination there were 42 candidates, of whom 39 were successful, including 19 first-class. In the telegraphy examination, under the City and Guilds Institute, 22 certificates were gained, the total for the kingdom being only 70, notwithstanding that there were candidates from upwards of 20 different schools. In the electrical instrument examination two candidates were presented in honours; both took first-class certificates, one of them, Mr. A. Brooker, being also awarded the prize of £5 and a medal. Only one other first-class Honours Certificate was awarded this year. During the past five years the school has gained six out of the thirty-three medals and £24 out of the £85 awarded in telegraphy. Chemistry is re-introduced into the time table for the coming session, and a special course of lectures and demonstrations is announced in view of the coming transfer of the Submarine Telegraph Company's system to the Post Office. The forthcoming session commences on Monday October 1st.

Exeter.—At a meeting of the Town Council, on Wednesday, Sept. 12, the Navigation Committee reported that they had held a special meeting on the 18th August. The meeting was called in order that Mr. Chidley, solicitor to the proprietors of Trew's Weir Mills, who was then in Exeter, might have an opportunity of explaining to the committee the arrangements they were desirous of making with regard to the proposed works of the Exeter Electric Light Company. A letter was read from Mr. H. W. Michelmore, secretary of the company, enclosing plans of what the company proposed to do on the land adjoining Trew's Weir. The plan showed the waterways, the position of the turbines, and the ground plan of the buildings. The turbines were four in number, each of 24 horse-power nominal, using 3,000 cubic feet of water per minute. The excavation for the races would be floored with Portland cement concrete, with side walls of the same. Care would be taken not to interfere with the wing wall at the end of the weir, and where it was approached by the company's works the intervening space would be filled with concrete. The committee resolved that the suggested interview with Mr. Chidley could not be held until the surveyor had had an opportunity of examining and reporting upon the plans submitted. The secretary's letter and accompanying plans were laid before the ordinary meeting of the committee on the 4th September, when, having heard the observations of the surveyor and the wharfinger thereon, they recommended that the proposals of the company be declined.—Mr. Daw said the committee were almost unanimous in coming to that decision.—Mr. Wreford moved, and Mr. Williams seconded, that the committee hold a conference with the directors of the company, and this was carried by 18 to 12.

The Electric Light at Barnet.—The following extract is taken from the *Barnet Free Press*:—"Up to the 1st of September the streets were lighted by one hundred ordinary gas lamps and four large refuge lamps, two of which were kept burning all night. For these lamps the gas company were paid as follows:—One hundred ordinary lamps at £2. 18s., two large lamps at £16, and two others at £10, or a total of £342 per annum. These lamps have been replaced by seventy-one electric lamps, the charge for which is £5. 8s. each, or a total of £383. 8s. Two of the electric lamps are to be kept alight all night, for which doubtless something extra will have to be paid. At present, therefore, in point of cost, there is a balance of at least £40 in favour of the 104 gas lamps as against the seventy-one electric lamps, and this £40 is *plus* any sum paid for all-night lighting of certain lamps. Ratepayers might not object to additional cost if they obtained an equivalent in improved lighting, always provided that the cost does not become excessive, and that the ratio between cost and light will bear favourable comparison with what may be obtained in the case of gas. But are we getting an equivalent for the additional outlay? Is our town better lighted than it was with gas? These are early days in which to speak of what may or may not be ultimately accomplished with the electric light at Barnet, yet one may reasonably compare the present lighting of the High-street with what is was when gas was the illuminating power, and we venture to say that the comparison is not yet altogether in favour of the electric light. More lamps are required, and, leaving altogether out of account some twenty lamps or so which have not yet been lighted at all, there are portions of the district in which no provision has been made for electric lighting where gas was formerly used. This deficiency must sooner or later be supplied at a further cost to the ratepayers, who welcomed the electric light because they were led to believe that gas could be replaced lamp for lamp by electric light of equal power and at less cost. The fallacy of that belief is now apparent, and it remains to be seen whether the electric light company can make up in effectiveness for the comparative costliness of their light. We would not willingly say a word to damp the ardour of the enthusiasts in electrical science or to discourage their efforts, but we are bound to recognise that the company are held by their bargain, and that up to the present time they have not fulfilled the conditions of their contract in a manner calculated to gain the confidence of the townsfolk. It may be that the present lighting arrangements, being of a temporary character, do not give such perfect results as may be looked for when those arrangements have been finally completed. In any case the company should lose no time in giving effect to both the letter and the spirit of the contract into which they have entered. Electric lighting is on its trial in Barnet, and those chiefly concerned in its success should show themselves in earnest, since the system must stand or fall on its merits."

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SKETCH OF THE ELECTRICAL PAPERS IN SECTION A AT THE RECENT BATH MEETING OF THE BRITISH ASSOCIATION.

BY PROF. OLIVER J. LODGE, F.R.S.

Some talk of Isaac Newton, of Euler and Clairaut
Of Kepler and Copernicus, and old Galileo ;
But of all the mathematicians
There's none who can compare
With the row dow dow de dow dow dow
Of the British Engineer.

The above verse may be said to strike the keynote of the recent British Association meeting at Bath, as it appeals to an outsider. The note was struck both in the Presidential Address and in the address of the President of Section G, and it has been further emphasised, no doubt beyond the meaning of either President, by an instructive leading article in the oldest engineering journal. The following extract is from the *Engineer*, of date September 7 :—

"Sir Frederick Bramwell's address is mainly a pleasant discourse on the part which the engineer has played in the world, and is principally remarkable as a well-constructed refutation of the preposterous pretensions put forward by some men of so-called pure science. . . . The theme is so congenial that we feel no keen desire to criticise what Sir Frederick Bramwell had to say. Our only quarrel with him, indeed, is that he did not go far enough, or press his arguments with sufficient insistance. Possibly it was impossible or impolitic to push his arguments home. . . . No one, however, knows better than Sir Frederick that the world owes next to nothing to the man of pure science. In another page we give an abstract of the address, from which it will be seen how carefully Sir Frederick avoided the utterance of a word that might give offence. But we are not tied or bound by any consideration of this kind, and we should be lacking in our duty did we not assert whenever the occasion for assertion arises, that the engineer, and the engineer alone, is the great civiliser. The man of science follows in his train."

Meanwhile, in the quiet and peaceful atmosphere of Section A some good work has been done, and in the calm temperament engendered by such work and by the assured feeling of progress in insight and knowledge, there is a disposition, I doubt not, to grant to the engineer all the credit he, or others for him, can possibly claim, and not to resent even such a singular tone as is sounded in the above-quoted leading article. There is, after all, some excuse for a good deal of self-glorification when the society-transforming consequences of an engineer's labours is regarded ; and yet one would not be surprised if one learnt that great individual engineers—such, for instance, as the builder of the Forth Fridge—were among the most unassuming of men.

I propose to give a brief account of such of the communications to Section A as may be expected more particularly to interest the readers of this journal. It should be always clearly apprehended that when one man gives an account of another's work that other is in no sense responsible for or bound by what is said. It ought to be absurd to have to point this out, but experience shows that it is not unnecessary ; and it is especially necessary to call attention to the fact in connection with a hasty report of a great number of Papers, written without notes and without the respective authors' knowledge or supervision. However carefully one may attempt the task some errors are bound to creep in, and were it not that in process of time all these Papers will be published in authentic form by their writers one would not be justified in making the attempt. But persons not able to be present may find even a partially correct account of what went on at the meeting better than none at all.

First, then, the section was happy in having for its president a man exhibiting an altogether exceptional combination of qualities—profound knowledge, great originality, mathematical and experimental skill both of the first order, quickness of comprehension, and a ready wit. The address with which he opened the business of the section was not unworthy of the man. Its subject was that greatest of all physical subjects, "The Ether," and it largely consisted in a glorification of the quite recent experiments of Dr. Hertz in Berlin, whereby Prof. Fitzgerald shows that the existence of an æther is raised out of the rank of a very probable hypothesis, which it has long been, into the domain of demonstrated facts. He hints also that certain outstanding problems concerning the structure and properties of the ether can most probably be answered by a further discussion and repetition of experiments like those of Hertz. Our engineering friends ought not to sneer at the prominence given to such a refined abstraction or hypothetical figment as the ether may seem to some of them to be, for it is by its means they drive all electric motors, it is it they use in dynamos and transformers of all sorts ; it is the ether which transmits their signals, whether telegraphic or telephonic; and, though this may appeal to them less forcibly, it is through the action of the ether that mankind is enabled to see. Not to mention the as yet incompletely verified hypothesis that it is of ether that Engineers and all other material substances are composed.

On Friday morning the serious electrical business of the section began, and Prof. Rowland exhibited his most recent photographs of the solar spectrum, obtained by a yet more nearly perfect concave grating which he had just completed. The photographs exhibited at a former meeting by Prof. Rowland had far eclipsed anything previously accomplished ; but those now shown were still better, and represent an extraordinary stage of perfection. They are by far the most magnificent things of the sort ever seen. The special appliances in Prof. Rowland's laboratory at Baltimore for this work are so perfect and convenient, that the whole solar spectrum can be photographed on an immense scale in the course of a morning. Terrestrial spectra, such as that of iron, can be photographed for purposes of comparison at the same time on the same strips of glass.

It may be hastily thought that such a subject belongs primarily to optics, but it is not so. Ingenious mechanical devices and optical theorems are made use of in obtaining the result, but the influence of the result is more felt in other sciences. The existence of such a standard of wave-lengths and permanent measurable records of atomic vibration reacts upon several of the sciences. It reacts upon astronomy by furnishing a statement of the present condition of sun and stars, with which future observations may be readily compared ; upon chemistry by exhibiting the relations among the vibration numbers of the elements, whereby hypotheses as to the construction and compound nature of our elements may be tested ; and it reacts upon electricity by affording us some knowledge of the precise way in which the ether is disturbed by electric oscillations in the substance of the atoms, as well as by the motions of electrically-charged atoms themselves.

Lord Rayleigh followed, with an account of an exceedingly delicate and difficult experiment on the question whether an electric current through a liquid influences the velocity of light therein. It is well known that when an electric current flows through an electrolyte an actual transfer of matter accompanies it—two opposite transfers, in fact, as evidenced by the continuous appearance and escape of the travellers, one at each electrode. It is also known by a refined experiment of Fizeau, confirmed by Michelson, that when a beam of light travels down a stream of moving matter its speed is slightly increased, whereas if light travel against a stream of water it is slightly retarded. These things being so, it may be held as probable that whenever the two ions taking part in an electrolytic current differ in momentum a slight effect may be exerted on the velocity of light travelling with or against the current. But then, according to the calculations of Kohlrausch, confirmed by some experiments of the present writer,* the speed of the electrolytic ions is extremely small, the quickest being 30 microns per second, or about 4 inches an hour, for an applied slope of potential of 1 volt per centimetre.

The effect of such a creep as this was not what Lord Rayleigh looked for. It was quite within the range of possibility that the existence of an electric current in an electrolyte should so disturb the ether inside it as to produce quite a notable change in its index of refraction. Were such an effect discovered it would be a distinctly new fact, not taken account of or even rendered probable by existing theories, and it is very well to have the question experimentally examined, and to a certain extent set at rest.

* Birmingham British Association Report, 1886, p. 393.

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The method adopted was a beautiful interference arrangement of Michelson, whereby a beam of light is split up into two halves, which are sent along a certain route, or circular tour, in opposite directions, are then recombined into one again at the point whence they originally split off, and are examined by a magnifying eye-piece. The result is a set of interference bands more or less well defined. Tubes containing dilute sulphuric acid supplied with an electric current are then placed along the route taken by the two half beams of light, so that one half the beam will be helped and the other half hindered by the current, if it produce any effect at all. The thing looked for is to see if the interference fringes shift along microscopically when the current is supplied, stopped, or reversed. The result is negative, and by considering carefully how much of an effect could have been certainly perceived if it had existed, the definite statement is made that a current of intensity 1 ampere per square centimetre through dilute sulphuric acid does not affect the velocity of light in its own direction by so much as one part in thirteen millions, or by 15 metres per second.

There are two ways of experimenting. One is to order expensive and highly polished optical banks and other apparatus from an instrument maker; the other, to rig up an arrangement with odd bits of glass, cement and portions of telescopes. The born experimentalist adopts the latter plan; considering beforehand where exactness and steadiness is essential and where it is unnecessary, and accommodating his means to his end with forethought and localised precision. It is by this latter mode of experimenting that the just quoted result has been obtained.

A couple of Papers by the present writer followed. One, on the "Measurement of Electromagnetic Wave-Lengths," the other, on the "Impedance of Conductors to Leyden Jar Discharges." The point of the first Paper was to bring forward a case of electric resonance whereby pulses rushing to and fro along a couple of long insulated wires of certain length, synchronised with the known oscillations or alternations in a discharging Leyden jar circuit connected to them. The experiment is thus analogous to an acoustic experiment known by the name of Melde, wherein a tuning fork attached to a long stretched silk string throws it into synchronous vibrations when everything is properly adjusted. And just as the length of the sympathetic string is half the wave length of the sound emitted by the vibrating fork, so the length of each wire in the electrical analogue is half the length of the ethereal waves emitted by the discharging Leyden jar. These waves being essentially light, except that they are much too long to affect the retina. If Hertz had not simultaneously been experimenting in very similar directions, the interest of these experiments might have been greater, but as it is they are perhaps mainly interesting as affording a confirmation of the theory of Kirchhoff, Thomson, and Heaviside, regarding the rate of propagation of telegraphic impulses along a wire. These pulses travel at a speed always a trifle under the velocity of light—under certain perfectly known conditions very much under; but in the most favourable case of two thin parallel wires, transmitting exceedingly rapid oscillatory disturbances (the case of the above described experiment), the velocity of the pulses is, according to theory, exactly the velocity of light; and so it comes out in the experiment. The length of the waves emitted by the Leyden jar circuit can be calculated directly one knows the capacity of the jar and the self-induction of its circuit; the length of the waves sent along the wires can also be observed experimentally; the two determinations are found to be in close agreement.

The following data may be of interest:—

A microfarad condenser, discharging through a good conducting coil of 1 sec-ohm, gives a current alternating 159 times a second, and emits ether waves 1,200 miles long.

A gallon Leyden jar, discharging through a stout wire suspended round an ordinary sized room, emits waves between three or four hundred yards in length, its current alternating at the rate of a million per second.

A pint Leyden jar, sparking through an ordinary pair of discharging tongs, gives a current of 15 million alternations per second, with ether waves some 20 yards in length.

An ordinary electrostatic charge on a conducting sphere two feet in diameter, if disturbed in any way, will surge to and fro at the rate of 300 million vibrations a second, emitting waves a yard long.

Electric charges on bodies of atomic dimensions, if able to oscillate at all, would vibrate thousands of billions of times a second, and produce ultra-violet light.

The maximum amplitudes of current given in these several cases can also be stated if the initial difference of potential be given. For instance, the microfarad case charged to a volt will have a current amplitude of one milliampere; the pint jar case charged to give an inch spark will give a discharge current of maximum strength 2,500 amperes.

The second Paper by Prof. Lodge, "On Impedance of Conductors," has to do with the obstruction offered by conductors of different sizes and materials to sudden rushes of electricity. A series of experiments on the E.M.F. needed to force the contents of a Leyden jar, under given circumstances, through a wire of measured length and thickness arranged in the form of a circle (a single turn about a yard and a half in diameter being usually employed) are briefly described. The numerical results obtained are then compared with the theory of Clerk Maxwell and Lord Rayleigh, and are found to be in very satisfactory agreement.

The noteworthy thing about these sudden rushes, or violently alternating currents, is that they keep wholly to the outer surface of a conductor, and accordingly the obstruction they meet with has next to nothing to do with either the specific resistance or the magnetic properties of the material. A number of quantitative determinations have been made which will be published elsewhere.

The reason why these alternating or rapidly-varying currents keep to the outside of a conductor is merely because the outside affords the easiest path. If they penetrated its substance like steady currents do, it would have to be magnetised and demagnetised in concentric cylinders by them, and this would cause delay and obstruction. By keeping to the outside they avoid having to do this. It is true that they thereby throttle the conducting area open to them very considerably. They would meet with much less frictional resistance if they permeated the whole sectional area of the wire, but then, for these very rapid variations, frictional resistance is of far less consequence than the inertia-like obstruction of varying magnetisation; and, on the whole, they find it better to escape the inertia by keeping to the outside, even at the expense of a throttled and highly resisting path. The whole thing is a compromise, and currents of slower rates of alternation will penetrate deeper, always taking the course which reduces total obstruction to a minimum, until we come to steady or slowly-changing currents, to which the inertia effect of magnetisation matters next to nothing, while friction matters just as much to them as to any of the others; these, therefore, will flow through the whole cross section of the wire with complete uniformity. Regret was expressed both by Lord Rayleigh and by the President that Mr. Oliver Heaviside, who had done so much in the theory of these matters, was not present to join in the discussion.

Next came three Papers by Sir William Thomson, the third of which, as connected with the foregoing subject, it is convenient to take first. Its title is, "Five Applications of Fourier's Law of Diffusion, illustrated by a Diagram of Curves, with Absolute Numerical Values," and its subject matter is the accentuation of the analogy and complete mathematical equivalence existing between the different kinds of diffusion, so that the method suitable for treating one enables problems in the others to be solved. The best-known cases of diffusion are:—(*a*) *The diffusion of substance*, as when a heavy salt-solution creeps up from the bottom of a vessel of water until it becomes, in a century or two, thoroughly mixed; or when a scent diffuses in the air; (*b*) *the diffusion of momentum*, as when motion is transmitted from one part of a viscous fluid to the rest, this being the process by which tea can be stirred, and by which winds and whirlpools are brought to rest some time after the exciting cause has ceased; (*c*) *the diffusion of energy*, better known as the conduction of heat, a frequently quoted consequence of its laws being the gradual penetration of an

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alternating disturbance deep and deeper into the substance of a conductor—as, for instance, the diurnal and annual fluctuation of temperature finding their way down into the crust of the earth, so that at a certain depth one could find evidence of heat waves six months behindhand; (*d*) *the diffusion of electric potential* in the conductor of a submarine cable, worked out long ago by Sir William Thomson as one of the problems to which Atlantic telegraphy gave rise, and by the solution and complete understanding of which rapid submarine telegraphy became practicable; and (*e*) *the diffusion of electric currents* in the substance of a homogeneous conductor.

It is this last kind of diffusion which is evidently most interesting Sir William at the present time, and he does justice to Mr. Oliver Heaviside's labours in connection with it.

I have been saying above that a very rapidly alternating current keeps to the outside of a conductor, just as a very rapidly alternating force applied to the surface of water in a trough (say by means of a flat board lying on it made to vibrate horizontally) would only succeed in moving the surface water; but this is not a complete account of the matter. When an alternating cause acts at a surface its effect penetrates in waves of diffusion through the mass, dying out according to a certain law of decay. If the alternations are slow the depth of penetration may be very great, as, for example, heat waves in the earth's crust; if they are excessively quick the depth of penetration may be very small indeed. And so for any given frequency of alternation, there is a specifiable depth at which the substance of the medium will appreciably take part in the action, and beyond which no noteworthy effect is produced. The problem, then, is to determine this depth for such rapidities of oscillation as are most common in practice.

The modern supply of alternating currents for secondary generators would seem to have a frequency of something like 150 complete alternations per second, and Sir William Thomson reckons that the depth to which these disturbances penetrate into the substance of a copper conductor is about 3 millimetres, so that portions of the conductor beyond this distance from the surface are almost useless. Hence manifestly conductors for powerful alternating currents should be hollow tubes, or flat bars, or separated wires, and the useful thickness of flat copper bars adapted to carry the present rapidity of alternating currents will be about 6 millimetres, or, say, $\frac{1}{4}$in.*

Of the other two communications of Sir William Thomson it is not easy to give an intelligible account without introducing technicalities; but inasmuch as they afforded a text for a great deal of discussion, both in and out of the section, I must try and give a general notion of what they are about. Their titles are, "A Simple Hypothesis for Electromagnetic Induction of Incomplete Circuits: with Consequent Equations of Electric Motion in fixed Homogeneous or Heterogeneous Solid Matter," and "On the Transference of Electricity within a Solid Conductor." It is not often that the public are admitted to the genesis of scientific ideas, or are allowed to witness a development of opinion going on before them. But in the presence of Sir William Thomson this is no new thing. At his Baltimore lectures a few years back the whole University turned itself with enthusiasm into a research society, and many germs of discovery flourished or faded during the few weeks those lectures lasted. Then, the main topic was an elastic-solid theory of light. Now, we may observe a further step, and without abandoning an elastic-solid theory, which in some form or another is a necessity, Sir William is assimilating, and criticising, and extending, Maxwell's electrical theory. Finding in it certain apparent excrescences and redundancies, he seeks to lop them off and keep only that which is essential. Long-standing students of both Thomson and Maxwell join in, and throughout the meeting there is, among the *dii majores*, discussion and keen competition to see through the fog of symbols, to disentangle their real physical meaning, and to find a right and proper position for the half lopped-off apparent excrescences of Maxwell.

The main point under discussion relates to the mode and rate of propagation of electrostatic potential as compared with electromagnetic potential. Electromagnetic disturbances correspond to shearing strains in an elastic solid; they travel through the ether with the velocity of light—the lines of magnetic force spreading broadside on—and about them there is no difficulty. Difficulties begin with the propagation of electrostatic displacements, which correspond to the disturbances possible in an ordinary fluid, longitudinal not transverse disturbances, having to do with incompressibility instead of rigidity, disturbances which in ordinary matter we call *sound*.

Suddenly confer upon a conductor an electric charge: in all directions there is experienced a rise of potential equal to $\frac{Q}{r}$. How did that potential reach any given place? Was it by end thrust, or pulse of longitudinal compression, like sound? and, if so, at what rate did it travel? Maxwell assumes the ether to be absolutely incompressible, and, if so, the rate of propagation of disturbances corresponding to sound waves in it is infinite. Longitudinal pulses are not, strictly speaking, *transmitted* at all through a medium of infinite incompressibility, they are simply felt at all distances instantaneously.

That ether is *enormously* incompressible is proved (so it seems to the writer, and he has probably acquired it insensibly through the pores from Maxwell) by an experiment which is best called the "Cavendish experiment," referred to (in a poverty-stricken form) in French books by the name of Biot, and popularly known as the "outsidedness" of electrostatic charge. It is also proved (again to the mind of the writer) by the fact established by Laplace that gravitation, if transmitted at all, is transmitted with a velocity too great to be ascertained at present, and certainly much greater than the velocity of light. But that anything is *infinitely* incompressible is an assertion which it is impossible to make on the basis of any experiment whatever.

Accordingly, Helmholtz has taken into account the possibility of a slight compressibility, and has generalised Maxwell's equations by the introduction of a symbol, k, expressing this compressibility. Helmholtz's equations, therefore, enable this quantity to have any value which experiment may hereafter determine for it, including the possible value 0, which would reduce his theory to Maxwell's again. It is the value of this constant, k, the compressibility of the ether, which the President referred to in his address as hoping to be able to deduce by a further analysis of the experiments of Hertz.

But now, directly a possibility of compression and a finite velocity for longitudinal waves is introduced into the ether, a long outstanding difficulty in the theory of light—a difficulty from which it was hoped the electrical theory would be free, though the ordinary elastic-solid theory is not free—at once makes its appearance. This is the old friend (or enemy) of undulatory theorists, the wave of longitudinal compression, or the "pressural wave," as it is sometimes called. Indeed, in the form of a pressural wave—the instantaneous transmission of a thrust to infinity—it must come in even to an incompressible ether, if the transmission of electrostatic potential occurs by end thrust.

This electrostatic potential is denoted in Maxwell's equations by the symbol Ψ, and so the attempt to get rid of it and do without it in the general equations of an electromagnetic field was referred to by the President as the "murder of Ψ." Many deaths, and many bringings to life, this unfortunate symbol suffered in the course of the week, and I would not like to say that its fate is even yet decided. On the last day of the meeting Rowland and Fitzgerald seemed to come to an understanding, but whether Sir William will coincide with it, or will upset the whole thing once more, remains to be seen. As they put it the matter is now like this: The propagation of electrostatic potential does not go on by end thrust at all; it is not really analogous to a pulse of longitudinal compression, though it is apparently and superficially so; and accordingly its rate of propagation depends not at all on the compressibility or incompressibility of the ether, a question on which it has nothing to say one way or the other. An electrostatic field is not developed *sui generis*, but is always the consequence of a previously existing electromagnetic one, which, on subsiding, leaves it as its permanent record.

Plainly an electrostatic field cannot arise without the motion

* These numbers are not authoritative.

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of some electricity, either with or through a conductor. Now, whenever electricity moves, it at once has magnetic properties, its motion generates a magnetic field. When the motion ceases the field at once subsides, and in subsiding it may produce a succession of diffusing and dying away induction currents in neighbouring conductors; or it may, if the circuit be an incomplete one, leave a permanent vestige of itself in the dielectric as a field of strained ether—this state of strain being what we call electrostatic potential, and the field being familiar to us as an electrostatic field.

Generating it in this way, all distinction between rate of propagation of electrostatic and electromagnetic potential vanishes, they both travel together with the velocity of light; or rather, the thing which travels is the magnetic potential, and its permanent effect *in situ* is the electrostatic potential.

Thus, once more, the difficulty of a longitudinal or pressural wave disappears from the electrical theory of light, into which it had seemed to intrude itself, and Ψ is left to enjoy "a long and useful career," though it is not permitted an infinite or any other rate of propagation in its own proper nature. The question of the incompressibility or compressibility of the ether thus remains unanswered, and, as it would seem, unanswerable, by any such experiments as those of Hertz, or by any experiments on the rate of transmission of electrostatic potential. If any one asks how soon will the pull of a suddenly electrified body be felt at a distance ? one may answer, "As soon as the charging spark is seen." But if it be asked at what rate electrostatic potential travels, the answer is that it does not travel, but is generated *in situ* by the subsidence of a magnetic potential which travels with the velocity of light.

It must be understood that the last word has by no means been said on these great problems, and that what I have here written must be digested with salt. It is proper also to record the conviction expressed by the President that most of these refined points would probably be found mathematically treated somewhere in the writings of Mr. Heaviside.

(To be continued.)

HERTZ'S RESEARCHES ON ELECTRICAL OSCILLATIONS.

BY G. W. DE TUNZELMANN, B.SC.

(Continued from page 589.)

In a note in Wiedemann's *Annalen*, Vol. XXXI., page 543, Dr. Hertz states that since the publication of his Paper in the same volume, he had found that von Bezold had published a Paper in 1870 (Poggendorff's *Annalen*, Vol. CXL., page 541), in which he had arrived by a different method of experimenting at similar results and conclusions as those given by him under the head of Preliminary Experiments.

Induction Phenomena in Open Circuits.—In order to test more fully his conclusion that the sparks obtained in the experiments described in my last Paper were due to self-induction, Dr. Hertz placed a rectangle of copper wire with sides 10 and 20 centimetres in length respectively, broken by a short air space, with one of its sides parallel and close to various portions of the secondary circuit of the coil, and of the micrometer circuit, with solid dielectrics interposed, to obviate the possibility of sparking across, and he found that sparking in this rectangle invariably accompanied the discharges of the induction coil, the longest sparks being obtained when a side of the rectangle was close to the discharger.

A copper wire, *i g h* (Fig. 3), was next attached to the discharger, and a side of the micrometer circuit, which was supported on an insulating stand, was placed parallel to a portion of this wire, as shown in the diagram. The sparks at M were then found to be extremely feeble until a conductor, C, was attached to the free end, *h*, of the copper wire, when they increased to one or two millimetres in length. That the action of C was not an electrostatic one was shown by its producing no effect when attached at *g* instead of at *h*. When the knobs of the discharger B were so far separated that no sparking took place there, the sparks at M were also found to disappear, showing that these were due to the sudden discharges and not to the charging current. The sparks at the discharger which produced the most effect at the micrometer were of the same character as those described in my last Paper. Sparks were also found to occur between the micrometer circuit and insulated conductors in its vicinity. The sparks became much shorter when conductors of larger capacity were attached to the micrometer knobs, or when these were touched by the hand, showing that the quantity of electricity in motion was too small to charge these conductors to a similarly high potential. Joining the micrometer knobs by a wet thread did not perceptibly diminish the strength of the sparks. The effects in the micrometer circuit were not of sufficient strength to produce any sensation when it was touched or the circuit completed through the body.

In order to obtain further confirmation of the oscillatory nature of the current in the circuit *k i h g* (Fig. 3), the conductor C was again attached to *h*, and the micrometer knobs drawn apart until sparks only passed singly. A second conductor, C′, as nearly as possible similar to C, was then attached to *k*, when a stream of sparks was immediately observed, and it

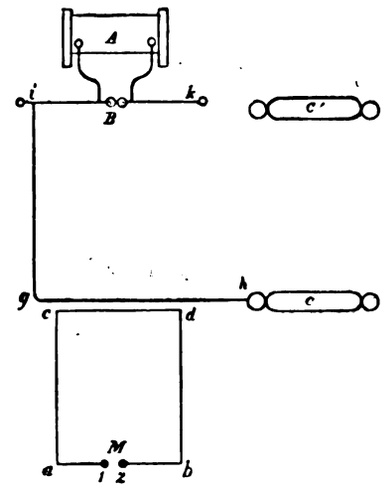

FIG. 3.

continued when the knobs were drawn still further apart. This effect could not be ascribed to a direct action of the portion of circuit *i k*, for in this case the action of the portion of circuit *g h* would be weakened, and it must therefore have consisted in C′ acting on the discharging current of C, a result which would be quite incomprehensible unless the current in *g h* were of an oscillatory character.

Since an oscillatory motion between C and C′ is essential for the production of powerful inductive effects, it will not be sufficient for the spark to occur in an exceedingly short time, but the resistance must at the same time not exceed certain limits. The inductive effects will therefore be excessively small if the induction coil included in the circuit C C′ is replaced by an electrical machine alternately charging and discharging itself, or if too small an induction coil is used; or, again, if the air space between the discharger knobs is too great, as in all these cases the motion ceases to be oscillatory.

The reason that the discharges of a powerful induction coil gives rise to oscillatory motion is that, firstly, it charges the terminals C and C′ to a high potential; secondly, it produces a sudden spark in the intervening circuit; and, thirdly, as soon as the discharge begins the resistance of the air space is so much reduced as to allow of oscillatory motion being set up. If the terminal conductors are of very large capacity, for example, if the terminals are in connection with a battery, the current of discharge may indefinitely reduce the resistance of the air space, but when the terminal conductors are of small capacity this must be done by a separate discharge, and there-

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fore, under the conditions of the author's experiments, an induction coil was absolutely essential for the production of the oscillations.

As the induced sparks in the experiment last described were several millimetres in length, the author modified it by using the arrangement shown in Fig. 4, and greatly increasing the distance between the micrometer circuit and the secondary circuit of the induction coil. The terminal conductors C and C′ were three metres apart, and the wire between them was of copper, 2 millimetres in diameter, with the discharger B at its centre.

The micrometer circuit consisted, as in the preceding experiments, of a rectangle 80 centimetres broad by 120 centimetres long. With the nearest side of the micrometer circuit at a distance of half a millimetre from C B C′ sparks two millimetres in length were obtained at M, and though the length of the sparks decreased rapidly as the distance of the micrometer circuit was increased, a continuous stream of sparks was still obtained at a distance of one and a-half metres. The intervention of the observer's body between the micrometer circuit and the wire C B C′ produced no visible effect on the stream of sparks at M. That the effect was really due to the rectilinear conductor C B C′ was proved by the fact that when one or other, or both halves of this conductor were removed, the sparks at M ceased. The same effect was produced by drawing the knobs of the discharger B apart until sparks ceased to pass, showing that the effect was not due to the electrostatic potential difference of C and C′, as this would be increased by separating the discharger knobs beyond sparking distance.

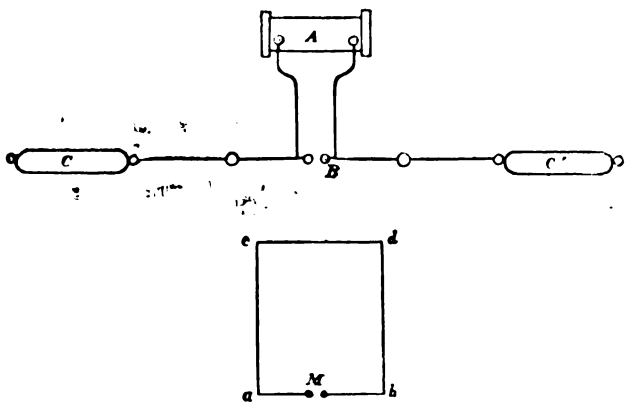

Fig. 4.

The closed micrometer circuit was then replaced by a straight copper wire, slightly shorter than the distance C C′, placed parallel to C B C′, and at a distance of 60 centimetres from it. This wire terminated in knobs, 10 centimetres in diameter, attached to insulating supports, and the spark micrometer divided it into two equal parts. Under these circumstances, sparks were obtained at the micrometer, as before.

With the rectilinear open micrometer circuit sparks were still observed at the micrometer when the discharger knobs of the secondary coil circuit were separated beyond sparking distance. This was, of course, due simply to electrostatic induction, and shows that the oscillatory current in C C′ was superposed upon the ordinary discharges. The electrostatic action could be got rid of by joining the micrometer knobs by means of a damp thread. The conductivity of this thread was therefore sufficient to afford a passage to the comparatively slow alternations of the coil discharge, but was not sufficient to provide a passage for the immeasureably more rapid alternations of the oscillatory current. Considerable sparking took place at the micrometer when its distance from C B C′ was 1 2 metres, and faint sparks were distinguishable up to 3 metres. At these distances it was not necessary to use the damp thread to get rid of the electrostatic action, as, owing to its diminishing more rapidly with increase of distance than the effect of the current induction, it was no longer able to produce sparks in the micrometer, as was proved by separating the discharger knobs beyond speaking distance, when sparks could no longer be perceived at the micrometer.

Resonance Phenomena.—In order to determine whether, as some minor phenomena had led the author to suppose, the oscillations were of the nature of a regular vibration, he availed himself of the principle of resonance. According to this principle, an oscillatory current of definite period would, other conditions being the same, exert a much greater inductive effect upon one of equal period than upon one differing even slightly from it.*

If, then, two circuits are taken having as nearly as possible equal vibration periods, the effect of one upon the other will be diminished by altering either the capacity or the coefficient of self-induction of one of them, as a change in either of them would alter the period of vibration of the circuit.

This was carried out by means of an arrangement very similar to that of Fig. 4. The conductor C C′ was replaced by a straight copper wire 2·6 metres in length and 5 millimetres in diameter, divided into two equal parts as before by a discharger. The discharger knobs were attached directly to the secondary terminals of the induction coil. Two hollow zinc spheres, 30 centimetres in diameter, were made to slide on the wire, one on each side of the discharger, and since, electrically speaking, these formed the terminals of the conductor, its length could be varied by altering their position. The micrometer circuit was chosen of such dimensions as to have, if the author's hypothesis were correct, a slightly shorter vibration period than that of C C′. It was formed of a square, with sides 75 centimetres in length, of copper wire 2 millimetres in diameter, and it was placed with its nearest side parallel to C B C′, and at a distance of 30 centimetres from it. The sparking distance at the micrometer was then found to be 0·9 millimetre. When the terminals of the micrometer circuit were placed in contact with two metal spheres 8 centimetres in diameter, supported on insulating stands, the sparking distance could be increased up to 2·5 millimetres. When these were replaced by much larger spheres the sparking distance was diminished to a small fraction of a millimetre. Similar results were obtained on connecting the micrometer terminals with the plates of a Kohlrausch condenser. When the plates were far apart the increase of capacity increased the sparking distance, but when the plates were brought close together the sparking distances again fell to a very small value.

The simplest method of adjusting the capacity of the micrometer circuit is to suspend to its ends two parallel wires, the distance and lengths of which are capable of variation. By this means the author succeeded in increasing the sparking distance up to three millimetres, after which it diminished when the wires were either lengthened or shortened. The decrease of the sparking distance on increasing the capacity was naturally to be expected; but it would be difficult to understand, except on the principle of resonance, why a decrease of the capacity should have the same effect.

The experiments were then varied by diminishing the capacity of the circuit C B C′ so as to shorten its period of oscillation, and the results confirmed those previously obtained, and a series of experiments in which the lengths and capacities of the circuits were varied in different ways, showed conclusively that the maximum effect does not depend on the conditions of either one of the two circuits, but on the existence of the proper relation between them.

When the two circuits were brought very close together, and the discharger knobs separated by an interval of 7 millimetres, sparks were obtained at the micrometer, which were also 7 millimetres in length, when the two circuits had been carefully adjusted to have the same period. The induced E.M.F.'s must in this case have attained nearly as high a value as the inducing ones.

To show the effect of varying the coefficient of self-induction, a series of rectangles, *a b c d* (Fig. 4), were taken, having a constant breadth, *a b*, but a length, *a c*, continually increasing from 10 centimetres up to 250 centimetres; it was found that the maximum effect was obtained with a length of 1·8 metres. The quantitative results of these experiments are shown in Fig. 5, in which the abscissæ of the curve are the double lengths of the rectangles, and the ordinates represent the corre

* *See* Oberbeck, Wiedemann's *Annalen*, Vol. XXVI., p. 245, 1885.

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sponding maximum sparking distances. The sparking distances could not be determined with great exactness, but the errors were not sufficient to mask the general nature of the result.

In a second series of experiments the sides *a c* and *b d* were formed of loose coils of wire which were gradually pulled out, and the result is shown in Fig. 6. It will be seen that the maximum sparking distance was attained for a somewhat greater length of side, which is explained by the fact that in the latter experiments the self-induction only was increased by increase of length, while in the former series the capacity was increased as well. Varying the resistance of the micrometer circuit by using copper and German silver wires of various diameters was found to have no effect on the period of oscillation, and extremely little on the sparking distance.

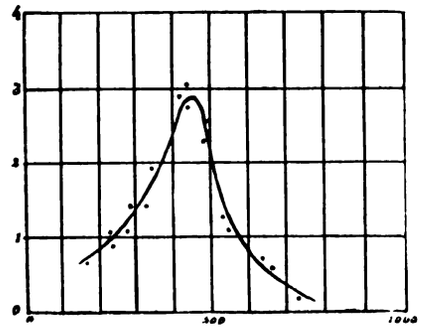

FIG. 5.

Curve showing relation between length of side of rectangle (taken as abscissa) and maximum sparking distance (taken as ordinate), the sides consisting of straight wires of varying lengths.

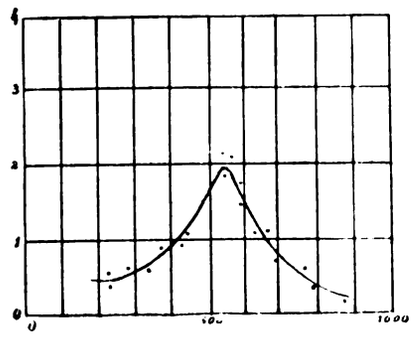

FIG. 6.

Curve showing relation between length of side of rectangle (taken as abscissa) and maximum sparking distance (taken as ordinate), the sides consisting of spirals gradually drawn out.

When the wire *c d* was surrounded by an iron tube, or when it was replaced by an iron wire, no perceptible effect was obtained, confirming the conclusion previously arrived at that the magnetism of the iron is unable to follow such rapid oscillations, and therefore exerts no appreciable effect.

(To be continued.)

DYNAMOS WITHOUT COMMUTATORS OR BRUSHES.

BY TH. MARCHER (OF MÜLHEIM).

The first recorded attempt to construct a continuous-current dynamo without the impedimenta of commutator and brushes is due to M. A. F. Gravier, who took out a patent in France for a dynamo of this class. In 1882 a Mr. E. Newton obtained a similar patent in England. In 1883 L. Hajnis, of Prague, took out a patent in Germany for a dynamo on this principle; but in which some of the defects of the Gravier machine were avoided. In 1887 the Cronstadt Electrical Manufacturing Company also designed a dynamo without commutators. Since then but little seems to have been done in this direction.

I will, in the first place, briefly describe the original Gravier machine, from which he subsequently developed the non-commutator type. In Fig. 1 N and S are the field-magnets; *a a a* and *b b b* are the armature coils, which are mounted on radial cores, as in the Lontin type; and $+f$ and $-f$ are the brushes. When the armature revolves in the direction shown by the large arrow currents are induced in the coils in the direction shown by the small arrows. The armature poles *a a a*, therefore, become S magnetised, and the poles *b b b* N magnetised. Now imagine a second armature of the ring type, interposed between the above-mentioned armature and the poles N S, this second armature having no coils at A′ A″ and B′ B″ (Fig. 2). The magnets *a a a* will produce in this armature a current flowing in the direction *c i*, and the magnets

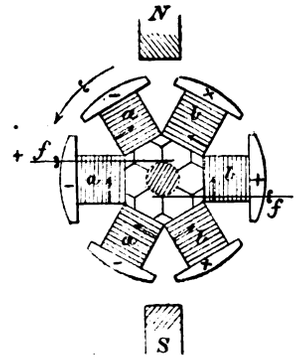

FIG. 1

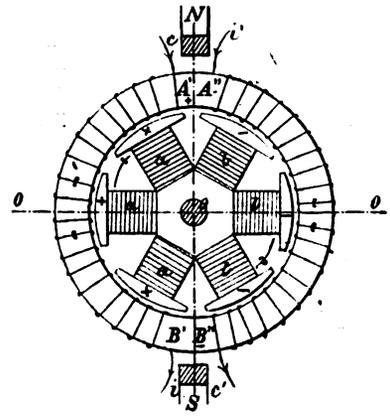

FIG. 2.

b b b will produce a current flowing in the reverse direction, *i′ c′*. Now, these two currents induce poles at A′ A″ and B′ B″ similar to those of the field-magnets, N S, at the adjacent points. If, therefore, sufficient residual magnetism was present, the magnet N S could be dispensed with, and the pole A′ A″ and B′ B″ would suffice. Gravier, however, was unable to get any good results from this form of machine, and subsequently designed one without commutator, collector, or brushes. In this dynamo (Fig. 3) Gravier had a revolving armature *i*, a revolving system of magnetisation, N S, a fixed armature I I, and a fixed system of magnetisation *n s*. The theoretical outcome of this arrangement is as follows:—The magnets *n s* induce currents in *i*, which excite the magnets N S, which in turn induce currents in I I; the current thus obtained passes into the external circuit, and also round the magnets *n s*. One method of winding is shown in Fig. 4. The Hajnis machine consists of the same four essential parts, namely, fixed armature and field-magnets, and revolving armature and field magnets, the revolving parts being mounted on the same shaft. This arrangement is shown diagramatically in Fig. 5. M M M M are fixed magnets, A A are revolving armature coils, B B B B are revolving magnets, and P P is the fixed ring armature. From each individual coil of the revolving armature connections are made to the corresponding magnet coil, each armature coil being one behind the

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respective magnet coil. The action of the machine is easily understood.

To test the practical value of the system I built a dynamo, somewhat as shown in section in Fig. 6, where M_1 M_1 are the

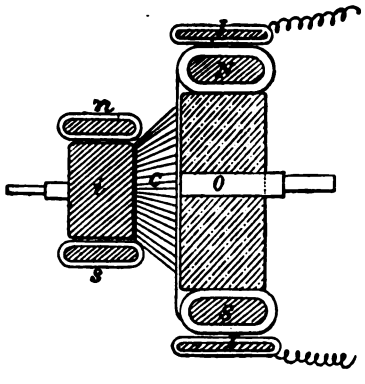

Fig. 3.

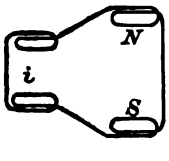

Fig. 4.

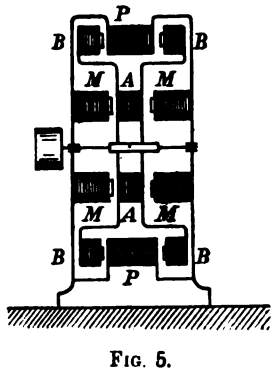

Fig. 5.

fixed magnets, I I the fixed armature, R R the revolving armature, M_2 M_2 the revolving magnets. The armature cores were both laminated in the customary manner. The experiments I carried out showed clearly that (as might have been expected)

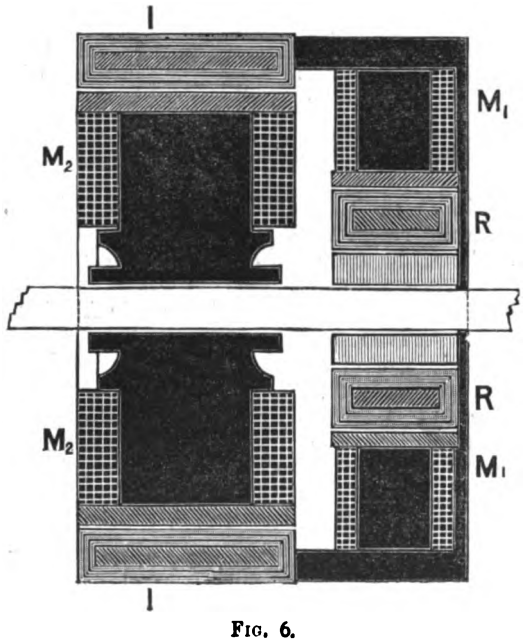

Fig. 6.

it was also necessary to laminate the revolving magnets to avoid eddy currents, and to magnetically separate the fixed magnet from the fixed armature. It would have been interesting to have carried the experiments further, and to have tested the efficiency of a machine constructed on this principle compared with that of an ordinary dynamo, but this I was unable to do at the time. Owing to the additional transformations of energy which take place in a dynamo of this kind, it is probable that its efficiency would be comparatively low; the avoidance of commutators and brushes would, however, I think, quite compensate for this inevitable defect.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

Chapter IX.—*Magnetic Fields.*

(Continued from page 571.)

Section II.—Electro-Magnetic Fields.

128. *Magnetising Force.*—The field of force set up in the interior of a coil of wire through which a current is flowing is found both by experiment and theoretical deductions to be proportional to the product of the strength of current and the number of turns of wire. If an iron bar be wrapped round with a given number of turns of wire, and a current of known strength passed through the wire, we have a definite field of force produced by the current in the coil which is capable of "exciting" or magnetising the iron. Hence we speak of the *exciting power* or *magnetising force* of the current, and in practice express it in *ampere-turns*. So long as the product of the number of amperes and number of turns is constant for a given volume of wire, the magnetising force is constant whatever individual values the current or number of turns may have. This is the same thing as saying that the current must vary inversely as the number of turns for the same magnetising force. For example, if we have one electro-magnet, A, wound with 50 turns of thick wire, and another, B, wound with 1,000 turns of fine wire, the volume or weight of wire being the same in the two coils, the current strengths in the coils must be in the proportion of 1,000 to 50, or as 20:1 respectively, in order to produce the same magnetising force on the iron in each. It is sometimes more convenient to express the number of turns or length of wire in terms of the resistance. We have already seen (para. 63) that the length of wire wound on a coil of fixed volume or weight varies as the square root of the resistance; therefore, for a given magnetising force the product of the current and the square root of the resistance of the coil must be constant; or, in other words, the resistance must be inversely proportional to the square of the current. Hence, in the above example, the resistances of the two coils A and B are respectively as $1 : (20)^2$, or as $1 : 400$. Further, since the volume is constant, the cross-sectional area of the wire multiplied by the number of turns is constant, and therefore the sectional area of the wire on each coil is inversely proportional to the number of turns on each, and the diameter of the wires are inversely proportional to the square root of the number of turns. Hence, in the above example, the diameters of the wires on coils A and B are in the ratio of $\sqrt{20}:1$ respectively. This is without taking into account space taken up by thickness of insulation. Similarly, the length of wire on each varies as the number of turns—viz., as 1:20 respectively.

129. *Variation in Field due to more or less complete Magnetic Circuit.*—Now let us measure with the magnetometer the strength of the external magnetic-field when the magnetising force is constant and the amount of iron in the magnetic circuit are varied. For this experiment two bobbins were taken (Fig. 109), each 20 centimetres long, and wound with No. 30 copper wire, to a resistance of 156·5ω. This represented, therefore, about 2,180ft. of wire wound on each (No. 30 measures 13·95ft. to the ohm at 60° F.). Also, the mean diameter of each coil being 4·25 centimetres, the mean length per turn of wire was $4{\cdot}25\pi = 4{\cdot}25 \times 3{\cdot}14 = 13{\cdot}3$ centimetres $= \frac{13{\cdot}3}{30{\cdot}48}$ ft. Hence the number of turns on each bobbin was

$$\frac{2180 \times 30{\cdot}48}{13{\cdot}3} = 5{,}000 \text{ turns approximately.}$$

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The two bobbins of wire were then connected in series to produce opposite poles at N S when the battery was connected. The cylindrical iron cores were 23·2 centimetres long and 2·5 centimetres diameter, and the two keepers or yokes, one of which, Y, is shown, were each 11 centimetres long and 2·75 square centimetres in sectional area. The parallel axes of the bobbins were placed 5·5 centimetres apart, and a potential difference of 42 volts connected to the terminals, maintaining, therefore, a current of

$$\frac{42}{156{\cdot}5 \times 2} = 134 \text{ milliamperes}$$

through the two coils, and a constant magnetising force on each coil of $\cdot134 \times 5000 = 670$ ampere-turns.

The results obtained from the magnetometer readings are tabulated:—

——	Magnetometer deflection.	Magnetic Moment. C.-G.-S. units	Strength of Poles. C.-G.-S. units
Coils without iron cores ...	·2	—	—
Iron cores inserted.....	100	8,508	1,547
Yoke added at end A.....	440	38,030	6,915
Yoke added at end B.....	180	—	—
Last yoke removed and larger one substituted	0	—	—

The moments were determined in the manner already described (para. 125, 1st method), the perpendicular distance between the needle and the polar line of the electromagnet being 36·3 centimetres, and the deflection due to the coils alone being subtracted from each reading. The strength of pole was found by dividing the moment by the distance

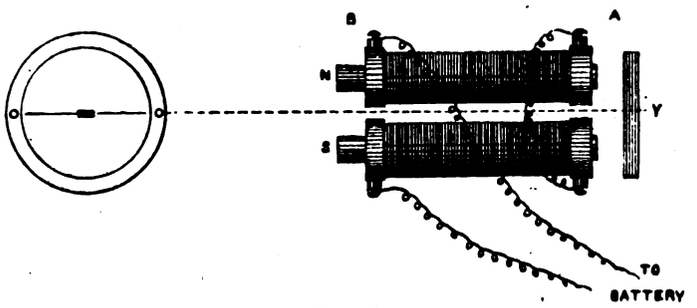

FIG. 109.

between the pole centres, 5·5 centimetres. The conclusions to be drawn from the above may be stated thus:—

1. A magnetic field is set up by the current in the coils alone.

(The deflection of two divisions at the distance of the coil from the magnetometer corresponds to a pole strength of about 30 C.-G.-S. units.)

2. The field is enormously increased by the insertion of iron cores.

Lines of force are evidently *created* by the presence of the iron in the field, since the magnetising force remains constant.

3. The field is still further increased by bridging across one air space by an iron yoke. Lines of force are again created, both through the interior of the iron and the remaining external air space, by making a more continuous iron circuit. We should therefore conclude that,

4. On completely closing the magnetic circuit by adding the second yoke at B, the field in the mass of the iron is still further increased, but that this tends to short-circuit the external field through the air. The magnetometer, however, being still deflected considerably, we should conclude that

5. The mass of iron is not sufficiently large to carry the whole of the field so created, and therefore there is some leakage of lines of force through the air, which affect the magnetometer. This is borne out by adding a larger mass of iron ($15{\cdot}2 \times 5 \times 1{\cdot}5$ centimetres) in place of the small yoke at B, which effectually short-circuits the field—that is, causes the flow of lines of force to be entirely within the iron mass.

(To be continued.)

DISRUPTIVE DISCHARGES AND THEIR RELATIONS TO UNDERGROUND CABLES.*

BY E. G. ACHESON.

From among the numerous problems that are earnestly calling for solution before perfection can be claimed in underground systems of electrical distribution for arc lighting, I selected as the one presenting probably the greatest importance, and, consequently, the one most desirable to solve, *the determination of the cause and cure of the frequent puncturing of the insulation, especially at the terminals, of lead-encased conductors, when carrying high potential currents.*

In a communication to the electrical press, under the title "The Influence of the Condenser on Disruptive Discharges," a detailed description of a series of experiments on the discharge between points in air was given, they having been made with varying E.M.F.'s and condenser capacities.

These experiments resulted in the formulation of the general law expressed in the equation

$$\frac{(\text{E.M.F.})^2 \times (\text{charge in coulombs})}{a} = d,$$

or

$$\frac{(\text{E.M.F.})^3 \times (\text{capacity})}{a} = d,$$

where a is a constant for the dielectric and d is the spark length, the charge being expressed in coulombs and the capacity in microfarads. In the same article the value of a was taken as 135 and d was expressed in inches.

While these experiments may serve as a basis or foundation to build upon, much more must be known before they will meet the requirements of the engineer operating with high potential currents, and with the object in view of obtaining at least a small portion of this required information, my experiments were extended into the more practical part of the subject, and furnished the results I have embodied in this Paper.

The most probable condition of a discharge in a cable would be between the cylindrical conductor and a point or projection on the lead covering; hence the first point to determine was the striking distance between such a cylindrical body and a projection or point.

Experiments were made with a point and the side of a wire, two sizes of the latter being used, a No. 8 and a No. 16 B. and S. wire gauge. There was no difference between the results obtained with the two sizes. The length of the spark was found to be about 55 per cent. when compared with that produced between points with the same E.M.F. and capacity.

This difference gives a new value for the constant a, which is found to be 263.

The equation for the spark length between a point and a cylinder will therefore be

$$\frac{(\text{E.M.F.})^3 \times (\text{capacity})}{263} = d \text{ (inches)}.$$

The following approximate values of a have been determined for the conditions and dielectric specified, d being expressed in inches.

Dielectric.	*Spark between.*	*a.*
Air	Points.....	135
Air	Points and wire.....	263
Paraffin and cotton	Points and wire	5,822
Ozite and cotton	Points and wire	7,759

The conditions governing the disruptive discharge, through the insulation of the covered, grounded cable, are so numerous that it would be quite impossible to exhaustively consider them, even if the necessary data were at hand, within the limits of this Paper. It will therefore be necessary to confine the subject to the more important conditions and the exposition of the law by means of a case that might be found in practical work.

Consider, for example, an arc-light circuit consisting of a dynamo and 30 lamps, connected in series by a lead-covered underground cable. For the purpose of illustration and calculation it is assumed that the lamps are separated a uniform distance of 300ft.; the size of the conductor, a No. 4 B. and S. wire gauge, insulated with one-tenth of an inch of cotton and paraffin; the capacity per mile is 0·704 microfarad, and the E.M.F. at the brushes of the dynamo 1,500 volts. Also, as an assistance in calculation, it is supposed that the drop in the E.M.F. occurs in the lamps only.

The capacity of each one of the 31 sections of cable separating the lamps and dynamo, and which are numbered in regular order from 1 to 31, will be 0·04 microfarad, and the capacity of each division, from conductor to conductor across the circuit, as between sections 2-30, will be,

$$\frac{\cdot04 \times \cdot04}{\cdot04 + \cdot04} = \cdot02 \text{ microfarad},$$

or, in this case, one half that of one side.

* Paper read at the Convention of the National Electrical Light Association recently held at New York.

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With these conditions each division, composed of the paired sections, as 1-31, 2-30, 3-29, and so on, will have a potential tending to break through the insulation of the lead, and thence across the intervening medium in the direction of the broken lines, of a value of 1,500 volts at 1-31, and decreasing by 100 volts for each succeeding division.

These various potentials will, provided the insulation is perfect and the leads well grounded, induce a static charge between the conductor and the lead of each section, of a value measured by the potential across the division, and the specific inductive capacity and thickness of the insulating material.

In the case under consideration the thickness of the insulation and the specific inductive capacity are such as to induce a condenser capacity of ·02 microfarad, and with an E.M.F. of 1,400 volts, as would exist between 2-30, the charge would be $1,400 \times \cdot02$ (m.f.) = ·000028 coulomb; and if the conductors forming the two sides of this division should, while in this charged state, be insulated from each other, as might be done by breaking the electrical continuity at both ends of either one of the sides, the energy stored within it would be able to produce a disruptive charge through air, from the conductors to a point, or *vice versâ*, equal to

$$\frac{(1400)^2 \times \cdot000028}{263} = \cdot2087 \text{ inch.}$$

This is almost $2\frac{1}{10}$ times the thickness of the insulation; but the thickness of cotton and paraffin composing the insulation of the cable that this energy would pierce would be

$$\frac{(1400)^2 \times \cdot000028}{58\cdot22} = \cdot0094 \text{ inch}$$

or less than one-tenth of the thickness of the insulation.

Two questions now present themselves. First: are the sides of division 2-30, or any one of the others, liable to become insulated from each other, or attain a condition favourable for a discharge, for will there not always be a path open for discharge around the circuit, either by way of the lamps or the dynamo? The second question may be stated thus: Is it probable, with the conditions of the case above taken, that the insulation will ever be pierced, seeing that the discharge through the insulating medium cannot be greater than ·0094in., whereas the thickness of the insulation is 0·1in.

It is evident that from accidental causes, such as the breaking of the circuit at two points, it is possible to have the two sides of the division insulated from each other; but such accidents are not liable to occur, especially when it is remembered that the breaks would have to be made simultaneously. To make the probability of this action occurring worthy of consideration, other means of producing it must be looked for and found.

On a circuit using coils shunted round the arc, the electrical continuity is established at each end of the two sides of the division by one of these coils and the arc.

From the experiments of various experimenters, prominent among whom may be mentioned Prof. Hughes and Dr. Oliver J. Lodge, it is concluded that the self-induction in these coils would be of such a value as to offer an almost insurmountable barrier to the flow of the charge through them, and this being the case the discharge, if it occurs at all, must be through either the arc or the insulation of the cable. To determine whether the charge would pass off through the arc, the apparatus shown in Fig. 1 was used.

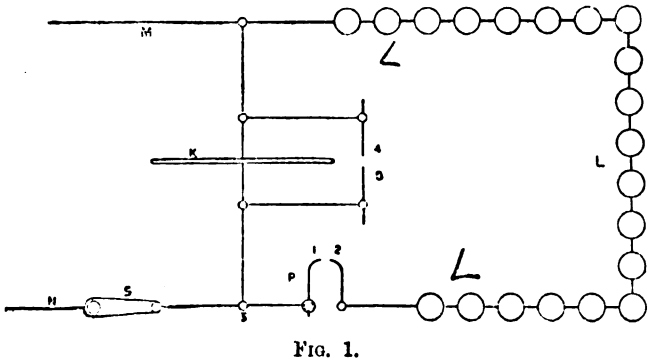

FIG. 1.

Twenty incandescent lamps, L L L, of 100 volts each, were connected in series to the lines M N; in the line N was placed the switch S and the contact points 1 and 2, the former being mounted in the revolving post P, thereby permitting of the points being opened. The condenser K was connected across the circuit from the line M at a point 3 between the switch and the contact points on the line N; around the condenser were placed the points 4 and 5, with suitable means of regulating the distance between them. M and N were connected to the sides of a transformer supplying an E.M.F. of 2,067 volts. The points 1 and 2 being in contact, no amount of rupturing of the circuit at S and adjusting of the space separating 4 and 5 would cause a discharge to occur between them; but upon opening the points 1 and 2, and thus establishing an arc in the circuit, the opening of the switch, S, would cause a heavy discharge between 4 and 5.

From this experiment and Dr. Lodge's results with circuits containing self-induction, the conclusion must be drawn that conditions favourable to a disruptive discharge are exceedingly likely to occur when upon opening an arc light circuit the various sections of the cable become, so far as the static charge is concerned, insulated from each other.

In considering the second question the fact is at once recognised that where the constant a for the dielectric surrounding the conductor is that of the cotton and the paraffin, a disruptive discharge would, under the circumstances cited, be impossible, and the answering of the question in the affirmative will therefore turn upon the probable lowering of the value of a.

Anyone familiar with insulations as applied to conductors knows that all of them, with the exception of rubber and gutta-percha and their compounds, will permit water or moisture to penetrate them, and as the hydro-carbons and water do not form chemical compounds, the one being insoluble in the other, this passage of the water must be a purely mechanical action, and furthermore, openings, cracks, or crevices must exist in order to permit of its passage. In many cases the cracks are visible to the eye, while in others they can only be detected by submerging the insulated conductor in water for a time and then testing electrically. But even after proving the existence of these cracks, it remains to be determined that the static charge will be influenced by them.

As one means of testing the case, a plate of glass ·072 inch thick was broken into two pieces, and the two parts immediately fitted into their former positions and held together by clamps. The crevice or space separating the parts was infinitesimal in width, as will be evident to anyone who may have made a similar experiment. The restored plate was placed between two discharge points, in such a position that the line joining the points passed through solid glass. Under these conditions I was not able, with my facilities, to cause a disruptive discharge to take place through the plate; but upon moving it so that the line joining the points would lie in the plane of the fracture, a disruptive discharge occurred with an E.M.F. of 2,067 volts, and a capacity in the circuit of ·00322 microfarad.

While this demonstrates the minuteness of the path required for a discharge, it is hardly a parallel case to what would exist in an insulated conductor where the insulation was built up out of many overlapping windings of fibrous material, and then treated with an insulating compound, for in this case the cracks or crevice produced by temperature variations and the bending incident to handling and laying of the conductor will not be direct lines or planes from the conductor to the metallic casing, but angle or zigzag lines, following the interstices of the fibrous structure. This difference would result in the lengthening of the path of discharge, but scarcely to an extent sufficient to raise the resistance to discharge to the value of the insulating material in a perfect state; and so long as the value is below that of the insulating material, the value of the constant a is also lowered, and it is therefore reasonable to assume that the conditions may become such as to warrant an affirmative answer to the second question.

Unfortunately, both of the two grand divisions of conductor insulators, the fibrous and the non-fibrous, have their faults, for while the fibrous has the, in some circumstances, serious fault of cracking, the non-fibrous has the even greater fault of losing its insulating qualities and running off the conductor when heated, as might occur by an accidental overloading of a circuit, and when it is confined, as in a lead covering, it permits the conductor to become decentralised and eventually come in contact with the lead casing. Between the two insulators, with the faults specified, inseparably associated with them, there would, for high potential currents, be little or no choice, but, fortunately, means have been devised whereby the existence of the cracks or crevices in the fibrous insulating envelopes when properly protected from water by a metallic casing is immaterial, as they are sheared of the power of diverting the discharge into the paths opened by them. These ends are accomplished by the simple expedient of causing the discharge to occur at such a place and in such a manner as not to pass through the insulating envelope.

This may be done in a great variety of ways, but the most simple one that has suggested itself to me is shown in Fig. 2, where A is the lead cover, I the insulation, C the conductor, and P a wire connected to A and extending out beyond I, its end, K, being adjusted in relation to C so as to leave an air space slightly less than the thickness of the insulating material I. Under these conditions, when a charge occurs it will invariably be at K and not through I.

While this simple arrangement illustrates the action and answers as a means of protection, it is evident that some device more durable and capable of adjustment would be preferable. A design meeting these requirements is shown in Fig. 3.

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In the figure A is the lead covering, I the insulation, and C the conductor. Mounted on the lead A and held in place by the band V is the metallic arm P, carrying at its outer end the pointed rod R. Another pointed rod R′ is held by a projection on the ring B, which is mounted on the insulating bushing D. A fusible wire F connects the ring B to the metallic sleeve or collar E. The distance between the points R and R′ can be adjusted, and the rods held in position by suitable screws.

It is evident that the operation would be similar to that of the device shown in Fig. 2. The electrical potential between the conductor C and the lead covering A before attaining a height sufficient to discharge through the insulation I, will discharge across the air space between the rods R and R′, for these rods, being in electrical connection with A and C, will attain their potentials, and the points of the rods will, according to a known law, have an electrical density above that of A and C, or that requisite to produce a discharge across the intervening air. The fusible wire F is inserted as protection against injury to dynamos and cables in case of a ground existing on the other side of the circuit.

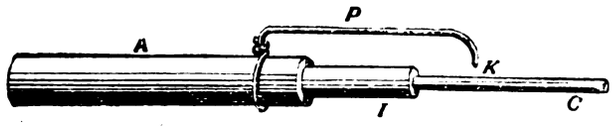

FIG. 2.

There are several points, apparently trivial, but really of much importance, relating to the design and material of construction of a device for discharging a cable.

The distance, measured on the exposed surface, separating the points of support of the discharging arms or rods, should be as great as possible, as there would be a loss of energy across this space in case the distance was small and dampness existed.

Another point to remember is that the constant a should have a known value, and therefore the most appropriate design, for the discharger is one employing points to discharge from an unvarying intervening medium, such as air.

In order to obtain some definite information on the question raised by Mr. Leggett at the Pittsburg meeting, as to the effect on the insulation of a short bend or indentation in the lead of a cable, I caused a very deep dent to be made in a cable, so deep, in fact, that it would at once have been condemned in practical work; and then connecting it into the working circuit, an attempt was made to cause a disruptive discharge to pass through the compressed insulation at the point of indentation; but the attempt was unsuccessful, the discharge preferring to occur at any other point.

Another experiment was made to determine the effect of bending the cable backward and forward several times in the same place. A length was selected in which the discharge always occurred at either one of the ends, and after the bending operation had been performed a number of times, I was able to produce the discharge through the bent portion in preference to the terminals.

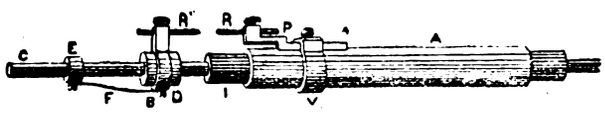

FIG. 3.

These tests show the superior strength of the insulation in the more condensed or homogeneous forms, and the weakening effect of much bending.

In this connection it may be well to inquire more fully into the tendency of the discharge to occur at the terminals of the lead.

It is a well-known fact that the greater number of the grounds or burn-outs that occur on arc-light circuits are at the terminals of the lead or at the joints, and it is precisely at these points that the charge, acting under well-established and familiar laws, would be most dense, and, owing to the presence of the edges or points for the electricity to flow from, the disruptive discharge will, under ordinary circumstances, take place between the edges or points and the conductor within the insulation. Owing to the special facilities offered at these places for the passage of the discharge, it is probable that in many cases burn-outs occur under the influence of a charge that would be unable to produce a discharge through the continuous portions of the cable.

In order to reduce the probability of a discharge occurring at terminals and joints, I would suggest that the lead whenever cut be made bell-shape in order that all edges or points be turned away from the conductor.

It may be appropriate at this point to consider briefly that vexed question, which way does the spark pass?

From the experiments and conclusions of Faraday I have made the following deductions:—

1. When the charged bodies are of the same size and form the *spark discharge* will, other things being equal, be *from* the positively-charged body.

2. Other things being equal, less potential is required to produce a *brush discharge* than a *spark discharge*, and when it does occur it will be from the negatively charged surface.

3. In all cases where the charge of electricity is on, or closely associated with, the discharging surfaces, a diminution of either surface will facilitate a discharge, and when any considerable difference exists in their areas the discharge will always be *from* the smaller surface.

4. A spark from a small body to a large one will be from eight to ten times greater in length when the small body is charged positively than it would be with a negative charge.

In general the direction of the discharge between the conductor and the lead, through the insulation, is subject to the form of the surfaces of the conducting bodies, a slight burr or point on either one being sufficient to determine the direction of the spark.

In a series of very interesting articles by Mr. G. L. Addenbrooke in the London *Electrical Review*, the subject of spark length disruptive discharges and the advantages of a perfectly continuous and unbroken dielectric are extensively treated. The influence of the capacity of the cable is, however, entirely neglected. Special stress is laid upon the advantages of a continuous envelope of insulation, and those using rubber-covered conductors are particularly cautioned against handling or bending them when the temperature is lower than 45° Fahr., as fissures or cracks are then liable to occur and permit of the passage of discharges. This, I confess, was information to me, and puts a certain limitation to the qualities I have given above to rubber, and which was written before this statement of Mr. Addenbrooke came into my hand.

As the experiments referred to in this Paper have extended over a considerable period (not less than six months), there have naturally been a number of questions and points presented from outside sources. Others have been led into the field to experiment, and with the equally natural result of obtaining in some cases effects that they have construed to be at variance with those I have secured. I have one case in mind where the experimenters found it impossible to produce a disruptive discharge so long as the lead of the cable was insulated from the ground; but the grounding of it made the production of the discharge feasible, and they concluded that the theory of a disruptive discharge was not correct. This is a repetition, under different conditions, of the very old experiment of attempting to charge a Leyden jar with the jar insulated. The first condition to be arrived at in the charging of a jar is the grounding of one of the surfaces.

A disruptive discharge through the insulation of the cable cannot occur without a charge being first formed; hence it is absolutely necessary that a ground be made to the lead.

The resistance of the ground connection to the lead is to a very great extent immaterial, as the charge is cumulative, and the energy expended in the discharge is only that held in the charge; hence though the ground resistance may be many megohms in value, and the charging process extend through a considerable time, there will eventually be a storage of energy on the surface of a value sufficient to rupture the insulation at the first change in the charging current.

The spark discharge is all but instantaneous in its action, and with the word restricted to this immeasurably short space of time it is necessary to have the energy on hand, as it were; there is no time to generate it, electrically, at the dynamo and convey it over long or even short distances.

The subject of disruptive discharges, with various resistances and self-induction placed in the path of energy, is beautifully treated in a Paper read by Dr. Oliver J. Lodge before the Society of Arts, April 17, 1888.

One word more before closing this subject. It is safe to predict that, the disruptive discharge being provided for, little or nothing more would be heard of the much-talked-of pin-holes in the lead and the moisture-absorbing terminals, the undergrounding of arc-light cables would become a thing of certainty, and our municipal governments relieved of a great bug-a-boo.

Cologne.—A recent examination of the lightning rods of Cologne Cathedral showed that the rod attached to the north tower had been struck; the flash must have been a violent one, for the platinum point was fused to a distance of 10 mm. During the last four years, the lightning conductors have protected the cathedral on five occasions. It is officially stated in Germany that fires due to lightning are steadily on the increase, and that since 1840 accidents from this cause have more than tripled.

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THE DISCUSSION ON LIGHTNING CONDUCTORS AT THE BRITISH ASSOCIATION.

The conjoint discussion between physicists and practical electrical engineers at the British Association meeting relating to the views recently put forward by Prof. Lodge on the subject of Lightning Conductors was certainly a very happy idea; and though its importance to the pure physicist was overshadowed by Prof. Fitzgerald's brilliant address, it was certainly, from the point of view of the electrical engineer, the most important outcome of the recent meeting.

The proposition put forward by Mr. Preece in his opening statement that "There is no authentic case on record where a properly constructed conductor failed to do its duty," accompanied by the statement that the principal object which he had in view was to defend it against all comers, was, as it stood, hardly called in question; but, as Prof. Lodge subsequently observed, the point in dispute was "what is it that constitutes a properly constructed conductor?" and though this question was not set at rest by the discussion, which, indeed, was not to be expected, many important points were raised on which further experiment is desirable; and we cannot doubt that a great impetus has been given to the investigation of a subject of the utmost practical importance.

Mr. Preece's contention that the magnetising power of lightning flashes militated against the oscillatory theory of the discharge gave rise to some suggestive remarks from Lord

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RAYLEIGH and Sir WILLIAM THOMSON which, like most observations from these authorities, are worthy of careful attention.

Mr. PREECE's warning, read in the light of Prof. FORBES' commentary upon his mode of expressing it, against unpractical mathematical speculations based upon no secure experimental foundation, is a much needed one, and will, we trust, meet with the attention it deserves. To the younger electricians this warning is especially valuable. Rejoicing in a comparatively ample mathematical equipment, they are apt to forget that while, as was pointed out by the late Prof. J. STEPHEN SMITH in an address to the London Mathematical Society, mathematics is the one branch of science which has never had to retrace a step or plead guilty to an error; yet mathematical processes, however ingenious, can only enable us to discover what lies hidden in the data to which they are applied, and can therefore never by themselves lead us to a single physical truth.

Mr. PREECE was, however, not so happy in his selection of instances of blunders committed by mathematicians; for, as was pointed out by subsequent speakers, in each of the cases which he cited for illustration it was an engineer, and not a mathematician, whose prediction had been falsified. There are not many mathematicians, we should think, who would be willing to accept Dr. LARDNER as a representative of their science, and indeed we should be inclined to ascribe his being made to pose in that unwonted capacity to the amusing playfulness which helps to make Mr. PREECE such an agreeable antagonist, and his speeches so pleasant to read.

His contention that a lightning flash was analogous rather to the bursting of the dielectric in a Leyden jar than to the external discharge in which oscillations may occur, was, we should say, the most important objection brought by Mr. PREECE against the validity of Prof. LODGE's conclusions, and Prof. FITZGERALD appeared to be of the same opinion. Prof. LODGE, in the course of his remarks, somewhat ruthlessly demolished the arguments advanced by Mr. PREECE in his inaugural address to Section G in favour of regarding electricity as a form of energy. The instances which he quoted of the failure of lightning conductors of the most approved pattern, though not touching Mr. PREECE's opening assertion in the form in which he had stated it, certainly established the impossibility of maintaining that existing conductors never fail.

The fact to which Prof. LODGE called attention, that the sparking between the secondary terminals of an induction coil is facilitated by exposure to light, was one which may not improbably prove of value in helping to throw further light on the nature of electrical phenomena.

The photographs of lightning flashes which had been collected by a Committee of the Royal Meteorological Society and were exhibited by Mr. ABERCROMBY possessed considerable interest, and M. JANSSEN's suggestion that the unexplained "dark flash" might be due to over-exposure, not on account of an unusual lightness in the flash, but because of its having an unusually long duration, was a valuable one and will be worth following up by experiment. Mr. TRUEMAN WOOD thought that if the dark flash had been due to over-exposure, it would have shown over the white one, which it did not; and Lord RAYLEIGH afterwards pointed out that it might be due to a formation of oxides of nitrogen, as suggested by Prof. STOKES, by a decomposition of the oxygen and nitrogen of the air, as those oxides, being opaque to the chemical rays of the spectrum, would cause the path of the flash to appear as a black line in the photograph.

Sir WILLIAM THOMSON endorsed Prof. LODGE's conclusion that the protection of powder magazines should be carried out by making the walls, roof, and floor of iron and banishing lightning conductors altogether, the iron floor, of course, being protected by means of a covering of wooden boards to obviate the possibility of sparks arising from persons walking upon an iron floor.

In the report of the Lightning Rod Conference, which was drawn up in December, 1881, while the importance of having all ironwork on the roofs of buildings in perfect metallic connection with the lightning conductor is insisted on, it is asserted that the possibility of such metal work inducing the charge to desert the conductor when struck by lightning could only occur if it were of inadequate conducting power, or imperfectly earth-connected. The results of the discussion, to say the least, throw considerable doubt on the truth of that statement. We also take it that no sane person who has studied the discussion will care to try the experiment of holding on to a conductor during a thunderstorm, in spite of the statement in the report alluded to, that "a man may with perfect impunity clasp a copper rod an inch in diameter, the bottom of which is well connected with moist earth, while the top of it receives a violent flash of lightning." The further statement that such a conductor might with impunity be surrounded with gunpowder is one which, we trust, will not be made the subject of an experimental trial.

IMPROVEMENTS IN THE TELEPHONE SYSTEM OF GLASGOW AND THE WEST OF SCOTLAND.

BY D. SINCLAIR, Engineer, National Telephone Company.

(Concluded from page 597.)

A comparatively new thing in telephone exchange business is the introduction of telephone call boxes. These are fixed at convenient places, and connected with the exchange system. Some companies charge their subscribers and the public alike for the use of them, but in Glasgow it has always been an advantage held out to intending subscribers that they could have the use of these boxes free of charge, and that consequently from any district of the city they could speak to their office. This system is very much taken advantage of.

With the idea of allowing subscribers to talk free of charge, and at the same time make non-subscribers pay for communication, a simple automatic call-box has been brought out by Mr. Smith, of Glasgow, and myself. The invention is little more than two years old, and we already have ninety of them at work in Glasgow and the West of Scotland. Nothing could be more successful than the manner in which these instruments have done the work required of them. A marked feature in the arrangement of the call-box is that no money is put in until the party wishing for the connection has spoken to the exchange and has ascertained that he can have the connection which he wants. If the line is clear the customer has next to put the toll into the box. The operator is able to tell whether or not this is put in, and Figs. 9A, 9B, 9C show diagramatically how this is accomplished.

If a local connection is wanted, *i.e.*, a connection in the same town, threepence is the charge, and the operator joins a battery on to the wire with a single-stroke bell in circuit. As the pennies drop into the box they momentarily disconnect the line, and the bell sounds once for each penny as it falls into the box. If sixpence is wanted for a connection by trunk wire to another town, the coin, in falling into the box, disconnects the local circuit of the telephone at the call box, the operator hearing a smart click in her telephone. I am aware that electricians can tell me that this click can be produced otherwise than by putting in the sixpence, but the users do

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IMPROVEMENTS IN THE TELEPHONE SYSTEM OF GLASGOW AND THE WEST OF SCOTLAND.

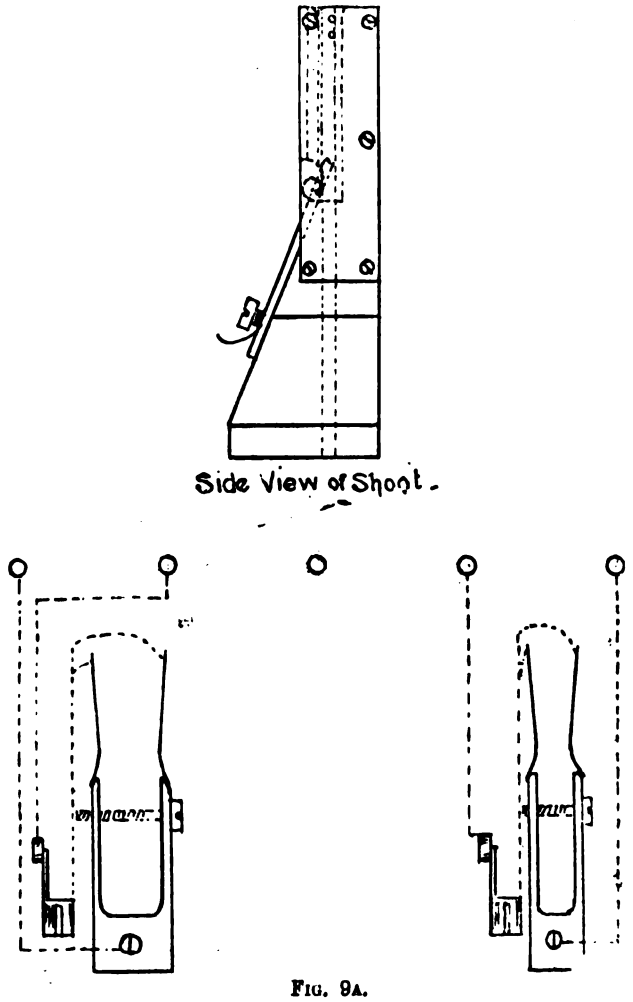

FIG. 9A.

Diagram showing connections of box. When a penny is dropped into the left hand slot it pushes aside the springs, breaking the line circuit and causing the bell in the Exchange to strike once. When a sixpenny piece is dropped into the right-hand slot the springs are pushed aside, breaking the secondary circuit of transmitter and causing a click in the operator's receiver.

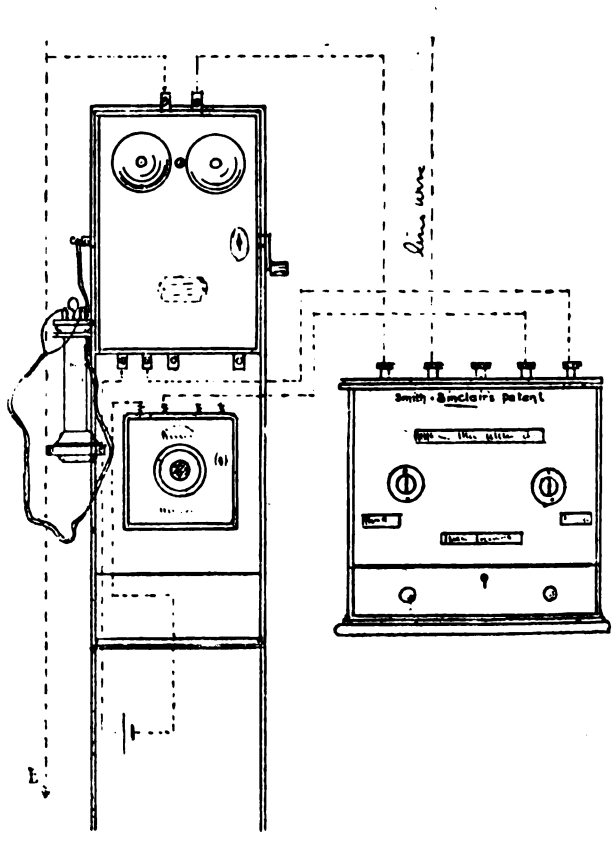

FIG. 9B.

Telephone instrument and call-box joined up

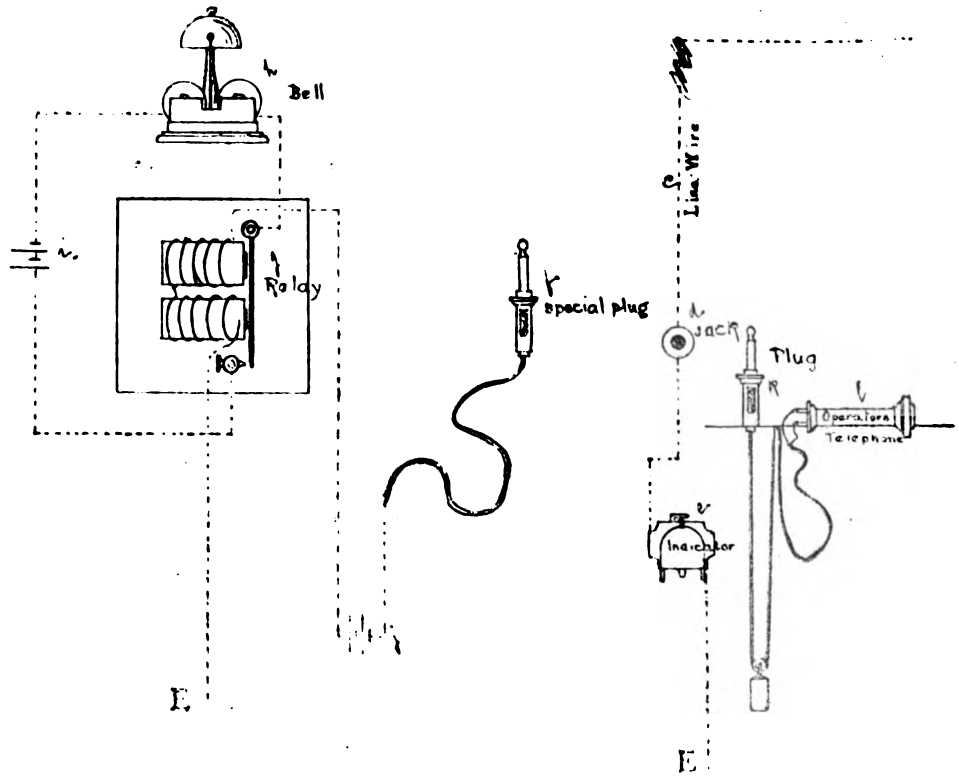

FIG. 9C.

Connections in Exchange. *c* line from call-office to jack *d* and indicator *e*, *f* special plug (for pence) for introducing relay *g*, bell *h* and battery *i*, *j* battery which closes relay and causes local battery to hold hammer *o* bell against gong, *k* ordinary plug (for 6d.), *l* operator's receiver.

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not know this, neither do they try, and if they did, the operator, after a little experience, knows at once if the least symptom of tampering takes place.

Up to this point I have only spoken of single wires, between which there is always a certain amount of overhearing by induction from one wire to another; but this is by no means of such vast importance in telephone exchange business as many have made of it. In Glasgow there are hundreds of single wires on which there never has been any practical trouble from overhearing by induction. The number who have suffered from this annoyance is very small indeed, certainly not more than one per cent. of the total number. Our experience roughly is, that where two or three wires only run on a line of poles for three miles and over, the effects from induction are such as to interfere with the proper use of the telephone. On shorter wires, and where greater numbers exist on the same

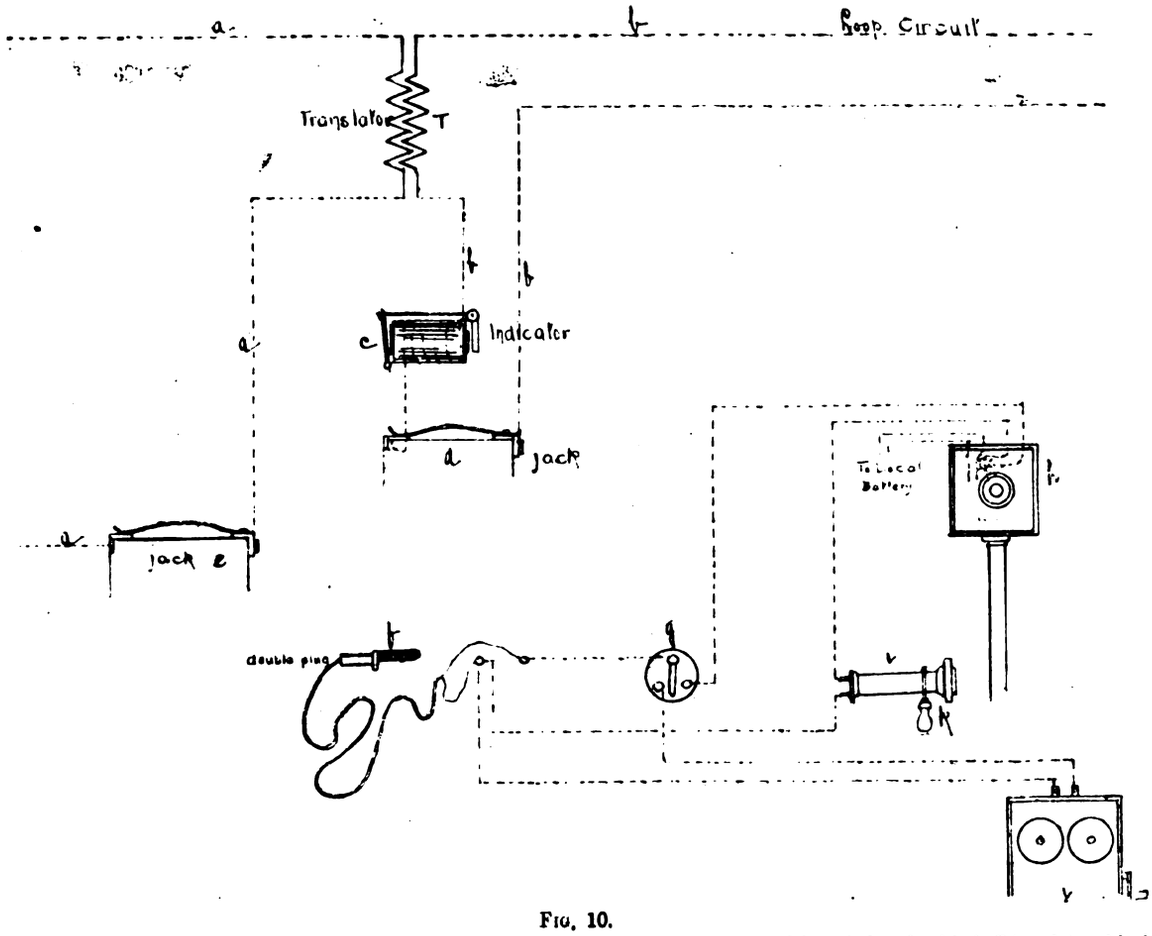

FIG. 10.

Method of speaking from a single wire through a loop. *a a a* local circuit, *b b b* loop circuit, *c* loop indicator, *d* loop jack, *e* local jack, T translator, *f* double-faced plug, *g* two way switch (for speaking and ringing circuits), *h* operator's transmitter, *i* receiver, *j* magneto, *k* receiver rest and battery cut-out.

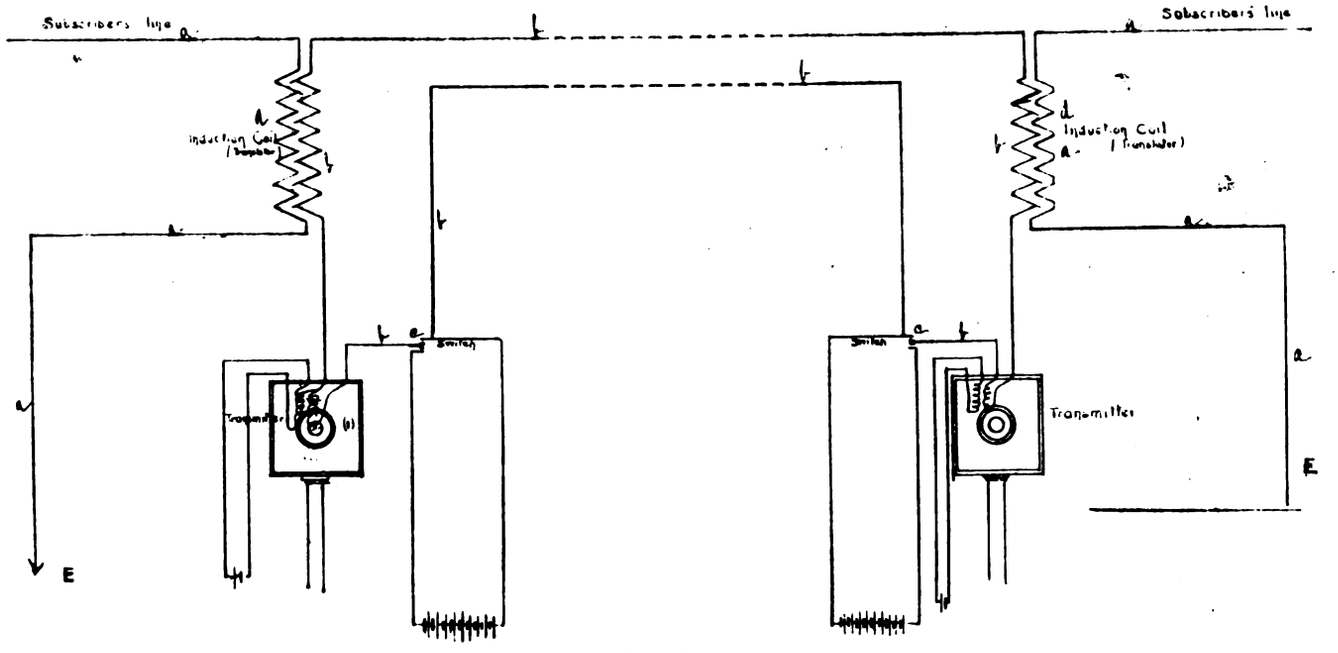

FIG. 11.

Loop circuit with batteries in circuit. Local circuits *a a a*, loop circuits *b b b*, *c c* switches for throwing batteries in and out of circuit, *d d* translators.

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poles, the induction is not of such a character as to interfere with the proper and business use of the telephone; it is true that there is not perfect quietness, but who in a busy city can command it, in the streets, in the offices or anywhere else?

For wires running together for long distances and on all trunk lines we use twisted metallic loops. The manner in which we join local single wires so as to speak through loop wires is shown on Fig. 10.

For this purpose we use an induction coil, with the secondary in the loop circuit and the subscribers' lines at each end through the primary circuit to earth, thus acting as a translator in the same manner as the induction coil in every telephone acts as a translator from the local circuit to the line wire. This arrangement works very well on our longest lines of between 80 and 100 miles. After considerable experimenting on the line between Glasgow and Edinburgh, the best results I got were with the wire joined as in Fig. 11. This differs from the ordinary method in having a battery of ten cells placed in the loop circuit at each end. The batteries are so joined up as to cause a continuous current to flow in the loop circuit all the time the speaking is being done.

The subject of inductive disturbances between telephone wires is one that is always before telephone engineers.

Time and experience have yet much to say on this subject. The results of the experience which I have so far gained I would sum up by saying that I know of no telephone circuit that is perfectly clear of all disturbances but the twisted metallic loop circuit. I know of no arrangement or condition of telephone wires or circuits where facilities are provided for the disturbing inductive effects to go to earth that they do not do so, and always in proportion to the facilities so provided—*e.g.*, a fifty-wire cable of, say, 200 yards in length, having telephones joined on two of the wires, with all the ends of the other wires insulated, will show that speaking by induction between these two wires is almost as strong as speaking direct on either of the wires; but when the other forty-eight wires are put direct to earth, either at one or both ends of the cable, the overhearing by induction practically ceases to exist. If any resistance is introduced between the forty-eight wires and the earth the overhearing between the two wires increases in proportion to the resistance so introduced.

ON A SYSTEM OF ELECTRICAL DISTRIBUTION.*

BY HENRY EDMUNDS.

The problem of the distribution of electricity has considerably occupied the attention of engineers lately, and several methods are in practical use, which may be classified as follows:—The direct low tension, in which currents of large volume are transmitted, requiring correspondingly large conductors. This system has the advantage of extreme simplicity, but is limited in its operations to short distances from the source of supply. Another is the secondary generator or converter system, in which alternating currents of smaller volume but much higher tension, are used—lessening considerably the weight of conductors, and getting over the limit of distance, enabling comparatively small wires to supply electiric energy over a large area, but attended with increased danger to life and property from leakage, and neutralising the saving of cost in copper in the increased cost of insulation and protection of the conductors. Both these systems are, however, subject to the annoyance of fluctuation in case of varying pressure, or total extinction of light, due to stoppage of machinery, when all work would cease. And if in order to minimise such accidents the generating plant be duplicated, the already large cost of machines, whose maximum output is only occasionally demanded, is enormously increased, thus adding to the capital invested and interest expected thereon.

In order to obviate the difficulties inevitably connected with any system of direct supply, of being always dependent on the continuity and regularity of the motive power, accumulators or storage batteries have been proposed, as it is seen to be necessary to have the equivalent of the gasholder to the retort, or the water cistern or reservoir to the spring or pump, in order to have a reserve independent of the source. This brings us to the question of how to supply batteries to the best advantage, and to examine into the methods hitherto employed on a large scale in connection with the public supply of electricity for lighting or other purposes.

In 1882 and 1883 I was in New York with the Brush Illuminating Company of that city, taking charge of the demonstration there of Mr. Brush's new system, which consisted in the employment of storage batteries, located in groups in series to each other, charged from a common main, carrying a 10-ampere current (the same being used to operate their arc lamps at night), devices being employed to automatically disconnect the batteries from the charging main when fully charged, and *vice versâ*, the idea being by this method to obtain double duty from their existing illuminating plant, and enabling them to charge batteries by day and run arc lamps direct at night, the charged batteries at the same time supplying current for incandescent lighting. But in actual practice serious difficulties soon presented themselves. The current employed for charging was too small, and there was not time to charge the batteries sufficiently during the hours of day for any great demand there might be made on them at night. Suggestions were made to obviate this by charging a larger number of small cells in series, and discharging in multiple. But this demanded correspondingly higher voltage pressure in the mains and at the generating station, which presented very serious practical difficulties. Batteries being so charged could not be used to supply light locally at the time of charging, thus removing the great *desideratum* in electric service, viz, continuous supply; and, further, the risk of breakage and damage therefrom was greatly increased. Besides, batteries under charge have an increased voltage, which either injures the lamps or causes annoyance by fluctuation. Ultimately, after great cost and expense, this promising system was abandoned, and, I learnt when in the United States a few weeks ago, has never been revived.

In England, also, experiments on a large scale were made at Colchester about the same period. Here batteries were charged with a high pressure changing current of small volume—duplicate sets of cells were employed, so that one set was being charged from the main while the other was discharging locally. But again difficulties presented themselves in practice. The pressure at the station or the charging mains, being at least equal to the sum of all the batteries in series, was either very high or else limited; the number of groups on circuit that could be charged at one time, also the freshly charged cells having a higher E.M.F. than those that had been discharging, caused serious fluctuation in the lights during the change from the main to the local. And as the cells automatically changed their position from the main to the local only when they had themselves arrived at a certain condition of charge, sometimes the local cells had got over discharged, causing serious damage through buckling and deterioration generally. The result was that the Colchester system was ultimately abandoned.

Having thus far glanced at the history of electrical supply, I now turn to the method proposed and patented by myself, known as the Edmund's System of Electricity Distribution, such as is now being employed in actual practice by the Cadogan Electricity Supply Company, London. This system differs essentially in every point from any of the plans hitherto tried or in operation at the present time, and may be thus described:—

A number of groups of cells, which we will call the local batteries, are placed at different points or centres where supply is required in the district, each battery having its individual number of cells according to the voltage required locally and the amount of current to be supplied. Unlike the Brush method referred to, these local batteries are electrically distinct and independent of each other and of the charging main; neither is there a duplicate set to be changed as at Colchester, but instead we employ an additional group with each of the local batteries, which we will term the main batteries, the number of cells of which are a divisor of the number employed

* Paper read before the British Association meeting at Bath, September, 1888. Section G.

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locally—generally one-third. For example, suppose the local voltage be 48 volts, 32 cells would be employed, which we would subdivide into four groups, eight cells in each, and for purposes of identification we will call these groups *a*, *b*, *c*, and *d* respectively. Groups *b*, *c* and *d* are connected in series in the local (*see* diagram), giving 48 volts. Group *a*, being in the main, being charged for a limited period of time—in practice two minutes—is then removed from the main charging circuit and placed in the local discharging circuit, when, say, group *b* is removed from the local into the main to be charged ; *b* now in turn exchanges places with *c* and *c* with *d*, so that each group *a*, *b*, *c*, *d* follows each other in turns from the main to the local or local to main, whereby in every eight minutes each group has received its increment of charge from the main and has supplied the same in turn to the local, and so on continuously, until in twenty-four hours each group has received its full charge of current, enabling the battery to maintain its maximum discharge for eight hours, the current employed in practice being 70 amperes, and the size of cells proportionate. Incidentally we find many advantages due to charging cells in this manner. We can maintain a constant potential on the local circuit, so that we have not the interference and fluctuation due to charging and discharging at the same time. The high-tension main is never at any time in electrical contact with the local circuit, thereby freeing the system from leakage to earth and its attendant danger. Also the cells are kept in much better condition by continually receiving short increments of charge and having periods of rest from discharge. The loss due to difference of potential between the charging and discharging current is minimised, it being found in practice we can continue charging the cell to its maximum capacity with a mean voltage of 2·25, instead of 2·5 per cell, as is required where cells are charged continuously. This, on a large scale, is a considerable element of economy where there are a number of cells in the charging main. Also we find that an approximately constant potential on the local circuit enables us to run lamps at a higher efficiency without the risk of rupture due to sudden rises of pressure ; and, so far as we can judge, the life of the batteries is considerably lengthened by this mode of intermittent charge and rest. And, in addition to all these advantages, we have a great saving in the generating station in cost of plant, only one-third the power being required to operate the same number of lights for eight hours that would be necessary for any direct system, and much less electric force or pressure on the charging mains to supply the same number of lamps, thereby saving cost of installation and chance of leakage.

The additional advantage of being able to run a smaller station for 24 hours in the day is obvious, as we do not have any idle plant, with interest thereon. The current being always constant in volume enables a single main of one size throughout to be used, preventing complications, and only requiring increase of pressure as the work extends, which pressure would be only one-third the Brush or Colchester systems referred to for the same number of cells in the local centres, or could at their pressure charge three times the number of batteries. For example, where batteries are used in 100 centres on the Brush or Colchester plan, each centre giving 50 volts, requiring at the station a charging potential of over 5,600 volts exclusive of the line, while with the distributor plan it would only require a charging potential of under 2,000 volts for the same work, with this it would be only 1,800 or 2,000 volts, according to the length of the line.

The apparatus for carrying out this system I call a distributor (Fig. A). It combines in one instrument a time mechanism causing changes to occur at regular periods of, say, two minutes, by energising an electro magnet at each period, rotating a shaft carrying cams that cause levers to make the necessary contacts for changing the position of the cells from local to charge and *vice versâ*, a polarised switch, whereby the current is prevented from entering the batteries in the wrong direction, and a voltage regulator which causes the batteries as a whole to cut themselves out of the charging main or otherwise, according to their being fully charged or requiring charge. A simple form of meter registering the current is supplied. The diagram of the cycles of operation will explain what takes place, and I have constructed several distinct instruments for effecting these cycles, some with levers and mercury contacts, one with rotary brush contacts like a compound commutator, and the one shown in cut which we are now using, in the designing of which I have received great help from my assistant engineer, Mr. Albert Howard.

The manner of effecting the cycles is explained by diagrams 1 to 6 A, B, C and D represent the accumulators at one point of lighting, which are divided into four equal groups. For instance, imagine there are 32 cells in one house, then A group would consist of 8 cells connected together in series, and B C and D the same.

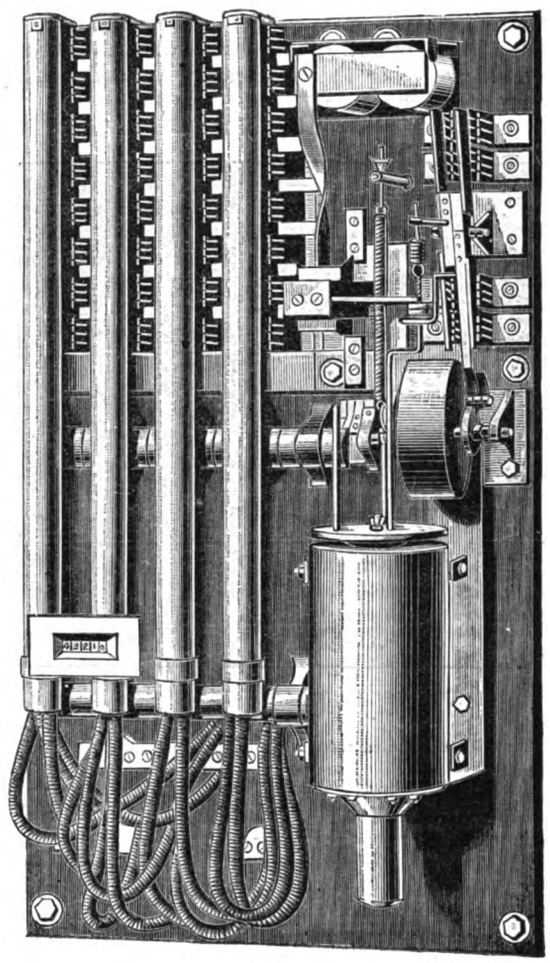

FIG. A.

In diagram 1, A is receiving a charge from the central station, over the main cable B, and batteries B C and D are connected together in series and furnishing current to the lights B. After this state of discharge has been in operation for a fixed interval of time, the distributor begins to work automatically and makes the various connections necessary, as follows :—

Fig. 2. A resistance, I, has been switched into the main circuit in parallel with battery A.

Fig 3. A has been switched entirely out of circuit, leaving the main current of 70 amperes, which have never been interrupted, flowing through the resistance Y.

Fig. 4. A has been switched into parallel with B, in the local or discharge circuit. This is done without the slightest alteration in the lights, as the electromotive force remains the same as before.

Fig. 5. B has been cut out from the discharge circuit, leaving the lights on to A C and D.

Fig. 5. B has been connected into the main charging circuit in parallel with the resistance Y.

The resistance Y is then disconnected, leaving the charging current flowing through B, which receives a charge for the fixed interval of time and is then switched back into the local

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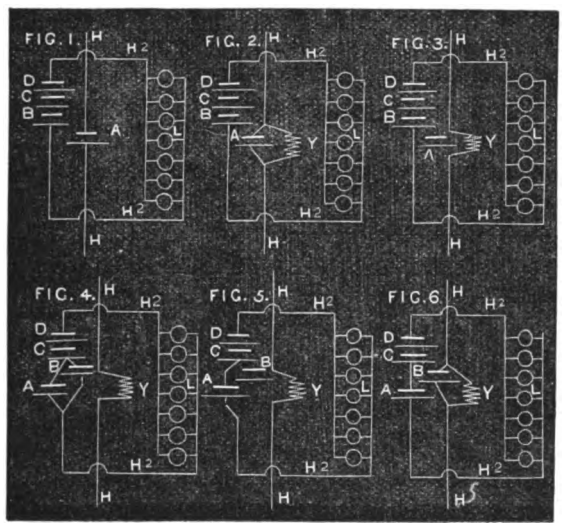
circuit, while C receives its increment of charge. In this way each section of the batteries passes through equal periods of charge and discharge.

The time occupied in the mechanical movement of the entire cycle is three-quarters of a second, and the period during which the charge is on can be varied at will.

Such a system as I have briefly described lends itself to many purposes in connection with electricity supply. For instance, in the working of a railroad switches and signals, electrically, a distribution at each block station would enable a whole line of rail, say 200 miles, to be supplied from one source, the pressure on the main being only a small fraction of the sum of the local pressure, or in electric tramway work, a charged main, well insulated, of high pressure, could supply a number of points *en route*, which in turn could each, independently of the other, supply large-volume, low-pressure currents locally, saving risk of breakdown and consequent interruption of traffic.



But more particularly is it useful in detached house and surburban lighting, for it solves the problem of giving each house its own individual supply of electricity continuously day and night, totally independent of continuous or regular working at the central station or of interference from other work on the same circuit, being at the same time absolutely safe from the danger of shock, and, above all, supplying the electric light at a reasonable cost.

ON THE MEASUREMENT OF ELECTRICITY IN A HOUSE-TO-HOUSE SUPPLY.*

BY W. LOWRIE.

The supply of electricity from central stations has for years received a large amount of attention, but until within quite recently a practical house-to-house supply was impossible, owing to the enormous weight and cost of the copper conductors or mains required to convey large currents at low tensions to any considerable distance. The sectional area had to be very great, to avoid a high percentage of loss due to resistance. This objection, which was fatal to any extensive venture in a house-to-house supply of electricity, has now been overcome by the introduction of high tension, alternating current, and secondary generator or converter system. By the employment of this system the current is so greatly reduced, and therefore the size of the mains is so lessened, that even in very long distances any loss due to their resistance may be reduced to a practicable minimum without any serious outlay of capital.

One of the most important features in a house-to-house supply of electricity is a reliable method of a meterage to the different consumers; now, even in the case of the old systems of low tension continuous-current circuits, the difficulties of meterage have hitherto not been satisfactorily overcome, the greatest difficulty in these systems being the very high percentage of loss due to the passage of very large currents through the resistance offered them by the coils or other mechanical appliances which have to be introduced into the circuit rendering it impossible to obtain the full luminosity of the lamps; or in the case of an electro-deposition meter the enormous quantity of copper carried from plate to plate, and consequently their large area and thickness, which is necessary, and also the difficulties connected with the accurate weighing of these very heavy plates, are insurmountable objections. Still more difficult has it been considered to meter alternating currents, for they will neither deposit metals nor decompose liquids; and if any attempt is made to construct a mechanical meter retardation is set up against the current to so great an extent in the coil or coils necessary to control or act as a motive power to suitable mechanism that here again insurmountable objections are met with. But it is the very fact of this inability of the alternating current to deposit metals or decompose liquids, which has hitherto been considered fatal to any system of meterage, which enabled Messrs. Lowrie, Hall and Kolle, the inventors of the new system herein described, to form a most efficient and reliable method of electro-deposition meterage. This new system is the differentiation of the main or alternating electromotive force. This desired effect can be brought about in many ways, the one used now by Messrs. Lowrie and Hall in their house-to-house lighting system at Eastbourne being by the introduction of a constant electromotive force into the said main or alternating circuit, which, whilst it reinforces the main electromotive force in the half-alternation in a direction positive to it, retards it in that direction which is negative to it, so producing a subsidiary or resultant extra current to the main or alternating current in that half-alternation which is positive to the constant electromotive force. This subsidiary current must be necesarily exactly proportional to the main current, or, what is the same thing, to the resistance of those appliances in which the electrical energy is expended. Thus, by putting a deposition cell in series with the source of the constant electromotive force, the amount of deposit will become available as a current measure. So that the fact of the current being an alternating one allows the use of a deposition cell (when the addition of a constant electromotive force has been made), for where, as before pointed out with a continuous current, the passage of copper would be excessively large. By the application of this invention to an alternating current this passage may be reduced to a minimum so long as it remains sufficient for a practical measurement, for this said passage depends alone on the magnitude of the subsidiary electromotive force.

Having now described their method of obtaining an alternating current, in which the maximum current in one half of an alternation is greater than that in the other half in the opposite direction, we will proceed to describe the practical method of obtaining from it the efficient method of meterage at present adopted by Messrs. Lowrie and Hall, and to give a detailed description of the appliances and also the methods of obtaining constants, &c., and other matters appertaining thereunto. The main is severed as it proceeds directly from the dynamo, converter, or other source of electrical energy to the lamps or other appliances in which the energy is expended, and the meter put across the break, so that the entire current which has to be metered passes directly through it. The current on entering the meter passes through a secondary cell, whose electromotive force = 2 volts, so producing the necessary differentiation in the positive and negative directions in half of an alternation. That is to say, that supposing the electromotive force of the dynamo or converter to be 100 volts and the mean current to be 10 amperes, then in the half-alternation positive to the constant cell at its maximum point, total electromotive force = 202 volts, therefore the maximum current $= \frac{202}{10} = 20{\cdot}2$ amperes, while in the other half-

* Paper communicated by Mr. W. H. Preece, F.R.S., to the British Association meeting (Section G) at Bath, September, 1888.

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alternation total resultant electromotive force = 198 volts, therefore the current = $\frac{198}{10}$ = 19·8 amperes, so giving an effective current of ·4 amperes. But this current lasts for only one-half of an alternation, in the same way that an alternating current does, in consequence of its necessary fall from its maximum positive point to a neutral point in order to rise to its maximum negative point, so that, although at its maximum point the effective current = ·4 amperes, yet its average current is only ·2 amperes for all the time, or, which is the same thing, a current due to 2 volts only. So it is evident that the resultant current may be considered as one merely resulting from 2 volts constantly acting through the circuit resistance. The application of this effective current takes place in a depositing cell, which is a cell in which the electrodes are of copper, alternately connected together, and the solution a slightly acidulated saturated solution of recrystallised sulphate of copper in distilled water.

The meter exhibited is one for a twenty 16 candle-powder 100-volt lamp installation, or for a maximum current of 12 amperes, the area of the plates being 48 square inches, giving an area of 4 square inches per ampere, which, with the strong solution used, gives a resistance quite neglectable.

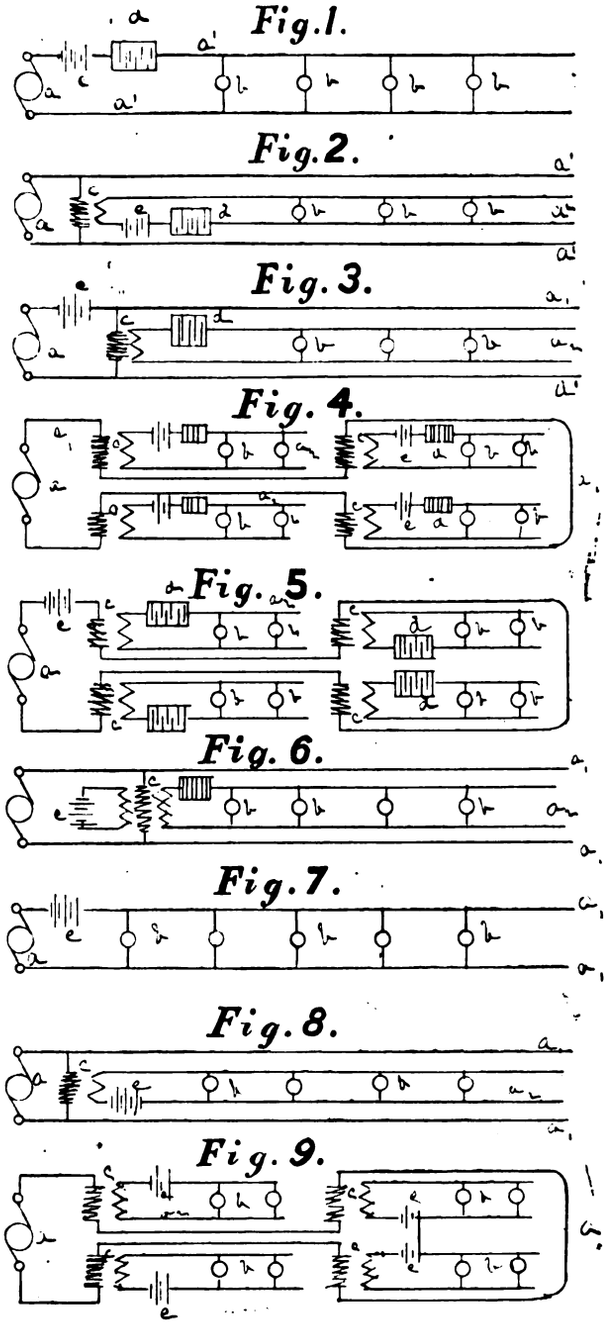
The capacity of the secondary cell is to register 400 units without recharging. The depositing cell is composed of an alloy unacted upon by the solution; the plates are kept at equal distances by distance pieces, by which, also, the connections are made between the alternate plates. They are also kept at equal distances by slots in vulcanite pieces supported by metal bridges, the exterior sides of the plates being coated with an insulating enamel, so that no deposition can take place upon them.

By an examination of the sample meter, a very simple method of removing the plates for weighing purposes, &c., without danger of injuring the deposits, will be seen; their removal being effected by releasing the nuts at the ends of the distance pieces and the plates slid out. The whole is contained in a cast-iron case, with the cover screwed down, the cables entering through insulating washers, the insulation of the secondary cell and depositing cell from the containing case being effected by an insulating frame.

To obtain the constants in the constant electromotive force and depositing cell system, take for example an electric lighting circuit with an electromotive force of 100 volts, and for a constant source of electromotive force a secondary cell of an electromotive force of 2 volts. Then with an alternation in a positive direction to the cell, total E.M.F. = 102 volts; and in a negative direction, resultant E.M.F. = 98 volts. So giving a difference of potential of 4 volts for half the time of an alternation, as before explained. Therefore, in so far as the chemical action is concerned, the electromotive force of the cell (*i.e.*, 2 volts) may be considered as working constantly through the resistance of the lamps. From this the constants of grammes per unit or units per grammes are easily arrived at thus:—In a 100-volt circuit with 10 amperes flowing work = 1,000 watts; and since resistance of exterior circuit = 10 ohms, therefore the subsidiary current from the secondary cell = $\frac{2}{10}$ = 0·2 ampere; therefore the effective quantity of electricity passing through the electrolyte, with 1,000 watts in exterior circuit for one hour (*i.e.*, 1 unit) = ·2 × 3,600 = 720 coulombs. Therefore, the constant for a copper deposition meter is during one unit of exterior work 720 × ·000327 = ·23544 grammes of copper are deposited.

The requisite capacity of the secondary cell is only one-half that of the capacity calculated from the number of ampere-hours required to deposit the copper. Since the discharging current, when the current is positive to the cell, is that resulting from 4 volts for half an alternation, more than 98 volts (*i.e.*, 2 volts from the cell × 2 volts from the dynamo), and on the negative alternation the cell is charged resulting from an E.M.F. of 98 volts. So that the charge of the dynamo neutralises the discharge, leaving a 2-volts discharge for only one-half the time. Given pure copper sulphate and distilled water and good copper, it is obvious that the meter must be absolutely accurate. But in consequence of slight impurities, which must necessarily occur, an error certainly of not more than 2 per cent. may be deducted, so giving an accuracy, under ordinary conditions, of at least 98 per cent.

The use of copper in the depositing cells is quite optional, as any metal and solution may be used by which any practical electro deposition may be obtained; copper, however, is considered at present by the inventors to be the most convenient and cheapest electrode. Various forms of self-reading or self-recording depositing cells are made, the usual form being a dial pattern, the needle of which is actuated by the alterations of the weights of the electrodes. Another form is that of a gas meter, in which the electrolyte is decomposed by the passage of the subsidiary current, a graduated gauge-glass enabling a consumer to see approximately what his consumption may have been.



In the following and other diagrams which will be described, a indicates the generator, a_1 the main circuit, a_2 the secondary circuit, b the lamps or other appliances in which the electrical energy is expended, c the secondary generator or converter, d the depositing cell, e a constant electromotive force.

Fig. 1 is a diagram of an electric lighting circuit coupled directly in parallel with the dynamo, as in the old low-tension

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system, with a constant electromotive force e, and the depositing cell d placed in the circuit, so that all the current which has to be measured passes through them. The differential action of the current causes an electro-deposition of metal by the influence of the electromotive force e on the alternating or main electromotive force, which being exactly proportional to the amount of electricity passed through b, becomes a measure of the same as before described. Fig. 2 is a diagram of a secondary generator or converter system in which the primary circuits are coupled in parallel, the primary circuit a_1 inducing currents in the secondary circuit a_2 by means of a converter c. The depositing cell d and the constant electromotive force e are placed in the secondary circuit a_2, thus becoming a measure of the current as before described in relation to Fig. 1. In a secondary generator or converter system the secondary cell may be introduced into either the primary or secondary circuit, the depositing cell being, in all cases, between the secondary coil of the converter and the apparatus in which the electrical energy is expended. Fig. 3 is also a parallel secondary generator or converter system, in which the electromotive force, e, is placed in the primary circuit a_1, and the deposition cell d is placed in the secondary circuit a_2. The differentiation of the electromotive force produced by the constant electromotive force e in the primary circuit a_1 is reproduced by induction in the secondary circuit a_2 by means of the converter, c. Electro-deposition results in the depositing cell, as before described. The diagram (Fig. 4) indicates several converters, $c\,c$, placed in series in the primary circuit, a_1, which induce currents in several secondary circuits, a_2 a_2, arranged in parallel with the appliances in which is expended the electrical energy. Both the constant electromotive forces $e\,e$ and the deposition cells $d\,d$ are placed in the said secondary circuits, and thus become a measure for the electricity passed, as described in the preceding figures in each individual secondary circuit. Fig. 5 is also a series secondary generator or converter system, having the constant electromotive force e in the primary circuit a_1, and the depositing cells $d\,d$ in each individual secondary circuit $a_2\,a_2$, the same differentiation of the electromotive force produced by e being reproduced by induction in the secondary circuits $a_2\,a_2$ by the converters $c\,c$, as hitherto described in connection with Fig. 3. Fig. 6 is a parallel converter system; the constant electromotive force e in this case is used in a separate winding of the converter c. This, in combination with the primary circuit a_1, produces by induction, in the converter itself, the differentiated current in the secondary circuit a_2, electro-deposition resulting in the depositing cell d, as described previously in connection with Fig. 3. We may mention that, to obtain this differentiation, instead of a secondary cell, a primary cell or a dynamo may be used, or any other means of obtaining the desired effect.

The following is an example of another method of meterage, and an apparatus connected thereto operating in the manner above mentioned, but using no deposition cell, the measurement being taken in the constant electromotive-force cell itself:—Let it be required to measure the current duration of a number of lamps in a lighting circuit. We place in the lamp circuit, and in series between it and the generator, an electrolytic cell, which comprises two dissimilar metals, placed in an acid or alkaline solution. When an alternating current is passed through this cell and the lamp circuit the passage or flow of the current is alternately retarded or reinforced by the normal electromotive force set up in the cell itself, which subsidiary electromotive force causes a wasting or loss of weight of the positive electrode. As the resistance of the lamps in the lamp circuit varies according to the number and kind used, and the duration of the flow of current through the same, so does the current vary in the cell which acts upon the positive electrode. This current is directly proportional to the electromotive force of the cell and the resistance of the lamp circuit; the wasting away of the positive electrode therefore becomes available as a current meter.

Fig. 7 is a diagram of a similar low-tension circuit to that described in Fig. 1, but without the deposition cell d. In this arrangement one of the electrodes of the constant electromotive force e loses weight proportional to the electricity passed through the lamp circuit b, and this loss becomes a measure of the same as before described. Fig. 8 is a diagram of a similar secondary generator or converter system as that described in Fig. 2, but without the deposition cell d. The electromotive force e in the secondary circuit a_2 has one electrode losing weight in the same manner as before described in the example of a low-tension system given in Fig. 7. Fig. 9 is another series converter system similar to that described in Fig. 5, but without the depositing cell d, the measurements being in this case obtained by the wasting away or deposition of the metal forming the electrodes of the cells $e\,e$, producing the constant electromotive force which causes the differentiation in relation to Fig. 7.

This differentiation may also be produced by mechanical means. One of these is the addition of a subsidiary coil upon the armature of the alternating dynamo, which is so arranged and commuted that it is cut out of the circuit during the second half of an alternation, or it may be so commuted that in the second half of the alternation its electromotive force is in the opposite direction to that of the dynamo, so giving double the differentiation of potential that it would in the other case. The current is commuted at the neutral point of the alternation, so that no high-tension break occurs at any time.

Another method is to pass the alternating current, through a solenoid having a magnetically saturated iron core, the result being that in the half-alternation positive to the direction of the exciting current no retardation takes place, whilst that in the negative direction is retarded. To this latter method, that described in Fig. 6 more properly belongs, except that in that case the exciting current is from the constant electromotive force e round the separate winding round the iron instead of round a separate coil having an iron core.

In a secondary generator or converter system, where differentiation is effected by these means, the same differentiation is reproduced by induction, and an electrolytic cell, or other means of measurement, is put in direct series between the converter and those appliances in which the electrical energy is expended. This also can be applied in the diagrams 1 to 5, the arrangements described being substituted for the constant electromotive force e.

ELECTRIC LIGHTING IN AMERICA.

In the Mechanical Section of the British Association on Monday, the 10th inst., Prof. GEORGE FORBES gave an address on "Electric Lighting in America." He said:—A visit to the United States of America shows one the enormous progress central station electric lighting has made in that country, and when we land again in England we are equally struck with the dimness of the lighting everywhere. In America there is not a single town I am acquainted with where you can walk through the streets at night without seeing abundance of arc lights in the streets—I do not mean in the chief towns only, but out-of-the-way places in the distant parts of the States where gas has not penetrated; there the electric light has fixed its position, and is being used frequently (applause). There is not only lighting but developments of electricity everywhere. A most curious paper was shown to me yesterday. It was the journal of a village in Alaska, and the same paper which treated in a scientific manner of the introduction of electricity for various purposes into the village also treated on the desirability of having laws passed to expel the Indians from the city at 9 o'clock every evening (laughter). At the time I was attending the Electric Light Convention at Pittsburg last February it was estimated there were 300,000 arc lamps being lighted from central stations in America. The progress, however, has not only been made in America of late years in arc lighting (it was a fact that especially struck Englishmen the way arc lighting had developed in earlier times; but it was thoroughly established there when the British Association were there four years ago), the progress that struck us most was the central station lighting for incandescent lights. At the time I am speaking of, February of the present year, it was estimated that there were two and a-quarter millions of incandescent lamps in use in the United States. The rate of manufacture has increased to my knowledge enormously since that short time ago. There are four or five manufacturing places in the States at this moment, each capable of turning out ten thousand incandescent lamps every day (applause). And I have no doubt the incandescent lamps in the United States are now to be counted by millions per annum. Of the incandescent central stations, there are two classes which attract our attention. Those upon the three-wire system, in which the current is supplied

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to the main conductors for the towns, and the lamps are connected by branches to the system of positive, negative, and intermediate mains. This system was largely adopted in the Edison central stations, which gave us the greatest interest—I think it was in the year 1884—when we were over in America, and they have continued to advance by the use of the three-wire system, which has developed to a very great extent indeed. But I feel quite sure that the greatest progress which has been made in central station lighting in America since the Association visited that country has been by the work which Mr. Westinghouse has done in that country (applause). Mr. Westinghouse has made his name famous by increasing the safety of electric lighting, and by in all parts of the world introducing the railway brake that bears his name. He saw the results which had been attained by Gaulard and Gibbs by alternating currents, and distributing the electric light by means of that alternating current of very high tension; that it could be passed over conductors in the streets, the conductors being of thin diameter and cheap construction; and that at the consumers' premises this high-tension electricity could be reduced in tension by means of converters on the induction principle, and passed into the houses at a harmless pressure, and suitable for the ordinary incandescent lamps at present used. I cannot fail to take the opportunity presenting itself to me to say what I feel of the energy and determination by which Gaulard and Gibbs, in spite of adverse criticism, persevered and continued to improve their invention, and proved to the world it was possible to have a commercial system of lighting by means of these converters. Mr. Westinghouse, on seeing this system, took it up, and the result is that he has established in the course of a few years an enormous business in central station work. It is now a possibility in America—not a possibility only, but a daily occurrence in America—for a town to write an order for a central station to be sent at ten days' notice. They do not order a dynamo, mains, and a set of conductors and other apparatus independently, but complete central stations are now being sent out from Mr. Westinghouse's factory at a stated and uniform rate. In December of last year, some of the manufacturers of incandescent lamps drew up a long list of the number of lamps used in different parts of their country, and I have abstracted from it some notes which show me in December of last year Mr. Westinghouse's alternating-current plant was supplying 153,285 lamps, occupying 152 distinct sets of plant, and there were forty-two sets of this plant of more than a thousand lamps each. At the present moment there are central stations being supplied by this apparatus. It has been said that in this country we do not go ahead so much as in America. Theories have been suggested for it. Prof. Ayrton's most admirable reason seems to go a long way in explaining it—viz., we have two definitions of inertia, one English and the other American. The English definition is resistance to motion, the American resistance to stopping (laughter and applause). In electric lighting we have been stopped a great deal by that, I was going to call it, iniquitous Electric Lighting Act (hear, hear, and applause). I regret extremely in the interests of the public, and of electric lighting generally, an Act has been passed this year which has not yet put electricity on the same footing as gas. It is a matter of extreme regret to all those who have learned the benefit of the electric light that that Act should have been passed (hear, hear), and so the due recognition of the value of the electric light has been delayed (hear, hear). I do not think the Electric Lighting Act is the only thing that has delayed our progress, because I see in electric traction and other developments of electricity the Americans have gone ahead a very great way indeed. I certainly do not put it down to want of capacity on the part of our manufacturers. The best dynamo machines are ordinarily designed in England; the best arc lamps we have are made in England; but while this is so in England, in the States they are determined, as long as they have something which they know will work well, to make it work till something better is produced. It is not in this that the want of English progress is to be found, but in men of capital who are also technically instructed (hear, hear). It is the extension of technical instruction among the moneyed classes which has developed engineering enterprise in America so much. I will now try to describe some of the leading features of the Westinghouse central stations which I visited, and perhaps this may be of use in helping us to draw some conclusions as to the lines on which we are to be developing in our own country. I do not in the least wish to say American arrangements are the best. In many points I see objections, and there are many places where I wish to see improvements; but we have in the system I am going to describe thoroughly successful working arrangements, and although we in this country may not adopt in all points such arrangements, still, I feel it would be of use to us to learn what is being done on the other side of the water. It is a curious thing, for example, in America there is no work hardly being done with accumulators. There is an example in which we lead the way, as compared with the Americans. I was struck with this in 1884, and still more in the present year. Accumulators do not seem to work in the American atmosphere. At any rate, people had been importing numbers of them, and yet they were not recognised as the satisfactory apparatus which we have thoroughly come to consider them in this country. They are looked upon as uncertain as they were four or five years ago with us. The system, then, chiefly depends on apparatus called by the name of a secondary generator, transformer, or converter. It is simply an induction apparatus, with two coils—a primary and a secondary. The primary coil, in contradistinction to the ordinary induction Ruhmkorff coil we have known so much, is of high resistance, a large number of turns of wire; while there is a very small number of turns of wire in the coil of the secondary part, which goes to the lamps. The alternating current produces induction; in passing through the primary coil it produces induction which re-acts upon the secondary coil, there being produced an induced current of lower tension going into the houses. The two coils are completely separated, and when properly constructed it is quite impossible the high tension can ever reach the secondary circuit. Consumers of electricity have nothing to fear from a dangerous potential being distributed from the central station; the wires in the houses are perfectly insulated from it. The wires from the central station are carried generally on poles; there are feeders to the separate districts. The converters are generally attached to the outside wall of the house to be supplied, but are often attached to the poles carrying the feeders. They are sometimes placed inside the house. The secondary wires inside the house, to which the lamps are attached, are laid in the usual manner, and connected with the secondary poles of the converters. The dynamos run day and night without cessation. We hear a great deal about the impossibility of running machinery day and night without breakdowns. I cannot help saying (endorsing the opinion that I have found existing in America) that this scare of danger has been greatly exaggerated in this country. When we see our huge ten thousand and fifteen thousand horse-power engines travelling over the ocean, with all their eggs concentrated in one basket, and performing the journey, lasting days and days, and even weeks, without a breakdown, it seems absurd, when we are able to subdivide our power, as in a central station, there should be any serious danger of a breakdown in a properly organised central station. As a matter of fact, I assure you under the American plan of running without accumulators, central stations have been running for years and years; it is of the utmost rarity that such an accident happens as to stop the general lighting. It occurs *very* rarely indeed. The Edison station, which has been running so many years, has only once broken down, and that was an accidental occurrence owing to the current being turned on too greatly on a foggy day. That was the only time when the current has been interrupted and there has been a breaking down. And every station reports the same thing. The one view in America is undoubtedly that there is no danger of breaking down in a properly organised station, with a proper number of dynamos, and plant and apparatus well laid down. It happens that in the department of furnaces and boilers there is much of special interest in many of the Westinghouse stations. This arises from the fact that over a great part of Western Pennsylvania, nature supplies fuel as natural gas from wells in that region, and it is carried in pipes to a considerable distance. But this is a circumstance so peculiar to the district it requires only a short notice here. I was surprised to learn from Mr. Dowson (Mr. Dowson read a Paper at a previous day's meeting on "Gaseous Fuel") that he did not expect to use fuel gas for heating the boilers of steam engines. In Pennsylvania it has been found so valuable a fuel for boilers there that it has been determined in many outlying districts to supply fuel gas for this purpose in preference to using coal furnaces. The gas, with its due proportion of air which produces the high temperature of a Bunson burner, is admitted by pipes with a sufficient number of nozzles into the combustion chamber and subsequently passes through the tubes of the boilers. The gas is nearly free from carbon; the hydrogen, which is paramount, undoubtedly weakens the iron of the boilers, but practice showed that this action does not go far, and the iron acquires a final condition in which it does not deteriorate, but seems capable of indefinite use. In the best stations the admission of gas and air to the furnaces is regulated by means of a valve controlled by a lever, which in its turn is subject to the pressure of the steam in the boiler. The combustion is proceeded with at a rate which depends on the pressure in the boiler, and the pressure in the boiler is automatically kept constant in 24 hours. The attendance of one man to a station of several thousands of horse-power is quite sufficient. As to the steam engines I need not say much. I do not know that the Americans can teach us anything in steam engines. I may say there are some points in connection with the class of steam engines to be used which are of importance. It has often been thought it would be desirable to introduce economical engines of large type, such as our marine engines, in central station lighting. Practical experience has hitherto decided the question in an opposite manner. It is found to be more economical and safer to have a number of dynamos in a station which are driven by separate engines of high

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speed, the power being in America always transmitted to a belt with no counter-shafting. On the question of subdividing power there should be no doubt at the present moment. It has been proved over and over again by experience. It does not seem probable at first sight a number of independent engines could be more economical than a single one. The explanation lies in the special conditions of central station lighting. It is only necessary to observe that the maximum load in a lighting station is many times as great as the average load. Thus, if a single engine is adopted for the maximum load, it is working unloaded during a great part of the 24 hours. The consumption of steam to the power developed is very high, and the engine is not an economical one. With independent engines none need do work much under its best load, and when the load increases other engines and dynamos can be switched in, and are always worked at or near the best economical conditions. Twenty per cent. more work is required where counter-shafting is introduced; the load of the engines and dynamos is sometimes only one-eighth the maximum load. It was found desirable to use an engine whose economical load is somewhat under its maximum load. Additional power is speedily added. A breakdown of an engine or dynamo does not stop a station. One of the most annoying accidents in electric central stations—in fact, *the* inconvenience—is that due to the short-circuiting of the mains. The more so is that the case in American stations in which conductors are all passed overhead. It frequently happens through the falling of broken telephone wires on the mains. In this case a small independent engine is brought up, and no damage done. With a large engine, and the whole network of conductors connected with it, the dynamo grinds on, and may be destroyed unless the cause of the short-circuiting is burned up. Now, a word or two about dynamos and converters—the actual apparatus used in America. I attribute a great deal of manufacturing success of American electric lighting plant to this—when they have fixed upon types of machines they are going to make they stick to these lines, and lay down machinery which will enable them to produce these types cheaply, and having thought out a system thoroughly in the beginning they do not require to make a completely new type of machine for every order that comes in. They are thus able to manufacture machinery cheaply, and in such a way that every part is replaceable. At this moment I confess if I had to choose between two dynamos of which one was a little better than the other in efficiency, but one was manufactured in this manner and the other to a special design, I should be very much inclined to lean in favour of the one which is made by machinery, and of which all the parts are interchangeable, and of which I could get any one of the parts by return of train on telegraphing for it. The convenience of working is much greater. I have, for the benefit of those who are electrical engineers and manufacturers here, put down the facts in connection with the three types of alternating dynamos used in Mr. Westinghouse's works:—

DYNAMOS.

Type.....	1.	2.	3.
No. of lamps	650	1,300	2,600
Current	35	65	130
*Resistance armature	·76	·37	·15
*Resistance field	14·5	7·0	3·6
Lbs. of wire (armature)	17	30	60
Lbs. of wire (field)	420	—	—
Total weight ..... in lbs.	4,800	9,000	—
Volts.....	1,050	1,050	1,050
Revolutions per minute.....	1,600	1,000	1,000

* At 30° Centigrade.

No. 3 has an armature about 2ft. in diameter and 2ft. long. It runs 1,000 revolutions per minute. The weight of the armature is 200lb. I need make but little reference to the figures. The voltage is the same in each case, but the number of lamps varies—650, 1,300, 2,600. In this country there is a tendency to use a higher voltage—2,000. In Westinghouse's system they use 1,000 volts at the converters. Mr. Westinghouse's system reduces the electrical pressure in the same proportion as has been most general in Europe—in the ratio of 20 to 1. The 1,000 volts in America is reduced to 50 in the lamps. In this country 2,000 volts is reduced to 100 volts in the lamps. Here there arises a question which must be decided immediately now central stations are being put down in this country—what electric pressure you are going to use. The advantage in the higher pressure is that you are able to save the copper to a very large extent indeed while we are able to use lamps of only 50 volts instead of 100 volts. This is looked upon by Westinghouse as the greatest advantage gained by the introduction of the Gaulard and Gibbs system—that he is able to use lamps of 50 volts instead of 100 volts. The higher the voltage of the lamps the shorter their life, and a 50-volt lamp is a far more perfect thing than a 100-volt lamp. We are greatly troubled with the expense of lamps compared with their life. This is a serious item in the general supply of electricity, and a 50-volt lamp appears the more economical one. Electrical engineers will attach to this point an importance making it worthy of consideration. It may even be said we ought to go still further, and reduce the voltage still more. There is another point which will occur to the electrical engineer, whether it is not desirable to use the lamps which the Bernstein plan perfects—that class of lamps of low voltage placed in series in houses. One of the most serious difficulties of introducing electric lighting central stations is the cost of the wiring of the houses. By putting lamps in series the cost is much diminished, and it becomes a question of this—will the difficulty of cost not be prevented occurring by the beautiful device of Bernstein? The primary current of the converters would be put in series in the same way as originally proposed in the Gaulard and Gibbs system, and we should then be doing what they were striving to do in the series arrangement: not to have two primary terminals inside a house at a potential—1,000 to 2,000 volts—that is dangerous. In the house there would be no two conductors of a greater potential than 50 or 100 volts. If at the same time we are using the low-volt lamps we should still have the long life to lamps that Mr. Westinghouse has attained; there are grave reasons for considering an arrangement of lamps in series—of primary coils in series. I am not here to put forward suggestions on what we may do in England; I only wish to tell you it is being done in America. I wish to guard myself against saying that they have the best arrangements at every possible point. I think the construction of the Westinghouse dynamo is pretty well known in this country, and it is needless for me to speak of it. Probably we are agreed the old type of alternating dynamos has probably seen the end of its days. It will not be likely to be constructed in that manner very much longer. One of the chief difficulties seems to be when you have a large number of coils revolving in the space between the poles you are obliged to make a considerable clearance, and that causes you to use great power. I am speaking to electricians just now. Mr. Westinghouse makes a small clearance only, and gets an advantage in that way. Part of the perfection of his dynamos—it is very good—is obtained by the extremely good insulating arrangement. Mica is chiefly used. Shellac is given up altogether, and they use copal coach varnish with linseed oil, which I am told is a splendid insulating material, and I have heard from one or two gentlemen in this country since I mentioned it to the Society of Telegraph-Engineers it has been tried with great success. I will not, then, speak any more about dynamos, details of which can be obtained elsewhere. I now put down the type of converters which are used by Mr. Westinghouse. There are only five types used—5, 10, 20, 30, 40 lights.

CONVERTERS.

Converter	1.	2.	4.	6.	8.
Number of lights.....	5	10	20	30	40
Wire on primary	25	22	19	17	16
,, secondary ..	11	8	8	8	7
Turns on primary	900	700	480	400	560
,, secondary ...	45	35	24	20	28
Resistance primary ...	4·8	21·9	9·9	7·	5·
,, secondary..	·04	·043	·0197	·0176	·0107
Weight finished ... lb.	50	60	95	—	160

Thickness of iron plates ·006 to ·0065in. Paper insulation ·0025in. Number of plates in No. 8 converter, 1,350.

In this country there has been a tendency to make converters much larger, but for ordinary use in houses I must say I think Mr. Westinghouse's system seems to be simplicity itself, more especially as we find it necessary in our houses to wire the houses in such a way as would suit our meters. Our meters at the present time can, however, range from one lamp to a dozen lamps, or even to fifty lamps. Probably, for this reason, Mr. Westinghouse has determined the size of his converters in the way he has. There are some points about them worthy of attention, in which they differ from the English ones I have seen. In the first place, by the use of one thousand volts a far cheaper converter is made, and there is great safety in the plant required for a house. It is so much cheaper to make a thousand-volt converter. Then, again, the number of alternations—the rapid alternations of the Westinghouse plant. There are 16,000 alternations per minute. In this country there has been a tendency to make the alternations less than that. We know the iron you are obliged to put in a converter depends on the number of alternations. The greater number of alternations the less iron, and the quantity of iron affects the resistance. You are able to use a much smaller converter by the higher number of alternations. The only thing is if you have a smaller number of alternations the construction of the dynamo becomes easier, but it takes up more space, and the converter is larger. The iron which is used in the converters is Welsh Taggard iron. In the use of these converters 50deg. Centigrade is the maximum rise in temperature allowed. Mr. Westinghouse

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asked me to make some tests of the efficiency of his converters. It is supposed the converters have not a high efficiency when working at half load. I may mention the efficiency I have found varies very slightly in the different types, owing to the iron being better in some than in others. Mr. Westinghouse in some converters is able to get at half a load 95 per cent., which is a splendid result, and, I think, is a greater efficiency than most people have considered to be possible. I do not think we need trouble to consider the average waste of efficiency in the use of converters when properly designed as more than 10 per cent. I must also say that Mr. Westinghouse has got in his lamps 600 watts developed for the brake horse-power by his engine; that is a very good return for these alternating-current dynamos, and it shows the alternating-current dynamo is to-day much superior to the older one. The wire is nearly all overhead in the States, and this, of course, differs from what we want to do here. The wire which is used in the streets is called simplex wire. It is made by a firm in Boston. Ought the conductors to be merged into one heavy main with all the dynamos feeding it, or should the mains be divided with several to each dynamo, or ought we to have intermediate arrangements? These points we must settle in future. I do not express any opinions now. The experience of the Westinghouse Company leads to the subdivision of the mains as much as possible, because the short-circuiting of the mains leads to only one dynamo being affected. The chief trouble of the mains is short-circuiting, and by limiting the range of the district over which that danger exists much security is added to the general system. Whether alternating dynamos do good work in parallel—can we put a number of dynamos on to one main? This is another question. It can be done. It is interesting to see the way in which it is done. One dynamo is working a main, and we wish to switch on another dynamo. Both are set to work, and the two wires to be attached to the same wire of the main are so connected that the current is passed through little connecting terminals of the two dynamos in such a manner that the phase of one dynamo is exactly the same as the phase of the other; the lamp goes out because the two lamps are connected both with the positive or negative conductor. Then when we are wanting to switch in a second dynamo, we watch this lamp and it goes through the phase of brightening, dimming—brightening, dimming—as the phase of the two dynamos coincide and come into opposition. You have simply to take the switch and practise with your hand to get the time, and when you have the time you switch it on when the lamp is out, and then you have the two dynamos working perfectly in unison. But the answer to the question whether dynamos would work in parallel is not quite complete. They work successfully when fully loaded, but when doing less than half load they do not work in parallel well, they are very troublesome. As a matter of fact, the tendency of the Westinghouse plan has been to subdivide the mains as much as possible, and put several different feeders on to one dynamo. There are several conclusions one may draw as to what is likely to be the practice in this country, but I would rather not deal with that question. I have no doubt there are many gentlemen here who will speak as to the practice in Europe on the subject—in the way of alternating-current distribution. There is one thing which will probably be spoken of—the high speed of the Westinghouse dynamo. I believe there is a needless opposition to high speed amongst engineers in this country. High speed is dangerous, undoubtedly, if it tends to disruption on the part turning at high speed. But if we have a perfectly uniform cylinder of iron revolving, I have no objection to turning at any speed as long as I know the shaft will not give way. The Westinghouse dynamo, from its construction, is capable of turning at the high speed indicated without any serious danger (applause).

After the address by Prof. Forbes, a Paper by Mr. Edmunds on his system of distributing electricity was read, and Mr. Lowrie's Paper on "The Measurement of Electricity in a House-to-House Supply" followed. The three Papers were discussed together.

DISCUSSION.

The PRESIDENT (Mr. Preece) said he knew Mr. Lowrie's arrangement was in use, but it had been kept very quiet. It was rather a novelty if he understood its action aright.

Sir WM. THOMSON acknowledged the great advance made in electric lighting in America, and said their own country had been very slow in obtaining practical results such as were obtained in America. Glancing at the two systems—the alternating-current plan and the constant-current system—Sir William said one way of carrying out the direct-current system was to use accumulators to allow high-potential current to be carried by small wires to a distance, and to distribute the supply to the public by dividing the accumulators. It was possible one system might prevail for a time, and another system prevail ultimately. Lamps had become such a comparatively small part of cost of a system of electric lighting, that the durability of a 50-volt lamp would not be the determining reason that would lead to the adoption of that standard. He believed in other respects 100-volt lamps had advantages. It seems quite probable also that lamp makers, if asked with sufficient urgency to do so, will succeed in making 8-candle 100-volt lamps, which shall be at least as durable, with the same number of watts per candle, as any 50-volt lamp or 100-volt lamp hitherto made.

Mr. E. P. SELLON, as a manufacturer of incandescent lamps, said there was no doubt the lower E.M.F. lamps had a longer life than the others, and that their first cost was more economical.

Mr. S. WALKER said the earlier forms of incandescent lamps were not reliable. Defects had now, however, been got rid of, and 100-volt lamps were as good as the other. He thought they had far better save their copper and use a 100 or even 200-volt lamp. They could not help acknowledging the skill and energy shown in America in electrical work.

After further discussion,

Prof. FORBES said: Before I pass on to answer the questions raised on my own communication I would like just to make one remark about Mr. Lowrie's Paper, "On the Measurement of Electricity in a House-to-House Supply." Where Mr. Lowrie spoke of meters he says hitherto the waste of energy has always been too great, and that automatic current meters have not been successful. I cannot let that statement go unchallenged. There is an automatic current meter which has worked extremely well—a meter I showed the Association last year. In reply to Sir William Thomson, I would say no one must think because I have been speaking of the alternating current I am advocating it. I am not wishing to advocate anything the Americans adopt. I merely wish to lay before you what is being done in America, and not that it should be looked upon that everything there is right by any means. I think we should do a great many things ourselves, and improve on the American system. I quite agree with what Sir William Thomson says about accumulators. I always felt that they were very desirable when they had the qualities they now possess. They are now working extremely well. They have fulfilled the conditions, as far as was required, very well; but still are far too costly, unfortunately, and I hope within a short period we shall be able to have the cost reduced. Sir William Thomson has asked me about the working in parallel of the alternating-current machines. Of course it was known by Mr. Wilde they could be run in parallel. I know in the old days in the Grosvenor Gallery it was tried with Siemens' machines; dynamos were run with different belts from the same engine, and could not be got to work in parallel. The Westinghouse dynamo can work in parallel, and several others. Dr. Hopkinson had shown in his Paper read before the Civil Engineers Institute that it can be done. The self-induction machines run better altogether than those which have not much self-induction, and that is, I think, one reason why Mr. Westinghouse's runs well and Mr. Siemens's did not. The machine I have described having been once started in unison, as I stated, will keep in unison, the belt slipping slightly if one goes too fast. It is the slip of the belt which allows them to check each other if the engines do not run perfectly. At the same time the check is much greater when the maximum current is passing through, and it is only when they are doing a good deal of work the unison is perfect. If much under half-load they get out of synchronism. This is shown by the lamps flickering; the electromotive force of the two dynamos would in that case be nearly opposing each other sometimes. There is, I assure you, no difficulty in running in parallel.

Mr. KAPP: There must be a period when the lights are out.

Prof. FORBES: No; you may put on one dynamo and take off another without hindrance. The Alleghany River separates Pittsburg from the town on the opposite side of the water, and when one centre is hard up for electric current it is helped by power being switched on on the opposite side of the river. Then the question comes up about the 100-volt lamps being preferable to the 50-volt. I will not express any opinions, seeing there are various opinions about it. I will leave it to public discussion elsewhere. In America it is believed the durability of a lamp is much greater with the smaller potential. As to the insulation in the converters, I am sure it is impossible to have connection between the primary and secondary coils. The converter does not get so hot that you cannot put your hand on it. I mentioned that 50deg. Centigrade rise is allowed.

Mr. PREECE (President), in thanking the readers of Papers, said he thought too much blame must not be put on the 1882 Act, which had not in any way interfered with the action of corporations. The fact was there was so much about electrical systems that was unsettled that corporations did not see their way clear to risk the money of the ratepayers (applause). He should recommend a strong committee of the Society of Engineers to consider the question of 100 or 50-volt lamps, and as to the different voltages, so as to have some uniformity arrived at. He believed Mr. Edmunds's system would compare very favourably with other systems.

Sir William Thomson on the Objects of the British Association.—In a letter to *The Times* this week Sir William points out that the object of the Association "is the advancement of science. It contributes to this object in a manner altogether peculiar to itself, by bringing together from all parts of the world persons engaged in scientific investigation, and giving them facilities for helping one another in their work, and being helped in it by what they see and hear. No one not following the course of scientific progress, generally or in some particular department, can fully understand how much of practical impulse is owing to the British Association for the contributions made in the course of the year to the scientific societies and magazines, in which achieved results of scientific investigation are recorded and published."

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BRITISH ASSOCIATION.

DISCUSSION ON LIGHTNING CONDUCTORS.

On taking the chair in Section A of the British Association, on Tuesday, September 11, 1888, Prof. FitzGerald called upon Mr. W. H. Preece to open a joint discussion with Section G on lightning conductors.

Mr. W. H. PREECE, F.R.S., said it was a most remarkable thing that if they wanted to know much about atmospheric electricity and its effects they would have to go back to the works of Benjamin Franklin, 140 years ago. Scarcely anything in this direction had been done since then. Up to the year 1881 there was not even a code of rules extant in the United Kingdom to guide people in protecting their buildings from the destructive effects of atmospheric electricity. It was proposed in 1878 to establish a conference of various societies to discuss the effects of atmospheric electricity, and to form a code of rules for the erection of lightning conductors. All the manufacturers in this country, all the architects who were members of the Institute of British Architects, and the whole of the press of this country, were invited to assist the conference. The conference divided itself into several sections; all works, English and foreign, were examined and abstracted, all rules and regulations then published were compared, and at the York Meeting of the British Association in 1881 a report was adopted. The work of the conference was collected and published; and there existed at the present moment, published by Spon, in Charing Cross, one of the most admirable works that ever had been collected on atmospheric electricity and its effects. If anybody really wanted to know what to do they could not do better than obtain that book, because they would find there the work of nearly everybody who had laboured in this field. This report was divided into three parts. In the first part was discussed the purpose which a lightning conductor is intended to serve; in the second part there was a statement of those features in the construction and erection of the lightning conductors, respecting which there had been or is a difference of opinion, and the final decision of the conference thereupon; in the third part there was drawn up a code of rules for the guidance of those who erect these conductors. The report itself was most decisive and most important; there was a true ring about it—the ring of men who knew what they had done, and what they were writing about. He could not help reading to the meeting, because it would form the basis of a good deal that would be said in the course of the discussion, how a lightning conductor was defined in the report. "A lightning conductor fulfils two functions; it facilitates the discharge of the electricity to the earth, so as to carry it off harmlessly, and it tends to prevent disruptive discharge by silently neutralising the conditions which determine such discharge in the neighbourhood of the conductor. To effect the first object a lightning conductor should offer a line of discharge more nearly perfect, and more accessible, than any other offered by the materials or contents of the edifice we wish to protect. To effect the second object the conductor should be surmounted by a point or points; fine points and flames have the property of slowly and silently dissipating the electrical charges; they, in fact, act as safety valves. If all these conditions be fulfilled, if the points be high enough to be the most salient features of the building no matter from what direction the storm cloud may come, be of ample dimensions, and in thoroughly perfect electrical connection with the earth, the edifice, with all that it contains, will be safe, and the conductor might even be surrounded by gunpowder in the heaviest storm without risk of danger. All accidents may be said to be due to a neglect of these simple elementary principles. The most frequent sources of failure are conductors deficient either in number, height, or conductivity, bad joints, or bad earth connections." The paragraph ended with this most decisive and clear assertion—an assertion that he was there to defend—that "there is no authentic case on record where a properly constructed conductor failed to do its duty."

They had there defined the functions of a conductor, and lest it should be thought that the conference had neglected the teachings of modern theorists it would be only right to point out that it was asserted in the report "we will assume the conductivity of equal lengths and weights of iron in the case of steady currents of electricity," and, further on, "that the suddenness of lightning discharge modifies the conductivity." This report was signed by Grylls Adams, Ayrton, Latimer Clark, E. E. Dymond, Carey Forster, D. E. Hughes, Hayter Lewis, W. H. Preece, G. J. Symons, and John Whichcord. They all had had a great deal of experience in the performance of lightning protectors. He, personally, had now under his supervision at the present moment 500,000 lightning conductors, and throughout the Post Offices of this country their apparatus was protected by about 30,000 or 40,000 lightning protectors. If 500,000 lightning conductors and about 40,000 lightning protectors were not sufficient to give a man a little experience, what would give a man that experience? (applause).

A gentleman of the name of Mann—Dr. Mann—had practised the protection of buildings by electricity to a very large extent in South Africa, and had made himself much associated with the introduction of the system. He was an active member of the Society of Arts, and in order to commemorate his memory his widow gave a sum of money to the Society on condition that they gave lectures on some subject in which he was interested. The Society at once thought there was no better subject than atmospheric electricity, in which Dr. Mann took so much interest, and they had no hesitation in selecting as their mouthpiece for that occasion one who had lectured in that hall with great effect, and whose power they were all prepared to bow down to; that was Prof. Oliver Lodge (loud applause). Prof. Lodge was selected to deliver lectures at the Society of Arts to crack up or eulogise the report of the conference (laughter). But they had produced, he was sorry to say, a veritable Balaam, who rode upon the British Ass, and instead of going there to bless, he ended by cursing the work of the conference (renewed laughter). If all the vaticinations of Prof Lodge were true, the work of that committee and the work of the last 140 years would be useless—no lightning protectors could possibly protect, and no discharge could possibly be led to earth.

These were strong assertions. He thought that Prof. Lodge had in his Papers before the Society of Arts,* and in his Paper published in the *Philosophical Magazine*,† committed certain fallacies which it would now be his (Mr. Preece's) duty to bring before the Association. In the first place Prof. Lodge assumed that a lightning rod formed a part of a flash. Well, it did not; nobody had ever seen, to his knowledge, a flash of lightning strike a conductor. The function of a lightning conductor was to prevent the possibility of its being struck by a flash, and if it were struck by the infinitesimal part of a flash then, he said, that the lightning protector was not a lightning protector; it had some defect in its construction that ought to be remedied. But supposing it did, then the lightning protector would form but a very small portion indeed of the path of a lightning discharge from the cloud to the earth. A great deal depended upon the height of thunder clouds. They saw in text-books ridiculous assertions about the length of lightning flashes. Now who could measure the length of a lightning flash? There had been several extremely accurate measurements of the height of thunder clouds. In South Africa Dr. Mann measured them, and his measurement made the height 650ft. The most accurate measurements had been made by M. Lacoine, an eminent Frenchman, in charge of the Ottoman telegraphs in Constantinople; he made the height of a thunder cloud and therefore the length of a flash about 325ft. There were these two measurements which he believed to be accurate. During the past summer months he had been rusticating and enjoying himself amongst the mountains of North Wales. He saw there several thunder clouds, but he saw no lightning. He took several fiducial marks there upon the mountains; he had the 500ft. line and the 1,000ft. line and the 1,500ft. line in his mind's eye. All those thunder clouds seemed to be 500ft., and he felt almost certain that nearly all our flashes of lightning do not average more than 500ft. In consequence of the researches of Sir William Thomson and of measurements made by Dr. Warren de la Rue and Hugo Müller, the striking distance across the layer of air for steady currents in one direction was pretty well known. It was something like 30,000 volts per centimetre, or somewhat approaching that—he did not quite remember the exact number. Now, if a flash of lightning were 500ft. long, and it varied directly as the striking distance, then Prof. Lodge's measurements as given in his Papers would be fairly accurate. But there was every reason to believe that the striking distance did not vary directly as the length, especially in the case of alternate currents which were modifying their conceptions in every direction of the action of electricity. Mr. Acheson, in America, had been making some very careful observations on the striking distance across air when currents were produced by transformers, and he made out that the striking distance varied not directly, but as the cube of the electromotive force into the capacity.‡ If that be so, then it would follow that the electromotive force forcing a current of electricity through the air and producing a flash was very much less than they had hitherto considered it to be. Again, a flash of lightning always goes along a path that has been prepared for it; a flash of lightning does not go fooling about waiting for a convenient house to strike (laughter); it does not come down upon a flagstaff or a telegraph pole or an unfortunate horseman with a sudden rush. Experiment, as well as theory, gives indications that wherever lightning flows there some preparation has been made for its passage.

There was next an assumption made which he also considered to be a fallacy, namely, that a flash of lightning is instantaneous. They all knew the experiments that were made to show revolving wheels—the spokes of a revolving wheel suddenly appeared whenever a spark passed, and most of them believed from this that a flash of lightning was really instantaneous. There was no proof of its instantaneity. What they saw was the flash, which was merely a flash of light indicating the path. How long the current lasted they could not tell. But there are dark and invisible flashes, if he might so call them. There are dark and invisible charges of electricity, and there are cases on record where people have been struck and killed underneath trees where no light of any kind whatever has been seen.§ He argued on the non-instantaneity of lightning flashes from their effects on telegraph wires. We had spread all over this country an enormous network of telegraph wires, and whenever a lightning flash took place anywhere some wire was sure to be affected somewhere, and wherever lightning took place it might not strike the wire—it sometimes did, but whether it did or did not apparently does not make very much difference in the effects observed, for they always got currents of sensible duration. Take the case of ships. Ships have often been struck, especially when their lightning conductors are a little defective, and there it had been observed—he would not say invariably but frequently observed—that the compass needles were turned about and went playing about whenever the ship passed through an electric storm. It was quite impossible that the compass of a ship which had a very slow rate of vibration could be deflected or turned round unless there be a considerable duration in the flash. That was a point on which the photographs taken would give a considerable amount of information, and he hoped that Mr. Abercromby would show them some of the beautiful photographs he had collected.

* See *The Electrician*, June 22nd and 29th, July 6th and 13th, 1888.
† See also *The Electrician*, August 10th, 1888.
‡ See *The Electrician*, August 24th, 1888, p. 490.
§ See *The Electrician*, August 10th, 1888, p. 431.

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He now came to, perhaps, the hardest nut to crack of all in the questions they had to discuss, one that he approached with a certain amount of diffidence, because it was supported by very high authorities, and that was the assertion that a flash of lightning is oscillatory in its character—that is, that it does not flow straight from the cloud to the earth and then disappear, but that it goes slashing backwards and forwards—somebody said a million times in a second; but he was not going to discuss that (laughter). At any rate, that the flash goes flying backwards and forwards with considerable frequency. He would say at once that this assertion of the oscillatory character of a lightning flash was based more on mathematical reasoning than on absolute observation. He was not going to say much on the mathematical part of this question—first, because he did not think it would interest the meeting, and, secondly, because he did not think he was quite equal to it himself. He did not pretend to be a mathematician, although compelled in the discharge of his duties to make use of mathematics in some shape or other every day of his life. He made mathematics his slave, and he did not allow mathematics to make him its slave (applause). He was sorry to say that there were those amongst mathematicians who certainly allowed mathematics to make them its slaves, and they get into quagmires and sloughs of despond out of which they had great difficulty in struggling. If he were speaking as a member of the committee of Section A he should feel a little hesitation in saying one word on the question of mathematics, but he was speaking as president of Section G, and he appeared before them as an engineer. He might tell them that engineers had no very great respect for mere mathematical development unless it was proved by absolutely true experiments (applause). He would give them two or three instances which explained why engineers had a little hesitation in accepting mere mathematical developments. Some 50 years ago or more—he forgot the date—it was proposed to cross the Atlantic by a steamer; it was mathematically proved that it was impossible for a steamer to cross the Atlantic (laughter) Some 37 years ago the Menai Straits were spanned by a tubular bridge. The greatest mathematician of the day, one of the luminaries of Cambridge, proved that it was impossible that that bridge could stand, and he used all his power to induce the Board of Trade to stop the opening of the bridge. He had himself heard no less an authority than an Astronomer Royal prove absolutely and completely—to his own satisfaction, not to others—that it was impossible to lay a cable across the Atlantic. He had also heard a gentleman at that table, one of their greatest authorities, calculate by the conditions then at his fingers' ends the speed at which currents were likely to pass across the Atlantic; but it was found that a little condition was wanting which changed the whole aspect of the question. Instead of their being able to speak across the Atlantic at the rate of about eight or ten words a minute, it was found to the surprise of everybody that when the cable was laid they were able to speak at the rate of twenty words a minute. These were instances to show why mathematical developments devoid of practical experimental proof should be received with a considerable amount of caution (applause), and he thought, therefore, that this theory, beautiful as it was, of the oscillatory character of a lightning flash, must be received with great caution. There were several facts against the theory. There was no doubt whatever that electro-magnets were powerfully excited for a sensible duration by lightning flashes. They knew that needles were magnetised and demagnetised; they knew that electrolysis could be produced by lightning flashes; he had pointed out to them that the mariner's compass was caused to fly about. Sounds were produced; he had stood in the telegraph office and he had heard distinctly letters of the alphabet signalled by a flash of lightning. He had introduced into his Presidential Address this quotation from Job: "Canst thou send lightnings that they may go and say unto thee 'Here we are'?" Now, he had heard the letter "R" most distinctly sounded (laughter).

The PRESIDENT: Have you heard the three "R's"?

Mr. PREECE: Only the first R—we have stopped at that (renewed laughter). Now, the letter R involved three currents—three oscillations were required to make it. He had also heard the letter C; that involved four currents. There was a case on record in the A B C instrument of Wheatstone of the letter G having been made. Now, the letter G required eight alternations to be made in order to be recorded. And there were other facts. Hence he said that these durable effects in telegraphs were contrary to the oscillatory theory of the flash, unless the frequency of these oscillations be very small indeed; he said there were very great doubts as to whether it was true for lightning flashes. It might be true for condensers, it ought to be true for Leyden jars, but they were not dealing with Leyden jars, they were dealing with flashes of lightning, which, if they were analogous to anything in a Leyden jar, were analogous to the bursting of the dielectric, and not to the external discharge where oscillations may occur. They had in a Leyden jar the dielectric with its charges of negative and positive electricity on each side of it under a considerable state of mechanical stress; when that stress is suddenly removed, as it is by a spark, then it is not difficult to conceive that there may be mechanical oscillations in the dielectric; but he could not conceive that those took place in a flash of lightning, which bursts through a mere layer of air. Speaking once more of oscillations, they had distinct evidence of slow oscillations in a flash of lightning, and he thought the photographs would also give some evidence of that. Prof. Elihu Thomson, in America, a very careful observer, and one of the ablest men on the other side of the Atlantic, had recently, during a thunderstorm, by wagging his head or his glass about, seen six distinct flashes pass exactly over the same path. They had other evidence in favour of slow oscillations, but at present they had no evidence whatever of these rapid oscillations, and if they did not exist then the whole of Prof. Lodge's ingenious theory fell to the ground. On this point he would read one little quotation from Faraday's researches, who showed how, when a spark flew across an air space, the whole of the electricity disappeared. Faraday said, "The ultimate effect is exactly as if a metallic wire had been put into the place of the discharging particles, and it does not seem impossible that the principles of action in both cases may thereafter prove to be the same." He thought that statement of Faraday had a most important bearing on the theory of electricity.

Now he would deal with another and extremely important point that Prof. Lodge had raised, which was one of immense value. He would tell them at once that, while he was attacking Prof. Lodge with all his power and force, he was also going to pat him on the back with equal power and force. There was no man who had worked so thoroughly and so honestly in this direction, and there was a true and a real pleasure in carrying on a discussion with a man who worked with the harmony and the good feeling that he showed (applause). Prof. Lodge had given some very beautiful experiments to prove his case. He took two Leyden jars, and they were charged with a Holtz machine, which was one of those new influence machines that produced static electricity with great ease and with great power; they were most charming instrumeuts when they were in the form that Mr. Wimshurst makes, and no electrician and no laboratory should be without them. One of the great advantages of this question being raised by Prof. Lodge was this, that it was dragging them all back to the early experiments they made in their youth when they first studied electricity, and experiments in static electricity were the most interesting and the most charming form of electricity that could be dealt with. [Mr. Preece then drew the following diagram on the blackboard.]

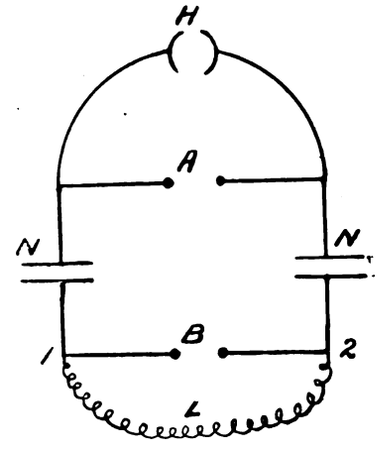

FIG. 1.

Here they had a Holtz machine, H, which charged each side of one condenser with positive electricity and the other with negative. The experiment was this: If the points 1 and 2 be connected with what Prof. Lodge called an alternative path, L, either iron or copper, then the distance through which the flash across the balls B flies is very much longer than it is when there is no alternative path. The real discharge itself is determined by the balls A. When the flash occurs through the discharge of those condensers then there is simultaneously a spark between B and between A, but it is the discharge between A that determines that between B. Prof. Lodge said that owing to this oscillatory character of the discharge there was in the alternative path L self-induction, a kind of obstruction, a real obstruction to the discharge that causes the charge to fly back through B rather than go through the conductor. The spark was much longer with copper than with iron. Prof. Lodge's experiments were perfectly exact. He (Mr. Preece) had repeated them in every shape and form that he could; he had had them repeated by others, and in all cases Prof. Lodge's experiments were found to be absolutely exact. He did not question them, and could not question them; they were true. What he did question was the deduction from these experiments, and there was a very great difference between an experiment and the deduction from that experiment (applause). In order that the alternative path should influence the charge or discharge there must be self-induction in that wire, and there must be frequency in the oscillatory character of the charge or of the discharge. Prof. Lodge argued solely on the discharge, and arguing on the discharge, then, his conclusions were right, but he did not take into consideration the charge. The oscillatory character may be true or it may not be true. For the purposes of this argument he would say it is not true, and therefore Prof. Lodge's theory fell to the ground. Here, however, in the charging current, they had a Holtz machine which charged up by a series of consecutive minute charges of electricity; they had in reality a frequency of charge—little charges were sent pulsating through all this system. Here they had a wire possessing self-induction—in one case a wire of copper, and in another case a wire of iron. Prof. Lodge said that because the length of the spark is greater with copper than with iron, therefore copper has more self-induction than iron. He (Mr. Preece) said that because the charge is a pulsatory charge, and because they had a greater spark with copper than with iron, there is a greater self-induction in iron than there is in copper. The increased spark in the case of copper is due to increased charge in the condenser; iron throttles the charging current. So that by arguing from the discharge as Prof. Lodge did, he made out the self-induction of copper to be greater than iron; on the contrary, by arguing from the charge he had himself made out that the self-induction is greater in iron than it is in copper, which is, of course, true; therefore by taking it from those two points of view they arrive at diametrically opposite results.

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There were many objections to this self-induction theory. There was no doubt whatever that Prof. Lodge in this inquiry had started an entirely new and fresh hare which electricians were bound to hunt up and follow and kill. He felt satisfied that Prof. Lodge was on the brink of some discovery in connection with static electricity. He did not think his explanations were right, and he did not believe in the influence which Prof. Lodge assumed of self-induction; in fact, he looked upon the way in which lately self-induction had been brought into account for every unknown phenomenon as being very much what the Americans call a species of bug. The Americans used that term not in the sense that we did; sometimes we call it a bug-a-boo. Now, self-induction is used in innumerable senses and in different ways. Prof. Lodge himself (who was one of their shining lights on this subject, and his Papers, whether they were right or wrong, were most charmingly written and were excessively interesting), with all his care, could not avoid speaking of this self-induction in various ways; for instance, in his Paper he sometimes called it electro-magnetic inertia, sometimes electro-magnetic capacity, sometimes self-induction, sometimes self-induction of the conductor, sometimes self-induction of a discharge, and he also called it inductance and electric inertia. As practical men in the telegraph world they had been familiar with self-induction for the past twenty years—they knew it, they called it electro-magnetic inertia, and its effects upon the wires were always spoken of as retardation. If they possessed in everyday language two terms so well known as electro-magnetic inertia and retardation, he could not for the life of him understand why every fresh writer on electricity should apply a new term to this well-known phenomenon. For instance, its effects are expressed by a very simple formula, and to this it is very desirable that some name should be given. Practical men had, without hesitation, accepted a term applied to it by Lord Rayleigh, and they spoke of it accordingly as "throttling." Self-induction has a kind of throttling effect on a current of electricity. Some people called it choking, but why it should be called impedance, why it should be called hindrance, and why it should have all the other names applied to it at the present moment, they could not possibly understand. He said that Prof. Lodge had made a discovery—he did not know what it was—but that Prof. Lodge, in being possessed by his mania, he would call it, for self-induction—he had self-induction before his eyes, and nothing else—had neglected to study Prof. Poynting's Paper to the advantage that one would expect. If he had studied Prof. Poynting's Paper, which showed that energy passed through the dielectric, and not through the conductor, he might have applied that principle to his experiments, and proved, with equal satisfaction to himself, that the peculiar effects he produced were due to something or other in the dielectric. He himself was not sure that Prof. Lodge would not find, on further inquiry into the matter, that there was something in the contact between the dielectric and the conductor. They knew that a conductor in contact with the dielectric, in contact with air, was subject to an electromotive force. They knew, for instance, when a row of people were collected together and a spark was passed through them that those who suffered were the two end ones. There were several instances on record where horses had been ranged in a row and the two extreme horses had been killed, while the intermediate ones were not touched. That showed that there must be some effect between the surface of the terminals and the air, of which at present they were ignorant. He thought that was a point that deserved experinent; wires could be obtained coated with various dielectrics. He could supply Prof. Lodge (if he still continued the experiments) with any quantity of wire covered with gutta percha, with paraffin, with bitumen, or with any other compound that was in the market. Then, again, there was something analogous to the transformation of energy in these experiments of Prof. Lodge. Let his explanation be absolutely true, let there be self-induction held in this alternating current, he (Mr. Preece) could not conceive from analogy any single effect of self-induction that would cause the E.M.F. between the two balls at B to increase from 100,000 to 140,000 volts. They had to account for a great increase of E.M.F. Prof. Lodge indicated in his Paper, read in Section A on Friday, that a spark of one inch, at a distance of three yards (he thought) increased to 14 inches. Here they had an increase of E.M.F. that would be something like an increase from 100,000 volts to 1,000,000 volts, and they could not account for that by any known phenomenon connected with self-induction. He thought those points rather tended to shake one's confidence in the oscillatory character of lightning, and in the influence of self-induction in determining the efficiency of lightning protectors.

The next fallacy of Prof. Lodge that he wished to touch upon was the assertion that a lightning protector protected no area whatever. If a lightning protector raised above a building did not protect the area around and about that building, what earthly use was there in the lightning protector. They knew from evidence in this book [Report of Conference] that areas are protected, and he had in a Paper in the *Phil. Mag.* worked this out in a way which he thought could scarcely be controverted.

Again, Prof. Lodge asserted that extended points are needless. The report of the Conference said that extended points are necessary. Of course those two views were diametrically opposed to each other. The authors of the report took their stand upon the experience of the past, and Prof. Lodge took his stand upon his mathematical assumptions.

Then Prof. Lodge advocated iron, as did he (the speaker); but he did not like, and he did not think any of them much liked, sudden conversions; they were not always agreeable. The most extreme Radical in that room did not feel very comfortable when he found that Mr. Gladstone was committed to Home Rule; so Prof. Lodge, when he suddenly turned round and became an advocate of iron, committed a very serious conversion. He found in *Nature* on November 3rd, 1887—only last November—this:—"A lightning conductor should not be a round rod, but a flat strip, or a strand of wires, with the strands as well separated as convenient, and though I have not mentioned the special effect of iron, I may as well say here that iron is about 90,000 times worse than copper."

He had already said something about mathematical developments; he thought that one of the serious errors committed by those who relied upon mathematical developments was that of hasty generalisation. This subject was dealt with last year by the President of Section A. He made his friend, Mr. Querelous, say that in dealing with mathematical developments you had only to write down equations and scribble away till you got something or other (laughter). There was no doubt that all the disputations of the learned never brought to light one effect of Nature before unknown; they were always discovered by experiment. But there was no question of this, that mathematical developments, in the hands of such masters as Lord Rayleigh, Prof. Fitzgerald, Sir William Thomson, with such experimentalists as Hertz in Germany, Prof. Lodge himself, and many others, were gradually opening their minds to the true character and the true nature of electricity. They were gradually reaching a time when they could speak of the mechanical theory of electricity. Prof. Fitzgerald made the subject of his address the fact that we had now absolutely proved the existence of an intervening medium for the transmission of these oscillations and these vibrations. They had in all the effects of atmospherical electricity indisputable proof of the fact that they were dealing with energy in some form or other. He had made this calculation—he wanted to know, as they all wanted to know, where this wonderful energy came from that was so destructive in a flash of lightning. They saw trees rent, buildings thrown to the ground, and terrific effects produced. Where did this energy come from? It was a very simple calculation to show that if they took aqueous vapour, which came in clouds from the ocean, and brought it in contact with a stratum of cool air, the aqueous vapour would be condensed into rain and would fall. If that rain fell at the rate of one millimetre per acre per hour it developed energy equivalent to 600 horse power per acre. If that was spread over a county they would get to millions of horse-power. They could readily see that in that simple operation of the condensation of moisture they had a source of power which only required further investigation on the part of mathematical physicists and experimentalists to develop into a true mechanical theory of electricity. He had always held the belief that sooner or later we should trace an electric current to be a mere vibration—a mere oscillation of the molecules that compose the mass of the conductors. He had carried out in Dr. Warren de la Rue's laboratory and with his great battery a series of the most brilliant experiments deflagrating pieces of wire. These pieces of wire were laid flat between white paper, and the result of the deflagration was shown upon that white paper. Here they had distinct indications that the passage of the current through the conductor assumed the form of waves. Prof. Hughes, one of their best experimenters, and one of the most marvellous men with his fingers (applause), had also been working steadily at this question. The notion that he had gone upon was that in order to account for heat, in order to account for light, in order to account for electricity, and in order to account for the difficult crux of the whole question—the duality of electricity—they would have to prove that the result of the motion in an electric current is spiral—that it is of the character of a right and left-handed screw.

He would say, in conclusion, that he had done all he possibly could to prove that the position taken up by the Lightning Rod Conference was the true one. He had feebly shown Prof. Lodge's views to be in some respects fallacious. He felt satisfied of this, that whether the result of the discussion established the truth of the position taken up by the Lightning Rod Conference, or whether Prof. Lodge would be able to succeed in defending himself, at all events it would have this advantage, that it would bring to their minds what they were all anxious to have brought before them, the true theory of electricity shadowed forth by Prof. Fitzgerald in his inaugural address, an address which he believed would mark this meeting of the British Association at Bath as an epoch in the history of electricity (loud applause).

Prof. OLIVER J. LODGE, F.R.S., on rising to reply, confessed that he had nothing whatever like the experience of Mr. Preece to base his statements upon; so far from having half-a-million lightning conductors under his supervision he had not even one. He had not a lightning conductor to his house, nor was there at present one to the college at Liverpool with which he was associated. He had asked for one to be put up; but lightning conductors seemed at present to be so expensive that the answer he generally got was that it is cheaper to insure (laughter). He thought there must be some fallacy in the argument (which ought to be treated in Section F) that because an insurance company is willing to pay if a thing is damaged, therefore it is nobody's business to protect it from damage. He did not know where the fallacy was; he felt sure there was one. However, manufacturers often acted on that principle. It was perfectly true that if his views were correct very few buildings were effectively and thoroughly protected at the present time; but then it was also true that if they were correct lightning conductors would in the future be bought for—he was going to say as many shillings as they are now bought for pounds; but at any rate they would become much cheaper, and that of itself would be no slight advantage, if, of course, they were equally effective.

Mr. Preece had poked some fun at mathematicians, but as he could hardly pretend to be a mathematician in that room he would not say anything in reply to it—in fact, it was quite unnecessary. At the same time, he was quite willing to argue the point without any introduction of mathematics and without a single symbol. As far as the term "self-induction" is concerned, if electro-magnetic inertia is preferred, he had not the slightest objection to use the latter phrase; it was a very good term, and the only possible objection to it was one of caution, namely, that it might seem to imply a little more than we certainly knew. For himself he felt that we should be quite certain, sooner or later, that self-induction is due to inertia—electric inertia—inertia of electricity, if they might say so. In using the term electro-magnetic inertia they might

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possibly be understood as implying a knowledge which at present they did not certainly possess. When they did possess it they would be a great deal further on towards the certain statement that electricity is a form of matter. He did not think Mr. Preece recognised how near he went, when he spoke of electro-magnetic inertia, to the assertion that electricity is a form of matter. Mr. Preece's argument (in his Presidential Address) was that electricity is a form of energy because you could buy and sell it, but they might as well argue that sugar is a form of energy for the same reason. Mr. Preece also argued that electricity is not a form of matter because they could make it do work; the hydraulic engineer might equally well argue that water is not a form of matter because with water they could do work.

Mr. Preece began by saying that there is no authentic case on record of a properly-constructed conductor failing to do its duty. He had read carefully the Report of the Lightning Rod Conference, to which Mr. Preece drew attention, and there had found a large number of entire failures. There was one very noteworthy one which was often quoted—a brass rod an inch thick on a steeple in Italy which was smashed all to pieces and the spire destroyed, the flash being seen, he believed, by a number of people. There were a heap of other cases. In his lectures last spring he quoted as the best protected building in the world the Hotel de Ville at Brussels, on which M. Melsens had spent so much time and trouble. That building was elaborately protected. It was protected by innumerable conductors, with admirable earths made in a variety of ways, bristling with points all over the top—everything, in fact, carried out in the most approved style, regardless of expense. But in the month of June that building was struck and set on fire.* The fire was put out. He was sorry that he did not know more of the particulars, which had not been published. He thought, however, that they ought to be published, because that was a building the protection of which had had books written about it—M. Melsens himself wrote a book about it. It should be very instructive to find out, when a thoroughly protected building was struck, how and why it was struck, and what damage was done, and all about it. He did not think, although he spoke from a limited experience, apart from reading, that it could possibly be asserted that existing conductors never fail.

Next Mr. Preece had a hit at him where, he admitted, Mr. Preece had the advantage. Mr. Preece quoted a sort of Midlothian speech of his (laughter), in which he had made an entirely erroneous statement (renewed laughter); but he was not introducing that as a statement of a mathematical calculation, or anything of the sort; it was a mere parenthesis thrown in, and it was very hastily done. Of course, one ought not to do those things, but still if one wrote much one would be very apt at some time or other to make hasty statements. He did not speak of his phase, when he thought that the magnetic permeability squared entered into the expression, as a personal matter, but it was instructive because it must be a condition of mind through which many people had gone. When the Society of Arts asked him to give a lecture on lightning conductors, he thought to himself, "Yes, I will tell them about self-induction," because he knew that the Lightning Rod Conference had not called attention to that, under the name magnetic inertia, or any other. He happened to be writing a Paper which appeared, he thought, in *Nature*—he was not sure where the quotation made by Mr. Preece came from—and in that Paper, having regard to the magnetic permeability of the two metals, copper and iron, he had stated that in regard to the magnetisability of its substance iron was 90,000 times worse than copper. He meant to say, therefore, that although iron was cheaper, was more difficult to melt, had a higher specific heat, and in a variety of ways was better than copper, yet, in regard to this electro-magnetic inertia, it was enormously worse. Before actually giving the Mann lectures, however, he made a few experiments on this point, and to his surprise he found that, so far from being worse, iron was often rather better; and that even a thin wire of iron carried off the discharge better than a thick wire of copper. This experiment naturally and at once effected his conversion. The experiment referred to was that of the alternative conductor; it might be of iron or copper, or any other metal, of any thickness they wished to experiment upon. The top part of the arrangement sketched by Mr. Preece was of no particular interest; at least, they need not attend to it now—the bottom part was the thing. The B spark measured the E.M.F., which drove the current through the alternative path. They should adjust the B part until the flash produced there did not know which way to go—whether to go through the wire or through the air. Half the sparks failed when that is attained. With a spark micrometer at B they measured the distance, and thus obtained the E.M.F. which is on the verge of succeeding in driving the contents of the jar through the wire. He tried first a thick copper wire, and afterwards he tried a thin iron wire of the same length; he found that a greater distance of spark, a greater E.M.F., was needed to drive the contents of the jar through the thick copper wire than through the thin iron wire. Whatever explanation might be given of an experiment of that kind, a direct intimation from heaven could be no clearer. For some reason or other the copper and the iron are at least equally good. He did not press the point that iron is *better* than copper, and he had never stated that copper has more self-induction than iron—that would be a mad thing to say; but it might happen, for some reason or other, that the copper obstructed the current more than iron. He preferred, however, to say that the two metals were equal.

Mr. Preece said that when the Society of Arts asked him to come and bless the Lightning Rod Conference he turned out a Balaam. They did not ask him to bless the conference, they asked him to give a lecture on lightning conductors, so that there had been no breach of contract. There were three parties in the little drama to which Mr. Preece referred—Balak, Balaam, and the ass (laughter). Balak was the gentleman who asked the prophet to come and give a lecture; Balak was therefore the Society of Arts, or, say, Mr. Trueman Wood. Balaam was the prophet, who went and said what he ought to have said. He did not not know who the third party was, unless—(great laughter)—unless he was the party who spoke against the prophet. Mr. Preece said that the function of a lightning conductor was to prevent a flash from striking the conductor—that is to say, that a lightning conductor never ought to be struck, or it failed; but they are struck, because they get melted, and yet in an earlier sentence Mr. Preece said they never failed. He did not know which of those statements was to be taken as correct. If a lightning conductor could prevent a flash from occurring by its point action, well and good; but he had shown in the lectures (he would not trouble them by repeating a statement of the experiments) that there were cases where a point had no protective action whatever, when it can be struck by a thick and heavy flash. There were other cases where the point acted with a brush or fizz and neutralised the electric charge without a flash. But they could not always depend upon it doing that, and so the lightning rod had two functions—one preventive if it can, and the other to carry off a flash when it cannot help receiving it. But they must remember that a flash—at least the electric charge—has always a certain amount of energy, and that it has to be dissipated somehow. It is not a question of a certain quantity of electricity which has to be conducted to earth and then there is an end of it; there must be a certain amount of energy, and they must dissipate it somehow. They could not expect to *hocus pocus* energy out of existence by saying they would conduct the charge down to earth; the quicker they tried to conduct it down to earth the more surging and violent disturbances they were likely to get. It might be better to let it trickle down slowly by using a moderately bad conductor than to rush it with extreme vehemence down a good conductor (hear, hear). Just as it would be safer to let a heavy weight suspended in a dangerous position slide down rather than to let it drop as quickly as possible.

Concerning the length of flashes, he wished he had first-hand information, but he had none; it was one of those things which meteorologists must determine. It was very important to know the length of the flash. He had seen it stated in books that the flashes were a mile long and perhaps more. Mr. Preece thought they were only 500ft. long; that was a matter of fact which could be investigated, but that was a matter upon which he had no direct first-hand information. As to whether the spark length is proportional to the distance or not, he would say that the experiments with oscillating currents to which Mr. Preece magnanimously called his attention yesterday, were conducted with alternating dynamos between points. Now the area of cloud and the area of earth below it are not points; they are flat surfaces, like the coats of a Leyden jar.

Mr. PREECE: They were alternating transformers.

Prof. LODGE replied that they were alternating currents as used in practical commercial work discharging between points. There the law did not seem to hold; but then it ought not to hold, so that would be all right. But between flat surfaces it ought, and the spark length ought to vary with the difference of potential between the two flat surfaces. At the same time if there were points on the earth's surface which were big enough, and if these points determined the flash, then the law of proportionality would not hold. However, the laws concerning discharge in dielectrics were well known and were scarcely matters for argument. The circumstances of an oscillating current did not apply as regards the length of the spark, because until the discharge occurred there was no oscillation; it was a mere static charge. The earth and the cloud above it are exactly like the coats of a Leyden jar, which are preparing to spark into one another, and which do spark into one another when the difference of potential rises to a certain maximum, and the air between is broken down.

The duration of flashes was another point on which much valuable work might be done by meteorologists and photographers. He had seen lightning flashes which certainly appeared to last two or three seconds. He could not imagine that it was one flash which was doing that; he thought it was a series of multiple flashes succeeding one another very rapidly. If any kind of flash can be shown to last long it is an argument that that kind is not oscillatory. The fact that they deflect a compass needle did not prove anything about it; it did not prove anything concerning their duration either, because a ballistic galvanometer is deflected by a momentary kick. A momentary blow given to a thing can deflect it, the blow having ceased long before the motion has ceased which it produced.

There was a difficulty which Mr. Preece did very well to advert to; that was the magnetising power of lightning, and he thought it was the strongest point Mr. Preece had adduced. A flash magnetises steel bars, deranges the magnetism of a ship's compass, conspicuously produces magnetic effects. An oscillating current ought not to produce these effects. An oscillating current with decaying amplitude is used by Prof. Ewing to demagnetise steel, not to magnetise it. The oscillating current would have a gradually decaying vibration. That would demagnetise things, but it ought not to magnetise. It does magnetise them; therefore how can it be a current of this kind? But then the same difficulty would be felt with the Leyden jar discharge. The Leyden jar discharge is certainly oscillatory, because it has been seen to be so, when the sparks have been analysed in a revolving mirror. And yet it magnetised steel needles when sent round them. He did not fully understand that point, and he hoped Lord Rayleigh would say something about it. Mr. Preece was quite right in saying that the whole theory depended upon the existence of oscillations. As far as the theory was concerned, he (Prof. Lodge) had merely called attention to these oscillations (which were well known in the case of Leyden jar discharges, and of which the mathematics had been worked out), and pointed out that they applied also to lightning, which he did not think had been much noticed. A pendulum is an analogue of them. Raising the pendulum represents the charging of a jar; charge it more and more, and then discharge it—that is, let it go. When you let a thing go, it naturally swings before coming to rest; it need not, it may meet with too much friction. Suppose it were oscillating in treacle; he would pinch it hard, so as to represent the oscil-

* See *The Electrician*, September 7th, 1888, p. 550.

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lation in treacle; it would then have a dead-beat motion down. It may be a slow leak, the discharging of a condenser through a leak, in which case it would come down very slowly. Those are cases in which there is no oscillation, and it entirely depends upon the friction—the viscosity it meets with. If the friction is very great, if it is like a leak, then it would go down slowly, and there would be no oscillation. If the friction is small, and if there is inertia, then it must oscillate. Mr. Preece admits the inertia. Suppose a Leyden jar going to spark, it possesses potential energy like a raised pendulum or bent spring; the instant it sparks a current rushes round. They had then a circular current, which was well known to deflect compass needles, to produce magnetic effects. That is the electro-kinetic inertia—represented by the ordinary inertia of the spring or pendulum when it passes the middle position. You have, first, a static charge; then, while it is flying past, you have a current and magnetic effects and kinetic inertia, which carries it on to its other extreme position of static charge; and so you have these oscillations gradually dying out on account of the friction. If they made it oscillate in water instead of in air, the oscillations would die out quicker. They would die out for two reasons: partly because of friction, which generates heat, partly because it produces waves. If they made it oscillate in water the surface would be disturbed, and waves would travel along; part of the energy would go in heat, and part in waves—that is, producing radiation, or light as they might call it if it were only quick enough to affect the retina.

He did not know what was the energy of a lightning flash, and he wished there were some means of determining it, as its determination would be interesting and important. As to whether lightning was likely to be oscillatory or not, that was a matter of the resistance or friction compared with the capacity and the inertia of its discharger. The smaller the capacity the more likely it is to be oscillatory; the bigger the electro-magnetic inertia the more likely it is to be oscillatory. The capacity discharged in a flash he said is small, and he said so for this reason, that the quantity of electricity discharged is not great; it is well known that the quantity of electricity concerned in a lightning flash was small; the quantity of electricity then existing in the portion of the cloud that is discharged is a small quantity, but the potential of it is enormous. It is able to spark 500ft.—possibly a mile; whatever its real length of spark may be. That meant an enormous potential. When they had a very small quantity raised to an enormous potential it meant that the capacity cannot be great, capacity being the ratio of the two. There was no reason for supposing that the capacity of a condenser discharged in a lightning flash is anything bigger than a Leyden jar—nothing like a microfarad or condensers of that sort. They had some means now of measuring the wave length produced by a discharge, and in that way they might determine a good deal more about them. He would mention as being interesting, perhaps, that the radiation of the waves produced by a microfarad condenser through a coil of self-induction one secohm, as Profs. Ayrton and Perry called it—he preferred to call it a quad—the waves produced by that discharge—ether waves—waves of light, if it is oscillatory, will be 1,200 miles long. They had nothing like that capacity discharged in a portion of thundercloud, which has a capacity of only about, as he guessed it, 10 metres electrostatic units. Mr. Preece had offered to supply him with covered wire in order to repeat these experiments on the alternative path. That was another instance of his magnanimity which he would have the greatest pleasure in taking advantage of, and Mr. Preece might expect on his return to London to have a letter reminding him of his promise, because he (Prof. Lodge) might, perhaps, want large quantities of covered wire for this purpose.

Finally, there was the theory of the protection of area. Mr. Preece said, "If it does not protect an area, what is the good of it?" That was not an argument. He knew Mr. Preece's theory on this point, because it had been published in the *Phil. Mag.* But the area, on Mr. Preece's view, was so extremely small that they might almost give it him without much argument [illustrating on the black board] (Fig. 2). Suppose A B is the lightning conductor and D E the ground; take a base-line equal to the height of the conductor, then take a point at the other corner of the square, then describe a circle with this point C as centre; and, of course, do the same thing on the other side. Now the protected area would be the portion (A D E), and that was not much (applause). If they applied that to every point of the house they would want a lightning conductor to every point, but Mr. Preece meant that therefore you must send up a rod to a gigantic height, so as to bring the house into the protected area. Even then they would not be safe. Why did he object to such a bit of protection as that? Mostly because he thought that areas of protection directed one's attention to side issues—to a thing which it is better not to think about, because there is no certain area of protection. Take another rod (F G) completely enclosed in this area of protection, and lead it up from the ground to near to the lightning conductor so as to leave a little spark space. If "area of protection" has any meaning, that rod ought to be protected, but he said that when a lightning flash (that was merely an assertion, and they need not believe it) struck that conductor A B they would almost certainly get a spark down to this supplementary rod F G, which would take its share and assist in conveying the current; therefore, it is not protected. If a man held a lightning conductor when the flash passed down it he would most likely be killed, and if it passed through gunpowder—well, he did not know about gunpowder, because gunpowder got blown about. It did not matter about the earth: let the intended conductor have a good earth and this supplementary one a bad earth, still the same effect will occur; a spark is likely to occur if the distance be not too great. He said that is so because he had made experiments in the laboratory after this fashion, amongst others. He took a rod which might be of copper as thick as they pleased, he put it in circuit with a Leyden jar, sending the discharge through the rod. This was a solid rod of copper; take a Wollaston platinum wire, or any other wire, as fine as possible so as to make the contrast greater, and arrange it to make a kind of tapping circuit; arrange so that the bottom end shall be in contact with the rod, and the top end an eighth or a sixteenth of an inch away. There they had a splendid conductor, better than any lightning conductor ever was. They would have no trouble about earth, as they had a little tapping circuit close to it—the Wollaston wire, which they could hardly see. It seemed absurd for any portion of the discharge to leave this inch-thick conductor to jump across a sixteenth of an inch of air space, and to make for the little thread of wire. Nevertheless a portion of it does, and from every spark that goes through the conductor a side branch goes to that little wire.

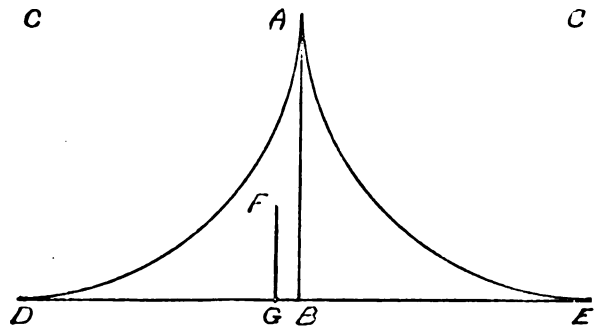

Fig. 2.

There was one point where Mr. Preece might have attacked him, but where he did not think Mr. Preece had made out the full strength of his case, namely, the question—What are the conditions of a flash? He (Prof. Lodge) had assumed that a flash behaves or may behave like the discharge of condensers in a laboratory; but it was a question whether a cloud discharge was of this kind. A cloud is not a good conductor; it consists of globules of water separated from one another by inter-spaces of air, it may be compared therefore to a kind of spangled jar; when a spangled jar discharges there is no guarantee that the whole of it discharges, it discharges out in a slowish manner; it may be that you have first a bit of discharge, then another bit, and so on, so that you may have a kind of dribbling of the charge out of it, and you may thus fail to get these oscillatory and sudden rushes. At the same time he did not think that they could always guarantee doing this with cloud discharges, and it would not be safe in arranging for protectors to protect for only one case, and that the easiest; they must provide for the possibility of a sudden and violent discharge. Still the conditions of actual lightning were to be ascertained by observing lightning and not by experiments in the laboratory.

There are many other known points to which attention might be called, and which would have application in practice. Thus there was the momentum of one spark exciting others; and he was sure there were multiple flashes. Mr. Abercromby had a photograph where the flash is breaking the air down in all directions at once. It is most extraordinary the way in which there seems to be a sort of *rot* set up in the air so that when one flash begins the whole region smashes up in all directions. There was another recently discovered point which could only now be just called attention to, namely, the effect of the light of one spark in assisting others to form. A spark of an induction coil here will be able to start the spark of another induction coil up in the gallery merely by its light; if it is closer it will do it better, but it will do it at very considerable distances. When they considered the very bright light of a lightning flash this effect must have very important consequences. There was no doubt that once a flash occurred the light of it must make all conductors in the neighbourhood—all the air in the neighbourhood—very easily able to break down, and so may give rise to a multiplicity of flashes from all the neighbouring points. That was why he said the idea of areas of protection was misleading. If one flash caused a lot of others you had better not have the one if you can help it. Therefore he said do not run up great long rods to precipitate flashes near powder magazines, or anywhere where it is dangerous, but try to avoid them if possible. If there must be one they must be very careful indeed to have all the other conductors arranged so that the sparks along them do not matter, because if one flash occurred they were likely to get others.

Mr. Glazebrook had just asked him to describe the effect of light in producing a spark. There was no difficulty in it; they merely wanted two induction coils. Take a common induction coil and separate its terminals until they just cannot spark into one another; let the coil be working, but let the sparks just fail to pass. Light a bit of magnesium wire and they would instantly begin to go; take the magnesium wire away and they will stop. Instead of magnesium wire have another coil or a Holtz machine, or anything else, to make the light. Let one be just on the verge of sparking, and let another instrument in another part of the room begin sparking; if the light of that spark can fall upon the space between the terminals of the first, especially upon the cathode of this space, these sparks will begin to pass too. The light of a spark, or ultra violet light in general, seems to make air conduct; a more accurate statement would be that it seems to diminish the transition resistance between the metal and the air, especially upon the surface of the cathode (loud cheers).

(To be continued.)

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CORRESPONDENCE.

SOME EXPERIMENTS ON ELECTRO-MAGNETIC ACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Several of my scientific friends have asked me the meaning of the remark on p. 548 of your issue of Sept. 7th, wherein you credit me with having shown that "knots can be tied in a line of (magnetic) force." May I take the opportunity of describing through your columns the experiments which I narrated to you two months ago, and upon which your remark was founded.

Early in the year 1885, in considering the nature of the process by which the variations of an electric current in a circuit set up electromotive forces in a neighbouring second circuit, it occurred to me that if this process were in reality due to action in the intervening medium, and not to action at a distance merely, then it should be affected not only by the material (magnetic or otherwise) of the intervening medium, but also by the structure given to that medium. This idea of structure simmered in my mind for some days, and early in February of that year it took a more definite shape. Every electrician knows how the mutual induction between two circuits is augmented by giving them a common core of iron. Could I not, while using iron, by giving to the pieces of metal employed a particular structural form, actually diminish the mutual induction which existed between the circuits when air only intervened? Nay, could I not by the same means neutralise, or even *reverse*, the ordinary inductive action?

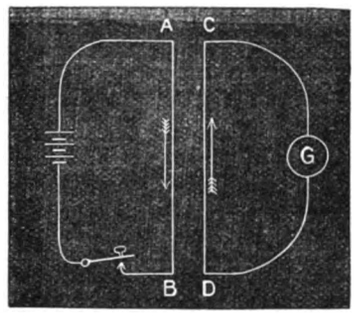

FIG. 1.

To test the matter I determined to begin with two adjacent parallel conductors forming portions, the one of a primary, the other of a secondary circuit. If these are represented respectively by A B and C D, in the diagram, Fig. 1, then in the

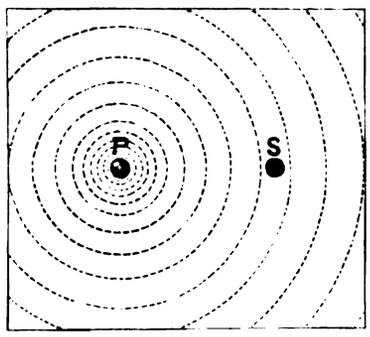

FIG. 2.

ordinary familiar experiment on induction, if a current is started flowing from A to B, it occasions a momentary inverse current from D to C in the neighbouring circuit. To neutralise, or if possible, reverse this action, I determined to introduce into intervening space portions of iron so shaped as to carry the magnetic lines of force due to the primary current out of their usual positions, and cause them to surround the secondary wire C D in the reverse sense to their usual one. To make my idea plainer, I may refer to Fig. 2, giving a section of the field in the case of ordinary induction. P is the primary wire, S the secondary. When we cause that which we call an electric current to start in P, a system of concentric lines of magnetic force is created around the wire, and these spread outwards from the centre, increasing in number until the "current" has attained its final strength. I may be pardoned if I venture, without pushing the similitude too far, to liken this action to the propagation of ripples on the surface of a pond around a central point of disturbance. As these lines of force spread outwards they meet the secondary wire S, and, to use Faraday's well-known language, are "cut" by it, this cutting of the magnetic lines by the conductor giving rise to an induced electromotive force. This action of cutting by the secondary circuit of the magnetic lines, due to the current in the primary, can be enhanced, as *was* well known, by providing iron along the path. A loop of iron wire over-wound in the manner indicated in Fig. 3 helps to

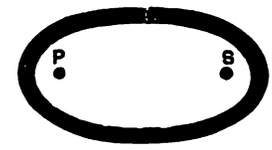

FIG. 3.

carry the magnetic lines of the primary circuit to the far side of the secondary, and greatly increases the induction. All this was known; here began my experiments. I caused a number of iron links to be made, twisted in the form of a figure of 8, but so that the two parts which cross one behind the other should not touch. These were to be threaded upon the two parallel circuits in the manner shown in Fig. 4, the object being to carry the magnetic lines across the secondary circuit in the reverse sense to the usual one, so that the cutting of the lines by the secondary wire should give rise to an inverse electromotive force. I find on refering to my note book that, using a considerable number of these and a battery of three Leclanché cells, I was completely successful, on February 26th, 1885, in obtaining not simply the diminution or annulling of the ordinary inductive action, but in producing an extraordinary induction, such that at the moment of starting a current from A to B an induced electromotive force was set up, tending to send a

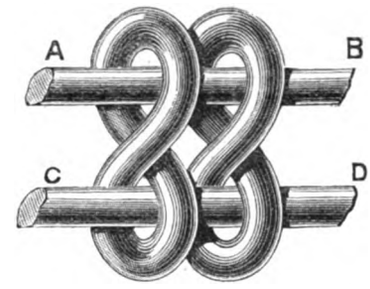

FIG. 4.

current from C to D. I showed the experiment at the time to some of the members of the Bristol Naturalists' Society at the end of one of the meetings of the Physical and Chemical Section. I also mentioned the matter to my friend, the Rev. F. J. Smith, of Oxford, who, however, when attempting to repeat the experiment with a single interwoven iron wire, instead of separate links, failed to obtain the same result. I should probably have pursued the matter further, and taken fuller means of publication at the time, had I not just then received a call to the Finsbury Technical College, and as double duties fell upon me, all my thoughts were absorbed in educational work until the summer, when I left Bristol. I discussed my experiments, however, with Dr. J. Hopkinson and with several other friends from time to time.

In the experiment above described (which was one of several made at the time) the "beknottedness"—to borrow Prof. Tait's term—of the magnetic matter occupying the active

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region of the medium had been artificially imposed as a sort of structure. I tried several times without success to produce such a structure naturally by discharging powerful currents through insulated wires lying in a mass of iron filings.

Returning from the question of action at a distance to the question of tying knots on magnetic lines of force, the possibility of the latter, or rather of generating magnetic lines in knots, can readily be shown by employing a knotted ring of iron, or bundle of iron wires, such as is shown in Fig. 5, as a

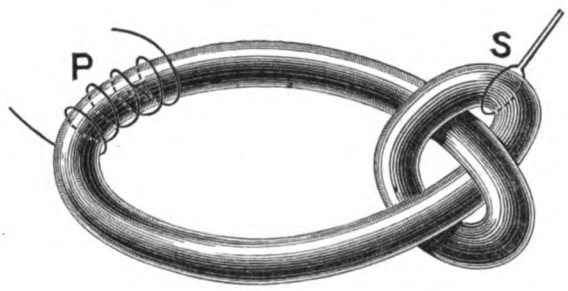

Fig. 5.

closed magnetic circuit. A magnetising coil is provided as at P, and a suitable battery and reversing key. Then an exploring coil, S, connected to a galvanometer, if slipped successively along the tortuosities of the core, will reveal the fact that the magnetic lines follow, at least for the most part, the knotted form of the core, and are themselves, therefore, knotted.

Yours, &c., SILVANUS P. THOMPSON.

20, Arundel gardens, Sept. 15, 1888.

LEA'S HAND-STARTER FOR GAS ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Sir David Salomons' letter in your last issue, my hand-starter for gas engines in its present form has no ratchet.

I abandoned ratchets because of the noise and the waste movement. There are no springs or rollers or balls, the grip is instantaneous, and when the hand bar is removed the shell is free to turn round either way on the shaft. The apparatus seems to be fairly well appreciated. In the case of a twin 8 horse-power engine, one man does easily with the starter what it certainly required two men to do previously. Fly-wheels and belts are not safe things to embrace and pull round. Serious accidents have happened with them.

No doubt Sir David Salomons' proposed double-acting arrangement would be very good; but it must of necessity be more expensive and more complicated than mine, which, exclusive of the four bolts and nuts, has only five pieces in it, counting the halves of the shell as two pieces, and including the hand bar.—Yours, &c., HENRY LEA.

LIGHTNING CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: When pilots differ widely as to the position of hidden rocks and shoals, and as to the force and direction of currents, being also divided in opinion as to the best method of avoiding them, the passengers are perfectly justified in forming their own conclusions on the subject. Such was my reflection after reading the report of what was said at the British Association on the subject of lightning conductors.

No branch of electrical science has benefited more from experimental research than this one, and I believe that more experience of lightning may be gained from a well-directed experiment, no matter where made, than from a piece of wire projecting from the top of every telegraph pole, even though they may be counted by thousands.

Experimental research has done, and is still doing, much to advance our knowledge of electricity; it must not, therefore, be ignored, but accepted as one of the great means to a great end.

There is a phenomenon in Nature which we call wind, and it is divided into well-known degrees of comparison according to the locality in this world of ours over which it more or less moves to establish an equilibrium; electricity is a phenomenon in Nature which behaves in precisely the same way as the wind.

Not by the mere passive experience of observation, but by the active experience of experiment did Dr. Franklin prove that lightning and electricity are one and the same thing, and having invented and brought into his own house a lightning conductor with which he experimented, he was able to formulate simple rules which he communicated through Mr. Peter Collinson to the Royal Society in 1753. These simple rules I should have thought would be all-sufficient for the guidance of those desirous of erecting lightning conductors for the protection of their buildings, &c., at any rate in this comparatively small country where, fortunately for us, lightning is much less prevalent and devastating in its effects than in some of the larger sections of the globe. I have seen lightning "strike" a conductor, and a very beautiful but awe-inspiring sight it was.

If the bottom end of a lightning conductor be placed at one end of an insulated tank filled with water, and a wire making a good earth enters the water at the other end, there are times when, the atmosphere being sufficiently electrically disturbed, the end of the conductor will give off gas and sound in the same way as one pole of a battery will when similarly placed.

I am painfully aware from personal experience of the great ignorance prevailing among "electrical engineers," who are usually employed for this work and who profess to understand the subject. After all, the erection of a lightning conductor is as simple, when properly done, as it is efficient, its length being so short that, to my mind, what metal is used is quite immaterial. Priestley foreshadowed that there was a difference between iron and the other metals when, in one of his experiments, he sent the charge from Leyden jars through two lengths of metal, one iron and one copper; the iron melted, but the copper remained intact. From this experiment he concluded "that copper would be a much greater security as a conductor to guard a building from lightning, besides its being less likely to rust, but then it is more expensive." Alluding to iron, he says, "It is very remarkable that when iron wires are melted by the electric explosion, *bright sparks* are generally dispersed about the room in all directions, but that they are seldom or never seen when wire of other metal is used. . . . ." "It is remarkable that iron should require more heat to bring it into a state of fusion than any other metal, and yet should require but a small force of electricity to do it."

It is always surprising to me how much good work was done in past days by the inadequate means at the disposal of the experimenters, for it must be remembered that they then had only frictional machines and Leyden jars with which to experiment, and yet among their valuable results are to be found conductivity, induction, &c.

In June, 1884, I delivered a lecture at the Royal Institution of Great Britain, entitled, "Volta and Magneto-Electric Induction." I then showed in my induction experiments, that with currents of low duration copper was superior to iron, but that when the currents were increased in speed then iron became superior to copper. I verified these experiments with revolving discs in a magnetic field, with the results given in my lecture, and I at the same time said: "If, as in the case of volta-electric induction, the lines of force are generated too quickly, or, as in the case of magneto-electric induction, the diamagnetic body passes too quickly through the magnetic field, the atoms of the substance in each case have not time to polarise with sufficient rapidity to radiate in the same time or place as when influenced more slowly by this force. This would account for the apparent interruption of the lines of force by the copper plate in the volta-electric experiments, and also for the 'drag' or retardation on the disc of the same metal, whilst part of it is passing quickly through a magnetic field. That being the case, it is easy to perceive that a speed of the copper disc might be attained when the current would be *nil* through the atoms being unable

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to polarise in the allotted time. Not so with magnetic metals, as iron or nickel, in each of which the atoms appear to be very susceptible to magnetic influence, and to polarise very quickly."

If these experiments are as valid as I believe them to be, it of course follows that upon the conditions and effects to be produced will depend whether iron or copper should be used as a conductor.—Yours, &c., WILLOUGHBY SMITH.

September 18th, 1888.

BOOKS, &c., RECEIVED.

"Pocket Handbook of Copper and Iron Wire in Electric Transmission, and the World's Facts of Electric Service." Sixth edition. (Washburn and Moen Manufacturing Company, Worcester, Mass.)

"Reports from Firms using Proctor's Mechanical Stoker." (Leeds.)

"List of Subscribers of the National Telephone Company." August, 1888. (Dundee.)

"Abstracts of Papers in Foreign *Transactions* and Periodicals." (The Institution of Civil Engineers, London.)

"Illustrated Catalogue and Price List of Electric Light Fittings." (B. Verity and Sons.)

"The *Journal* of the Franklin Institute." Vol. CXXVI., No. 753. (Philadelphia.)

"Special Supplementary List of Photographic Apparatus." (Mayfield, Cobb and Co., Limited.)

"The Waterhouse System of Arc and Incandescent Lighting." (Hartford, Conn.)

"The Technical Education of Engineers." A Course of Study recommended by the Manchester Association of Engineers.

"The Indo-European Telegraph Company's Tariff Book," with Rules, Regulations and Station List.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

12,918. E. G. RIVERS. Clevedon. An improved method and principle of constructing secondary batteries or accumulators. Sept. 7, 1888.

12,935. A. CALIPÉ, Jun. London. A new or improved electrical burglar alarm. Sept. 7, 1888.

12,963. J. P. ZIGANG. London. An improved telephone. Sept. 7, 1888.

12,986. R. CRESSWELL. London. An improved electric or galvanic sponge or pad for stimulating and curative purposes. Sept. 7, 1888.

13,000. T. M. SARGEANT and O. R. SWETE. London. Improvements in electric batteries. Sept. 8, 1888.

13,001. T. M. SARGEANT and O. R. SWETE. London. Improvements in the treatment of wood for rendering it impervious to acids and moisture, especially adapted for use in making electric battery boxes, but applicable also to other cases where it is desired to render wood impervious. Sept. 8, 1888.

13,008 J. W. OLDROYD. London. Improvements in electric incandescent lamps with interior reflectors. Sept. 8, 1888.

13,032. G. ALLAN and J. W. BROWN. Liverpool. Improvements in telegraphy and in apparatus therefor. Sept. 10, 1888.

13,035. C. M. DORMAN and R. A. SMITH. Manchester. Improvements in the construction of socket electric lamp holders, wall sockets, and electric lead connectors. Sept. 10, 1888.

13,038. G. QUARRIE. Birmingham. Improvements in facilitating the circulation or flow of electricity in and between animate and inanimate nature. Sept. 10, 1888.

13,061. J. CERPAUX, P. BORRE, and T. MARTENS. London. A new or improved combined telegraphic and telephonic apparatus. Sept. 10, 1888.

13,063. E. S. DEANFIELD and C GRAHAM. Croydon. Improvements in electrical indicators for use on vehicles, or for other analogous purposes. Sept. 10, 1888.

13,076. F. JACOB. London. Electrical signalling apparatus. Sept. 10, 1888.

13,078. U. E. GUÈRIN. London. An electric resistance meter and rheostat. Sept. 10, 1888.

13,122. E. J. PATERSON and C. F. COOPER. London. Improvements in the armatures of dynamo-electric machines. Sept. 11, 1888.

13,126. W. H. CUTTING. London. Improvements in electric calls. Sept. 11, 1888.

13,128. J. IRWIN. London. Improvements in electric railway signalling systems. Sept. 11, 1888.

13,145. E. BÖHM. London. Improvements in incandescent electric lamps. Sept. 11, 1888.

13,191. E. M. H. ANDREOLI. London. Electrodes for electrolytic operations. Sept. 12, 1888.

13,192. E. M. H. ANDREOLI. London. Electrodes for bleaching vegetable substances by electricity. Sept. 12, 1888.

13,193. E. M. H. ANDREOLI. London. Bleaching paper pulp by electrolysis. Sept. 12, 1888.

13,194. E. M. H. ANDREOLI. London. Bleaching China grass, rhea, &c., by electricity. Sept. 12, 1888.

13,208. C. WELLS. London. Improvements in the use of incandescent electric lights. Sept. 12, 1888.

13,215. W. CLARK. London. An improvement in electrical batteries (L. Maiche, France). Sept. 12, 1888.

13,218. E. L. BERRY and F. D'ARC. London. A method of preventing the deposition of crystals in the electrolytic fluids of electric batteries, the said method also allowing of the strength of such fluids being increased beyond their normal strength or that of ordinary saturated solutions. Sept. 12, 1888.

13,221. G. F. REDFERN. London. Improvements in mechanical telephones (G. F. Shaver, United States). Sept. 12, 1888.

13,223. G. SCARLETT. Liverpool. Improvements in or relating to electrical alarm-clocks and indicators. Sept. 12, 1888.

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13,274. R. K. Boyle. London. Improvements in and relating to telephonic and phonographic apparatus. Sept. 13, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

NOTE.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

September 15, 1888.

12,418. S. Z. de Ferranti. London. Improvements in conveying electric energy and in applying the same to the production of motive power. September 13, 1887.

12,419. S. Z. de Ferranti. London. Improvements in electric railways. September 13, 1887.

12,437A. R. E. B. Crompton and J. Swinburne. Chelmsford. Electrical measuring instruments. [Note.—This application having been originally included in No. 12,437, dated September 14, 1887, takes, under Patents Rule 23, that date.] September 14, 1887.

13,164. H. R. Fisher. London. The application of electricity to the controlling of gas and other cocks and valves. September 28, 1887.

13,561. H. W. Kolle. London. Improvements in electricity meters. October 6, 1837.

14,226. M. J. R. Jacquemier. London. Apparatus for measuring electric currents or electrical counters. October 19, 1887.

14,509. H. L. Callendar. Cambridge. Improvements in apparatus for measuring temperature on the absolute scale by means of change of electrical resistance. October 25, 1887.

15,158. J. Sinclair and J. P. Rees. London. Improvements relating to electric safety lamps. November 7, 1887.

15,939. W. Webster, jun. London. Improved apparatus for the electrolytic treatment of sewage and other impure liquids. November 19, 1887.

16,087. J. S. Farmer. Manchester. An electric contact maker, particularly applicable for use in connection with coin-freed apparatus. November 23, 1887.

3,986. B. M. Drake and J. M. Gorham. London. Improvements in plates for secondary voltaic batteries. March 14, 1838.

5,586. H. H. Lake. London. Improvements relating to holders or supports for electric incandescent lamps and to contact devices for use therein (C. Grivolas, France). April 14, 1888.

11,403. H. H. Lake. London. Improvements in apparatus for the propulsion of vehicles by electricity (F. J. Weiss, United States). August 7, 1888.

11,705. W. P. Thompson. Liverpool. Improvements in apparatus for measuring electric currents and recording the amount of electric energy consumed in a given circuit (The Westinghouse Electric Company, United States). August 14, 1888.

PATENTS SEALED.

September 7, 1888.

9,264. J. G. Lorrain. London. Improvements in electric clocks. June 29, 1887.

10,199. H. C. Bull and Company (Limited) and H. C. Bull. London. Improvements in electric-metallurgical processes and apparatus therefor. July 21, 1887.

10,555. C. P. Elieson. Leytonstone. Improvements in electrical batteries. July 29, 1887.

11,091. J. S. Raworth and H. M. Sayers. London. Improvements in and connected with friction couplings governed by electricity. August 13, 1887.

11,704. W. E. Langdon, J. C. Fuller and G. Fuller. An improvement in electrical insulators. August 29, 1887.

11,718. H. Gläser. Vienna, Austria. Improvements in actuating mechanism for electrostatic generators. August 29, 1887.

11,776. W. H. Beck. London. New or improved system or apparatus for synchronising electric telegraph instruments (G. A. Cassagnes, France). August 30, 1887.

14,270. B. J. B. Mills. London. Improvements in means or apparatus to be employed in the production of sheet copper by electro-deposition (E. Emerson, United States). October 20, 1887.

5,831. T. Schönherr-Schöner. London. Improvements in means or apparatus for lifting, lowering, and regulating the height of the elements in electric batteries. April 19, 1888.

6,191. C. A. J. H. Schroeder. London. A mode of preparing carbons for electric arc lighting. April 26, 1888.

7,851. W. P. Thompson. Liverpool. Improvements in switches for electric circuits (G. Westinghouse, jun., United States). May 29, 1888.

7,853. W. P. Thompson. Liverpool. Improvements in or relating to storage batteries (C. D. P. Gibson, United States.) May 29, 1888.

September 14, 1888.

4,533. M. R. Ward. Westminster. Improvements in electric locomotives and vehicles. March 26, 1887.

10,767. W. Lowrie, C. J. Hall and H. W. Kolle. London. Improvements in instruments for measuring electric currents, and for regulating and controlling dynamo-electric machines and prime movers. August 5, 1887.

11,751. A. E. Nicholl Streatham. Improvements in electrical signalling apparatus for railways. August 30, 1887.

11,932. C. D. Abel. London. Improved means for making and insulating the joints or connections of electrical conducting tables (Siemens and Halske, Berlin, Germany). September 2, 1887.

11,950. J. S. Ross and H. Bains. London. Improvements in electrical telephones. September 3, 1887.

12,025. E. Fitzgerald. London. Improvements in apparatus for operating or controlling type writers, type setting machines and the like by the aid of electricity. September 5, 1887.

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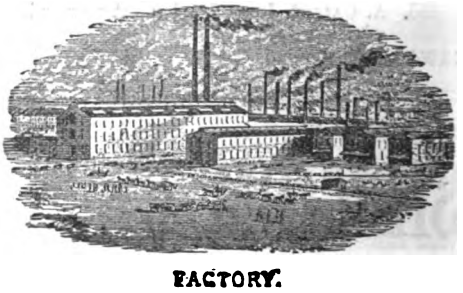
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16,554. G. BINTER. Munich, Germany. A new or improved electric apparatus for indicating distant water level and similar purposes. December 1, 1887.

1,128. The Rev. A. A. FORTIN. France. Improvements in galvanic batteries. January 25, 1888.

1,968. W. TILLEY. Brighton. Improved secondary battery or accumulator for the storage of electricity. February 9, 1888.

4,456. A. COLLINGRIDGE. London. An improved method of administering galvanic currents for curative purposes. March 23, 1888.

5,732. H. H. LAKE. London. Improvements in and relating to apparatus for measuring electric currents, which apparatus will also serve as a motor (E. Thomson, United States). April 17, 1888.

6,157. R. E. KEEN. St. Leonards-on-Sea. Improvements in lanterns for electric arc lamps and in posts or columns for supporting the same. April 25, 1888.

7,541. W. P. THOMPSON. Liverpool. Improvements in dynamo-electric generators or motors (H. W. Spang, United States). May 22, 1888.

7,850. W. P. THOMPSON. Liverpool. Improvements in or relating to alternate-current electric distribution (G. Westinghouse, Jun., United States). May 29, 1888.

7,977. H. G. MORRIS and P. G. SALOM. Philadelphia, United States. Improvements in the mode of filling secondary battery plates. May 31, 1888.

8,171. J. J. GHEGAN. New Jersey, United States. Improvements in magneto-electric liquid level indicators. June 5, 1888.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

11,543, 1887. TUDOR, H. Electrodes for electric accumulators, &c. (Price 8d.)

12,414, 1887. PHILLIPS, F. C., and HARRISON, H. E. Electric arc lamps. (Price 8d.)

12,763, 1887. FORBES, G. Electric meters. (Price 8d.)

13,853, 1887. CALVERT, G. S. Telegraphic apparatus for transmitting orders, &c. (Price 8d.)

13,978, 1887. NOBLE, A. Electric fixing gear for guns. (Price 11d.)

14,416, 1887. CORBETT, J. L. Telephonic apparatus. (Price 8d.)

14,954, 1887. TERRILL, W. Deposition, &c., of metals by electrolysis. (Price 6d.)

8,637, 1888. PARCELLE, A. L. Electric clocks. (Price 8d.)

10,631, 1888. KASELOWSKY, E. Electrical night signalling. (Price 8d.)

NEW COMPANIES REGISTERED.

SHEFFIELD TELEPHONE EXCHANGE AND ELECTRIC LIGHT COMPANY (LIMITED).—This company was registered on the 11th inst., with a capital of £60,000, in £10 shares, to purchase from John Tasker, of Sheffield, the goodwill of the Sheffield Telephone Exchange and the Rotherham Telephone Exchange, and also the electrical business carried on by him. The subscribers are:—

	Shares.
*J. Tasker, Sheffield, merchant and manufacturer	1
*J. Gamble, Sheffield, merchant and manufacturer	1
*G. Senior, Sheffield, merchant and manufacturer	1
J. Burdekin Jackson, Sheffield, merchant and manufacturer	1
*G. Franklin, Sheffield, chartered accountant	1
J. Jonas, Sheffield, merchant and manufacturer	1
J. F. Smith, Sheffield, timber merchant	1

The number of directors is not to be less than 3, nor more than 6; qualification, 20 shares; the first are the subscribers denoted by an asterisk, and Mr. William Tasker; remuneration, £300 per annum, to be divided as they may determine.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended September 14, 1888, amounted to £4,406.

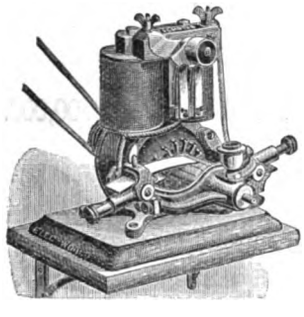
VICTORIAN ELECTRIC COMPANY.—At the ordinary general half-yearly meeting of the shareholders of this company, held on July 31st, at the City Bank Chambers, Melbourne, Australia, Mr. Rowan, the managing director, moved that the company be wound up voluntarily. The motion had the full consent of the shareholders in London, who had authorised him to act under the altered conditions, and thus the patent rights would be secured to the new company, to whom it was proposed to transfer the business. Negotiations with another company were still going on, and it was hoped that they would be of distinct value to this company. The motion was carried. The following resolution was subsequently agreed to:—"That Mr. J. F. Levien, Mr. F. C. Rowan, and Mr. H. Fink be appointed liquidators to sell and transfer the business, property, and goodwill of this company forthwith, or at any time hereafter, to a company registered under the Companies Statute, 1864, for the purpose of purchasing the same, and to receive in compensation for such transfer or sale shares in such new company, for the purpose of distribution amongst members of this company; or, if thought expedient, authorising the liquidator or liquidators to enter into any other arrangement whereby the members of this company may, in lieu of receiving cash, shares, or other like interests, or in addition thereto, to participate in the profits of or receive any other benefit from the purchasing company."

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended September 14th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,607.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated receipts of this company for the half month ended September 15th, 1888, were £2,479, as compared with £2,065 in the corresponding period of 1887.

PERSONAL.—Messrs. Arthur Carey, A.M.I.C.E., and Guy C. Fricker, A.M.I.T.E. and E., inform us that they have commenced business together as consulting electricians, electrical engineers and contractors, at No. 12, Delahay-street, Westminster, London, S.W.

DOMESTIC ELECTRIC POWER.



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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Sept 19, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Sept. 19, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	43½ 44½	3 1 8	Jan., Apr., July, Oct.	44⅜	42
2,614,820	Stock	10/0	Do. Preferred	72⅝ 73½	3 14 10	,, ,,	73½	71
2,614,820	Stock	nil.	Do. Deferred	15½ 16	...	February	16	15 15/16
130,000	£10	3/0	Brazilian Submarine	13⅜ 13⅝	5 4 8	Mar., June, Oct., Dec.	13⅝	13⅛
16,000	10	9/0	Cuba Submarine	13½ 14½	5 19 4	February and August	14⅛	...
6 000	10	10/0	Do. Preference	18 19	5 5 3	,, ,,	...	...
12,931	5	4%'87	Direct Spanish (£4 paid)	4 4⅛	...	March & September	4⅜	4
6,000	5	5/0	Do. Preference	9½ 10⅛	4 15 3	April and October	...	...
60,710	20	2/0	Direct United States	10 10½	3 18 1	Jan., Apr., July, Oct.	10½	9 15/16
380,000	10	4/6	Eastern	12⅜ 12⅝	4 15 1	,, ,,	12⅝	12⅜
70,000	10	3/0	Do. 6 per Cent. Preference	14½ 15¼	3 19 0	,, ,,	15⅛	14⅜
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	3 18 0	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅞ 13⅛	4 19 1	Jan., Apr., July, Oct.	13⅛	12 15/16
22,050	10	8/3	German Union Telegraph and Trust	9 9⅜	7 7 4	January and March	...	...
179,177	10	3/0	Globe Telegraph and Trust	7 7⅛	4 16 7	Jan., Apr., July, Oct.	7 1/16	7
178,992	10	3/0	Do. 6 per Cent. Preference	14 14½	4 4 3	,, ,,	14½	14 1/16
150,000	10	5/0	Great Northern	13⅜ 14½	5 5 3	Jan., July, and April	14 1/16	...
17,000	25	37/6	Indo-European	38 40	6 5 0	April and October	...	...
33,348	10	3/0	London Platino Brazilian	6 6½	...	May and November	...	...
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	...	...
338,225	Stock	13½%	Submarine	135 145	10 0 0	February & August	...	...
30,000	10	6/0	West Coast of America	7⅜ 8¼	6 1 3	January and July	8	7⅞
150,000	Stock	8%	Do. Debentures	114 119	6 14 6	June and December	...	...
88.321	10	nil.	West India and Panama	1⅝ 1⅞	...	...	1⅞	1⅝
34,563	10	*10/0	Do. 1st Preference	12 12⅛	...	April and October	12⅛	12⅛
45,181	15	9/0	Western Brazilian	12⅛ 12⅜	5 1 3	March & September	12⅜	12⅛
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	£5 7s. '87	Consolidated Telephone and Maintenance	1/16 1⅛	...	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	1/16 7/16	3 9 0	...	...	...
80,000	5	10/0	United	13½ 13⅝	5 9 0	June and December	13 1/16	13⅜
50,000	5	2/6	United River Plate	5⅜ 5⅝	...	April and October	...	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3 3⅛	...	...	...	...
23,692	5	nil.	Do. (fully paid)	4 4⅛	...	February & August	4 1/16	...
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅛ 2⅜	...	...	2⅛	2 1/16
312,000	½	5% '86	Maxim-Weston	1/16 1/16	...	February	⅛	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	38½ 39½	6 1 7	March and July	39⅜	39
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16⅞ 17⅛	5 14 3	February & August	17¼	16⅞

* On account of arrears of dividend.

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

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1. Performing the duties of Trustee, Executor and Administrator.
2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the duties of the family solicitor.

The Corporation acts as Trustees for the Debenture Holders in Public Companies.

For terms, &c., application should be made to the General Manager at the Company's Office.

GEORGE PEARSON, *General Manager and Secretary.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 541.—Vol. XXI. FRIDAY, SEPTEMBER 28, 1888. Price 4d.

NOTES.

Prof. Lodge continues this week his interesting sketch of the electrical Papers read at the Bath meeting. Prof. Hicks's Paper and the discussion to which it gave rise seem to be of considerable suggestiveness, and they deal with matters to which many physicists and mathematicians have lately been giving great attention. A *résumé* of the statements made upon each side during the recent discussion on lightning conductors is given at the end of Prof. Lodge's sketch, and will greatly diminish the reader's labour in picking out the important points of the discussion.

We are pleased to learn that Mr. Preece's advocacy of the term "joule," which was proposed by the late Sir William Siemens for the work done by a watt in a second, has prevailed with the Electrical Standards Committee, who have now definitely sanctioned its use. Mr. Preece's new term "therm" for the water-gramme-degree centigrade unit of heat has also been adopted by the committee. Mr. Preece has done an important service to practical electricians in inducing the committee to take up the subject of the redetermination of the specific resistance of pure copper, as copper can now be obtained commercially of greater purity than the so-called pure copper adopted as a standard by Matthiessen.

The influence of light on the electric discharge through air, which is referred to in Mr. de Tunzelmann's Paper on Hertz's experiments this week, and also in a note on some experiments of Dr. Borgemann, is, as we pointed out in our leader last week, a subject of great theoretical interest. We shall shortly give an account of a theory of electrical action recently developed by Prof. Lindemann, of the University of Koenigsberg, which appears to throw considerable light on the phenomenon.

The Tenth Annual Meeting of the American National Telephone Exchange Association was held at the Hotel Brunswick, in New York, on September 4 and 5. The president, Mr. Henry Metzger, of Pittsburg, in his opening address contrasted the unrest and disquiet which had so long existed in the telephone business from doubts respecting the legal standing of the patents possessed by the different companies, with the sense of security which has followed the recent decision in favour of the American Bell Telephone Company. He pointed out that the effect of this security had been in many cases to induce the directors of telephone companies to pursue a more liberal policy, and one more in accord with the necessities of the business; at the same time warning his hearers that it would not do to fold their hands and rest content with the fruits of this legal victory. Mr. Metzger further insisted on the necessity of their insuring themselves against the dangers of competition in the future by leaving no stone unturned to give the best service at the least possible cost. The warning is one which may well be laid to heart nearer home. A short account of the principal subjects discussed at the Conference will be found in our "American Notes" this week.

From a letter which appeared in the *Financial News* this week, contrasting the telephone systems of Continental cities with that which prevails in London, we learn that the German Government is rapidly substituting silicium bronze for the heavy galvanised wire which has hitherto been used by them. The writer asks, Why has not the United Telephone Company done likewise? Probably because that company is a company, and not a department of the State. With more reason it is asked, Why advantage was not taken of the last great snowstorm to reconstruct the lines on more enlightened principles? Possibly the company could reply to this by showing that they have done so as far as was in their power. We say possibly; but as the United Company never reply to criticisms, being fully occupied in earning and paying dividends, nobody can say a good word for them with any degree of confidence. We desire to give them fair play; but they take no pains to command favour, and they consequently get none.

The Streets Committee of the City have shown commendable promptitude in taking steps to consider the most effective means of lighting the City by electricity, in view of the Electric Lighting Act passed this year. We trust that the deliberations of the committee will lead to a satisfactory result, and that when they present their report it will meet with a more favourable reception from the City authorities than was accorded to the one presented last February, after the protracted negotiations with the Anglo-American Brush Corporation.

Although prices in most departments of the Stock Exchange have been advancing of late, there has been a special upward movement in the quotations of telegraph securities, which has not been been so much due to speculations for a rise as to *bonâ fide* investment purchases. Telegraph Shares have been gra-

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dually absorbed by the public during the past few weeks, owing to the increased activity in trade, while a further stimulus has been given to the movement by the restoration of rates by the Atlantic companies.

THE increasing popularity of the evening classes at the Finsbury Technical College affords a welcome proof of the valuable work which it is doing, not only in imparting useful practical information to artisans and others who desire to avail themselves of the opportunity afforded them, but also in exciting a more widely diffused sense of its advantages. While we regret that the resources of the college will probably not allow of provision being made for all the applicants this year, we have little doubt that the necessity of passing a test examination before entry will have a beneficial effect in stimulating intending applicants to qualify themselves as fully as possible for obtaining the utmost benefit from the courses of instruction at the College. In order to promote this result the scheme of examination will have to be carefully considered, for one which would lead to the mere superficial "cramming" of text books would most certainly have exactly the opposite effect, but as the examination will be under the direction of Prof. THOMPSON and his able and practical colleagues we need have no fear of the kind.

THE new directors of the ill-fated Maxim-Weston Company have issued to the shareholders a statement of the position of its affairs—a statement which, if published in relation to any ordinary social affair, might be regarded as one long indictment against their predecessors in office. The present directors have the courage of their opinions, and believing that the company can be carried on prosperously "with honest and attentive management," recommend the experiment to be made. We sincerely wish they may succeed, and shall watch with interest the proposal to issue the remaining 188,000 5s. shares at 2s. 6d. It will be seen that the solicitors of Mr. HUGH WATT and the late accountants of the company call in question some of the statements contained in the document above alluded to.

MR. ROBERT ROBERTS, although no doubt a very amiable and unsuspecting person, is certainly as deficient in humour as that famous Member of Parliament who began his speech with "Sugar, Mr. Speaker," and could not understand the burst of laughter which interrupted him. Mr. and Mrs. HOWARD pouring raw sugar into the hoppers on a top floor and sugaring Mr. ROBERTS on the ground floor is such a spectacle of drollery that we can only hope the sugar came quite up to—or down to—it in refinement. Let us not be misunderstood, however. We do not deny that the sugar which Mr. ROBERTS actually saw, and the 5,000 barrels a-day which he expects to see, was and will be refined by electricity; on the contrary, we ardently hope it may be so. What astonishes us and gives us pause is his robust faith in the unseen and the unproved. Even Helen's babies wanted to see "the wheels go wound;" but Mr. ROBERTS is satisfied with the ticking—or, more correctly, the rumbling—of the machinery, which, it appears, sufficiently denotes electricity in the estimation of this gentleman "from Birmingham." BIRMINGHAM ought to know something about electrical processes, if it knows little or nothing about sugar refining. But Mr. ROBERTS has absolutely nothing to tell the people of Birmingham—who are its chief supporters in this country—about the new process except that it is a secret and is going to make their fortunes. If the sugar did not come down the spouts as rapidly as had been predicted, it was because "Mr. and Mrs. HOWARD" could not supply the hoppers with raw sugar fast enough. At present the profits of the venture appear to depend on the muscular activity of these two scions of the HOWARD family; and as regards the future, unless the number can be increased and their secrecy relied upon, electric sugar refining will apparently be conducted on a limited scale. This is disappointing, for we are burning to know what these HOWARDS are doing in the upper chambers. It may be something electrical; but at present all we can learn about it is that they are acting very much like Mr. ARTEMUS WARD'S nigger, who turned the handle of his "perpetchual moshan mashin."

Southend.—It is proposed to work the tram cars running along the new pier at Southend by electricity.

Electric Sugar.—A sample of sugar refined by the new electric process is on exhibition at the office of the *Confectioners' Union*, at 171, Queen Victoria-street.

Walsall.—A new Science and Art Institute was opened on Monday at Walsall. *Fêtes* were held to celebrate the occasion, and a football match was played at night by electric light.

The Mason Science College.—The next session of the Mason Science College, Birmingham, will commence on 1st October. Further particulars will be found in our advertisement columns.

Breaking of an Atlantic Cable.—The Anglo-American Company's Brest-St. Pierre cable broke last Monday. This is the old 1868 cable, which was only repaired on the 28th of July last.

Society of Engineers.—The next meeting of this society will be held on Monday, October 1st, at the Westminster Town Hall, when Mr. W. Lawford, M.I.C.E., will read a Paper on "Light Railways."

The United Telephone Company.—We learn that several changes have been carried out in the staff of the United Telephone Company. The reduction in numbers is small, but there has been a thorough rearrangement of duties.

The British Association.—Among the money grants submitted to the General Committee of the British Association for approval at their recent meeting was one of £100 for continuing the work of the Committee on Electrical Standards.

Cowpen.—Owing to the dispute between the local board and the gas company the town of Cowpen has been left for some time in darkness. By way of protest against this state of things, there was recently a large torchlight procession all round the town. The negotiations with regard to the electric light have come to a complete deadlock.

Portuguese Cable to the Azores.—The *Diario Popular* of September 21st says that the submarine cable which is to join Portugal with the Azores was expected to leave London on Sunday last. The cable will be laid from a point on the River Minho to be chosen by the Government, which has instructed the engineer, Senhor Benjamin Cabral, to take the necessary steps.

Electrical Communication with Lightships.—In the course of a discussion upon the defence of the country, at the autumn

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meeting of the Association of Chambers of Commerce at Cardiff, Mr. Brooke, of Plymouth, said that the Plymouth Chamber were strongly of opinion that the Government should give greater attention to the question of electrical communication between lighthouses, lightships, and the coast.

Berlin.—The following is a list of the Berlin Theatres lit by electricity, and using a total of more than 13,000 incandescent lamps:—The Royal Opera, 5,000; The Comedy, 2,000; the German Theatre, 1,200; the Barnay Theatre, 1,250; the Kroll Theatre, 300; the Reichshallen, 600; the Freidrich Wilhelm Stadt Theatre, 1,200; the Lessing Theatre, 1,000; the Residenz Theatre, 1,000; and the American Theatre, 200.

Greenwich District Board.—At a meeting of the Greenwich District Board on September 19th a letter was read from the solicitors to the London Electric Supply Corporation, applying for a license, under the Electric Lighting Act, authorising that corporation to erect and maintain electric lines and works and to supply electricity within the district of the Board. The matter was referred to the District Committee, but was not to be considered until certain information was obtained.

The Telephone at Aldershot—During the recent experiments with the new rifle at Aldershot communication was maintained between the markers and the firing party by means of the telephone, and direction and elevation were corrected according to the intimations received from the targets. Some idea of the assistance afforded by the use of the telephone at these important experiments may be gathered from the fact that the firing took place at ranges varying from 2,000 to 2,800 yards.

Electrical Engineering Courses.—Prof. W. Grylls Adams, F.R.S., of King's College, London, will deliver a course of lectures on "Electricity and Magnetism" during the forthcoming Academical year. The lectures will be given once a week, and two days every week will be devoted to practical work. Courses of instruction in electrical engineering have also been arranged for the 1888-89 Session of the Glasgow and West of Scotland Technical College. Further particulars with regard to both of these courses will be found in our advertisement columns.

Manchester Electric Works Company.—We hear that Mr. Binswanger and some of his friends have purchased the works and patents of the defunct Electrical Portable Battery and Gas Igniting Company, with the intention of carrying on the manufacture of electric light fittings and other electrical apparatus. These large works, which are at Manchester, will be carried on under the title of the Manchester Electric Works Company. To meet the requirements of London customers, however, Messrs. Binswanger and Co. will still continue to manufacture in town.

A New Torpedo Boat.—A new submarine torpedo boat, called the "Gymnote," laid down at Toulon on the 30th of April last year, and built on the plans of M. Zede, a retired French Navy constructor, was launched on Tuesday last, the operation being carried out in the strictest privacy. The new boat is nearly 60ft. in length between perpendiculars, and about 6ft. beam. She is provided with a 50 horse-power Krebs electric motor and other machinery, the latter to be worked by means of compressed air. Accommodation is provided for one officer, two engineers, and a seaman.

An Electric Actinometer.—Messrs. Gony and Rigollet have devised a small battery of peculiar construction that may, according to the *British Journal of Photography*, be used as an actinometer. It is made by heating a clean plate of copper over a Bunsen burner till a layer of cuprous oxide forms; this plate, with one of unaltered copper, forms the battery. A galvanometer is introduced into the circuit and the battery then exposed. The effect is instantaneous, and disappears when the light is cut off. Diffused daylight produces an alteration of several hundredths of a volt, direct sunlight an alteration of at least a tenth of a volt. It is stated that with a Thomson galvanometer it is possible to recognise the effect of a candle flame at a distance of several yards.

The Krebs Telephone.—M. Krebs has recently designed a form of telephone the magnetic circuit of which is closed, save for the small air space between the core and the diaphragm, and at the same time is of constant magnetic resistance. Both the core and diaphragm are of soft iron, the magnetic field being produced by one or more magnets, which on the one hand have magnetic connection with the diaphragm, and on the other with the core carrying the bobbin. The diaphragm is of somewhat curious construction, not being of uniform thickness, but designed so that in no part of its section is the iron saturated. By this arrangement the variations in the magnetic field due to the vibrations of the plate are much intensified, with a corresponding increase in the efficiency of the telephone.

Strand District Board of Works.—Dr. Sandwell brought up the report of the Lighting Committee with regard to an application by the London Electric Supply Corporation (Limited) for permission to run a cable through Carey-street and across Portugal-street to the rear of the Royal College of Surgeons. The committee advised that the Board do not refuse the application, subject to certain conditions being complied with. The committee had considered the various applications before them in respect both to licenses and provisional orders for supplying the district with electricity. They were of opinion that the Metropolitan Electric Supply Company (Limited) presented the greatest advantages for the supply within the district, and therefore recommended the Board to approve the granting of a license by the Board of Trade to that company. The report was adopted.

Douse's Fire Check.—Among the appliances which were shown at the recent Fire Rescue Exhibition was Douse's electrical and automatic fire check. Briefly described, this is a chemical sprinkler which is fixed to the ceiling of the building to be protected. By pressing an electric button an alarm is sounded in every room, and the chemical sprinklers are set in action; it also acts automatically. The apparatus consists of a cylinder filled with chemicals, which, on being released, generate a gas in which fire cannot live. The setting in action by electricity is accomplished in two ways. First of all, there is a connection with the outside of the building, on the principle of the fire-alarms in the streets. If a passer by observed that a fire had broken out he could at once press the electric button, which sets the fire check in action. Secondly, immediately the temperature rises to 150° F. an electro-magnet is brought into play, and the sprinklers act automatically.

The Electric Lighting of the City.—At the fortnightly meeting of the Commission of Sewers, held on Tuesday at the Guildhall, Mr. J. V. Moore asked the Chairman of the Streets Committee whether he could give the Court any information on the subject of the electric lighting of the City.—Mr. Bridgman said although the new Act with reference to electric lighting dated only from this year, the committee had very effectually commenced to grapple with the question, and had come to a resolution to refer the matter to the engineer and solicitor to take the opinion of Mr. Preece, and to report on the matter generally, in order that the committee might have drawn up certain conditions on which the electric lighting companies might be asked to send in tenders for lighting the City,

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Several communications had been received from these companies, and their consideration had been adjourned in order that the committee might deal effectually with them when they got the report.

Leamington.—At the close of the meeting of the Leamington Town Council on Monday, the 17th inst., an animated discussion took place in committee on the question of the electric lighting of the town. After a letter of Messrs. Shippey Brothers, setting forth the advantages of the Waterhouse system, had been discussed, Alderman Gilbert moved a resolution to the effect that Messrs. Chamberlain and Hookham be requested to meet the Council in fourteen days from that date to explain fully what course they intended to take to improve the insufficient lighting of the main thoroughfare of the borough. This resolution was not seconded until after considerable discussion; and then Dr. Thursfield moved an amendment that an expert be called in to determine the quality of the light now being supplied, and whether it is of the illuminating power specified in the contract. A second amendment was moved, to the effect that an estimate be invited from Messrs. Chamberlain and Hookham for the erection of eight arc lamps to be fixed on the Parade as an experiment. This was carried after two hours' discussion.

The Paris Telegraphists.—About 1,500 post office and telegraph clerks met on Monday evening last at the Salle Wagram to protest against the disciplinary measure taken against their comrades of the central office by the Director-General. A number of female telegraphists were present at the meeting. A resolution was passed protesting against the punishment inflicted on the delegates who had signed a circular in the name of the whole body of clerks, and approving every word in that circular. A subscription on behalf of the clerks banished from Paris, started at the meeting, produced about six hundred francs. An official note has contradicted the statement that telegrams have been delayed in consequence of acts of the telegraph clerks. The note attributed the delay to the stormy state of the atmosphere. It appears, however, that there really was delay in the transmission of telegrams not explained by the state of the weather. At the Bourse the Morse apparatus was broken, and parts of the Hughes apparatus were removed. Communication with Amsterdam was interrupted, and telegrams to Brussels, Havre, Lyons, and Marseilles were delayed. A strict inquiry has been ordered into what has occurred, and several of the clerks have been temporarily suspended.

Telephone Extension.—In 1886 the Minister of Posts and Telegraphs granted to the Société des Téléphones, for thirty-five years to come, the concession of all the telephone lines then in existence or to be afterwards constructed. This concession placed a serious obstacle in the way of the development of the telephonic system, and the Government authorities have lately been pressed to seek some means for remedying the evil. An effective step in this direction, says *Industries*, has just been taken. M. Coulon, the Director-General of Posts and Telegraphs, has addressed to the departmental directors of his administration a circular relative to the construction of new telephone systems in towns. After setting out the actual situation of the urban State telephone systems, in which the subscribers pay the annual rent of 200fr., plus the cost of the apparatus and erection, charged for at the rate of 150fr. per kilometre of wire, the circular points out the method of procedure in the case of new urban systems. For all towns which shall apply for it, the Government authorities will draw up plans and estimates of the cost of erection and maintenance till the year 1890, and if the municipal authorities are willing to advance the money, the State will execute the work. The town will then be allowed to repay itself this advance by collecting the subscriptions till the sum is made up; in short, each town controls its own telephone system, the municipal budget provides the necessary funds, and these are repaid by the subscribers' rents.

Evening Classes at Finsbury Technical College.—The evening classes at the Finsbury Technical College open for the Winter Session on October 1. The numbers of students who attended during the past session at the courses in electrical engineering were so great that the authorities talk of instituting an entrance examination to keep out the less competent applicants if, as is expected, there is as great a rush as last year. The Wednesday evening elementary course, devoted chiefly to electric instruments and more general applications of electricity, remains almost unchanged from last year; but the laboratory work for this course has been revised, and the electric lighting of the beginners' laboratory and of the magnetic laboratory has been refitted. The Monday evening advanced course begins this year with the topic of Accumulators and Electro-plating, Professor Thompson having placed these early in the course in order that they may not be crowded out by the lectures on dynamo machines, arc lamps and glow lamps. The laboratory work for this course has been enlarged, and the dynamo room re-arranged so as to admit of more machinery being placed at the disposal of students. Mr. Robinson lectures on "Practical Physics," and Mr. Rousseau again takes a special laboratory class for instruction in electro plating and typing. There are no "special short courses" on electrical subjects this year, but Prof. Perry is to give one on "Spiral Springs" in the autumn, and another short course after Christmas on the "Differential Calculus as applied to Mechanical and Electrical Engineering." There is also a special class in pattern making for engineers. Prof. Thompson is to give a short course of lectures in the new year on "Optical Principles and Practice."

The Electric Light at Barnet.—The following is taken from the *Barnet Press*:—"We regret to say the electric lighting at Barnet has not improved since our notice of last week; there are still about one-third of the lamps unlighted, and although an attempt has been made to assist the electric rays by the feeble flicker of a few oil lamps, the present position is anything but satisfactory, a considerable part of the district being in darkness. On the 6th inst., at about ten o'clock, the whole of the lights went out for some minutes. Again, on the 12th inst., the lights were not started till a quarter-past seven, and after burning unsatisfactorily for an hour they all went out; they were, however, re-lighted, but finally collapsed at half-past eight, and were not lighted again till after midnight. As an illuminant of our public streets the new light has nothing to recommend it in point of cost, for it is indubitably more expensive than the gas which it has for the time replaced, and it is, to say the least, disappointing to find that, as a whole, our town is less effectively lighted than formerly. Matters of opinion apart, it is generally recognised that there has been failure on the part of the contractor to fulfil the contract which he voluntarily entered into after months of deliberation and arrangement; the agreed number of lamps have never been lighted, many of the lamps are admitedly below the contract standard, and when the light has failed, the reserve store of oil lamps (which we were told would be held in readiness in case of emergency) were conspicuous by their absence. The contractor is either doing his level best or he is not, and a judgment based upon either alternative is unsatisfactory: if doing his best, the result is poor; if he is not doing his best—well, he ought to be. Promises are held out of more powerful machinery

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and a better light presently. We should be sorry to discourage any reasonable hope of improvement; but we confess that the patience of the public is very severely tried."

Long-Distance Telephony.—Dr. Wietlisbach has investigated the best conditions for telephone lines, and has arrived at the following laws for the effect of the disturbing causes: 1. The greater the resistance and leakage, the smaller is the strength of the current received; 2. High self-induction increases the distinctness of high notes; 3. Large capacity increases the distinctness; 4. High resistance diminishes the effect of self-induction, and increases the effect of capacity; 5. Leakage diminishes the effect of capacity, and increases that of self-induction; 6. In a conductor having high self-induction and large capacity, the relative intensity of the undulations increases and decreases periodically with the rise in the height of the note; 7. The magnetic permeability and the polarisation of the conductor destroy the clearness of the transmission. If all of the factors remained constant, it would be possible to design a line in which the relations between capacity, self-induction, resistance, &c., were such that all notes would be transmitted with equal clearness. For example, in a submarine cable where the capacity is great, a man's voice is heard further and more distinctly than a woman's, since capacity increases the distinctness of low notes as compared with high notes; but it would be possible to so increase the self-induction of the line that both would be heard with equal distinctness, and at the same time both would be more perfectly reproduced, since all the tones would be given their proper relative values. Unfortunately this cannot be readily done in practice, since the leakage, which diminishes the effect of capacity, and increases that of self-induction, is in most lines a quantity which varies with the state of the weather. Dr. Wietlisbach thinks, therefore, that the best way to build a line is to make all of the effects as small as possible, using a looped circuit of copper wire of low resistance and capacity. The empirical rule used in practice is to make the product of the resistance and capacity of any line less than a certain constant which has been determined by experiment. One would suppose, however, that by roughly adjusting the capacity and self-induction of the line much clearer speech would result.

Influence of Light on the Electric Discharge.—The current number of the *Philosophical Magazine* contains an interesting letter on this subject from Dr. J. Borgmann, of St. Petersburg. Some time ago the author communicated to the Russian Physico-Chemical Society some experiments on the transmission of the electric current through air, in which flames or points were used as electrodes. In the case of flame electrodes the author arrived at the conclusion that the transition resistance at the surface of the cathode flame was less than that at the surface of the anode flame. He considers that there is a connection between these results and the experiments of Hertz, Hallwachs, Wiedemann, Ebert, and Arrhenius, according to which the effect of light is to diminish the potential, especially if negative. According to the results obtained by some of these physicists, a current can be produced through the air between a negatively charged body and any insulated body separated from it by air; while, according to the author's experiments, such a current is produced directly between the flames or points. The similarity of the effect of points and flames he attributes to the electric glow from the point. On repeating Hallwachs's experiments, the author found that in the case of a negatively charged zinc disc the loss of charge takes place at an increasing rate as the illumination continues. Some experiments seemed to show an after effect of the light. Another experiment described in the letter was the following:—An electric regulator was removed to a considerable distance from the zinc disc, and the electric light was weak. When the disc was illuminated no diminution of the potential on it was visible, even when a zinc screen, perforated for the passage of the light, was placed very near the disc. The screen was removed, and in its stead a Bunsen flame in contact with the earth was placed before the disc at such a distance that it could have no influence on its charge. As soon as the regulator was opened and the light thrown upon the disc, the diminution of the potential of the disc immediately began, *i.e.*, *a current was established between the disc and the flame.* Thus the use of a flame as one electrode favours the creation of a current through the air when a charged zinc disc forming the opposite electrode is illuminated.

The Discovery of the Conducting Power of the Earth.—Historical Note.—The discovery of the conducting power of the earth, one of the most important discoveries affecting telegraphy, was due to Prof. August von Steinheil, astronomer and physicist, who was born at Kappoltsweiler on the 12th October, 1801, and who died at Munich on the 14th September, 1870. In the year 1835, whilst studying at Göttingen, Steinheil was earnestly invited by Gauss to reduce the Gauss-Weber system of telegraphy to a practical shape. This was the commencement of Steinheil's work in the domain of telegraphy, and his investigations soon led him to transform his laboratory at the Munich Academy into a veritable telegraph office. The *Electrotechnische Zeitschrift*, in a notice of a recently issued pamphlet containing an account of his life and work, points out than this great discovery of Steinheil's was by no means his only one. We owe to him the first telegraphic apparatus for the visible or audible reproduction of electric signals, not to mention the principle of the lightning arrester now so universally employed. In 1837 Steinheil established telegraphic communication between the Munich Academy and the Observatory, a distance of over three miles, and between his private observatory and his laboratory. The conducting power of the soil in the case of frictional electricity had been shown in 1746 by Winkler; and in 1803 Basse, of Hameln, had shown that the same held for galvanic currents; but it is evident that neither Winkler nor Basse clearly understood the phenomenon they had observed. Profs. Ermann, of Potsdam (1803); Aldine, of Calais (1803), von Sömmering and Schilling (1811) repeated Basse's experiments, but none of them thought of this fact in connection with telegraphy. Gauss being imbued with the idea of utilising the rails of a railway line as conductors, Steinheil set to work to investigate the matter, and obtained permission to carry out his experiments on the Nuremberg-Fürth line, the first constructed in Germany. Steinheil joined the rails at either end by copper wires, and in this closed circuit he placed his telegraph instruments; but the rails not being insulated he was unable to transmit signals through more than about 30 lengths of rail. He then insulated the rails as much as possible, and again tried to transmit signals, but without success. It was evident that the current was short-circuited, and this could only be through the earth. Steinheil then replaced one of the rails by an overhead wire, the two ends of which were connected to the remaining rail. Signals were now easily sent through the circuit, and the same took place even when several lengths of rail were taken up. Thus, in 1838, exactly 50 years ago, Steinheil discovered the fact that the earth was a conductor, and could be used in lieu of a return wire. He immediately applied his discovery to his Munich lines with perfect success. When Steinheil first announced his discovery it was regarded as a piece of trickery, but before long its value was realised and its truth tested.

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SKETCH OF THE ELECTRICAL PAPERS IN SECTION A AT THE RECENT BATH MEETING OF THE BRITISH ASSOCIATION.

BY PROF. OLIVER J. LODGE, F.R.S.

(Concluded from page 625.)

On Saturday the principal communication was one from Prof. Hicks on "A Vortex Analogue of Static Electricity," wherein an idea concerning the ultimate nature of electrostatic attraction is promulgated, which promises to have the most vital influence not only in electrostatics, but in electro-chemistry and theories of valency in general. These points came out most strikingly, not on Saturday when the Paper was read, but at a later stage on the Wednesday following. It so happened that, by reason of the section meeting on this Wednesday an hour earlier than usual, several of the authors failed to turn up, and the sitting threatened to collapse. The section, however, promptly requested its President to fill up the time by telling them the present state of the controversy concerning the elimination of Ψ from the general equations of the electromagnetic field—the equations concerned with electromagnetic wave propagation. Prof. Fitzgerald at once responded by telling us, not about Ψ, but about Hicks; calling attention to a few ideas which the vortex analogue of static electricity had suggested to him. Prof. Hicks joined in with fresh suggestions, and in about ten minutes of to and fro conversation the most splendid possibilities of future theory, avenues of light permeating the ultimate facts of chemistry as the ramifications of a lightning flash permeate the atmosphere, were opened up. One may attend many British Association meetings without hearing a "desultory conversation" such as this; one may organise discussions and endeavour to secure them, but they are by no means certainly so procurable. Like genius they must arise spontaneously, or not at all, and woe be to the President who nips them in the bud.

The main point in Prof. Hicks' communication was a statement of the way in which, under certain circumstances, a hollow vortex may arise between two bodies which are being separated in a perfect fluid. These hollow vortices, or whirls, or cyclones, differ from ordinary vortices in having as their core a stagnant portion of fluid, or an empty space, and their motion is what is known as irrotational—that is, there is no spin at every point of the liquid. The consequence of the centrifugal force of the whirl is a reduction of pressure at the centre, as meteorologists well know is the case with atmospheric cyclones, and as anyone may see in an ordinary plug washhand basin. The effect of this reduced pressure at the axis of the whirl is to enable the circumambient fluid to press the two bodies towards each other, and thus to give rise to a measurable attraction. The mathematical laws of hollow vortices are found by Hicks to be such that they distribute themselves over the surfaces of bodies precisely like lines of electrostatic force, and they urge the two bodies together with a force varying inversely with the square of the distance. Thus they obey the laws of electrostatic attraction, and every hollow vortex may be called a line of force. Their ends abutting on the surfaces of the bodies will be analogous to, and will represent, the phenomenon called "electrostatic charge;" and however far the bodies are separated these "charges" remain constant. The aspect of the whirls being opposite, as seen from either body, their ends may be styled positive and negative respectively.

If a third body is introduced between the original pair, some of the whirls separate into two, with their ends abutting on the intermediate body, which thus acquires equal positive and negative charges: it is subject to induction. And so on. All the main phenomena of static electricity may be imitated by the behaviour of these hollow vortices in a perfect fluid, and they take the place of lines of force.

Now comes the chemical application. The circumstance which is essential for the generation of these hollow vortices, when two bodies are separated from contact, is that during contact they shall be connected by an ordinary vortex filament with its ends abutting one on each body. Such a filament causes throughout the medium a state of rotation which results in the generation of a hollow vortex at the point of contact as soon as that contact is broken. When the distance between the bodies (which may now be called atoms) becomes considerable, the original vortex filament is so pulled out as to exert very little effect, and it may be neglected; but the hollow vortex generated by it increases in energy as the bodies are separated against its attractive influence, and retains its cross-section unimpaired.

The original vortex filament joining the atoms in contact thus corresponds to what chemists call a "bond" or unit of chemical affinity. There may easily be more than one such bond, perhaps as many as six, joining two bodies; it is a question of stability, and the limit of number can be worked out by vortex mathematics. The hollow vortex which makes its appearance when the atoms are separated corresponds to the electrostatic charges and lines of force existing between the monad constituents of a dissociated molecule.

If there are two bonds with the same sense joining two atoms in contact, then when they are separated two hollow vortices will be found between them, corresponding to the two units of electrostatic charge which are found on a dissociated dyad atom. Any one hollow vortex may easily split up so as to distribute its ends properly over the surfaces of the bodies as they are further separated, but its essential properties are unaltered by fission; and the exact dependence of the electrostatic charge on the original number of dissociated bonds is an evident restatement of Faraday's law of electrolysis.

But there is the possibility that two original bonds should whirl in opposite directions, and in that case they would neutralise each other's effect at the point of contact and generate no electrostatic charge at all when the bodies are separated. Such a mode of combination may correspond to what chemists style "molecular," and atoms dissociated from such molecules would be intractable to electrical influence—the compound would not be an electrolyte.

There is no need for the original vortex filament to reach across from one body to another; its ends may quite well abut both against the same body, and in that case we shall have a self-satisfied pair of units of chemical affinity. Another body coming into the neighbourhood of such a looped bond may open it out; and it may do so in either of two ways; it may break it in two in the middle, thus linking itself to the first body by two bonds of opposite sign; or it may let one end slide from the original body on to itself, thus effecting a monad style of combination, giving rise to electrified atoms when dissociated.

Furthermore, of the self satisfied or looped bonds possessed by a body there may be a considerable number—possibly a very great number; it is again a question of stability to be worked out, but not yet worked out, by hydrodynamics; and the loops may some of them be long, so as to project a good distance from the body, while some may be quite short and close to its surface.

The long loops will correspond to the important bonds able to intersect and combine with another atom at a considerable distance—that is, at a high temperature; while the shorter and closer loops can only be expected to act at close quarters, *i.e.*, when the temperature of the substance is low. Thus it may turn out that at very low temperatures all manner of complex aggregations are possible.

At first sight it might seem as if high temperature favoured chemical combination, but that is a mistake. High temperature is often necessary to break up existing molecules, and so to enable fresh and often more powerful combinations to form; but high temperature is a dissociating and expanding influence *per se*, and it is at low temperatures that the most unwieldy complexes are formed.

So far nothing has been said concerning the nature of the atoms themselves; but assuming that they can be formed of groupings of circular vortices, it becomes of interest to see what combinations are stable, and therefore possible. It has been shown that the greatest number of columnar or cylindric vortices which can waltz round one another in stable equilibrium is six;

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but Mr. Hicks surmises that, the circular form being a little more stable, a combination of as many as seven *rings* may be able to group together, threading each other in regular succession, and forming a single atom of a definite kind, up to which there are six grades, constituting other and simpler kinds of atoms. To form a more complex atom than this, these seven rings must be treated as a single atom, which can begin to link itself with from one up to seven others; and then the grouping will begin again; so that the properties of the elements and their atomic weights will fall into octaves. Should this view be borne out by hydrodynamical calculation the meaning underlying Mendelejeff's law will have a good chance of displaying itself; or rather, it will have been completely displayed.

So busy was Section A, that on Saturday, when many of the sections took a holiday, it split itself into two in order to get through its work; and even so, one of the sub-sections continued sitting till three p.m.

Towards the end of the day the report of the Electrolysis Committee was read. It was a short statement of the work that had been done by the members during the past year, and was followed by a few Papers. The communication of Lord Rayleigh concerning the velocity of light in electrolytes should have formed part of this report, and would have done so had the secretary of the Electrolysis Committee (O. J. L.) looked after its interests as he ought.

Prof. Fitzgerald and Mr. Trouton have continued their investigations into the accuracy with which electrolytes obey Ohm's law, and are now able to state that if there is any discrepancy for sulphate of copper it is less than three parts in a million. This is a very satisfactory result, the obtaining of which means a good deal of careful work as well as an ingenious method.

An account of Dr. Gladstone and Mr. Hibbert's experiments on the conduction of alloys and solid sulphides followed, wherein it was shown that the conductivity of fusible alloy was mainly and probably wholly non electrolytic, while sulphides of the form M_2S were most of them electrolytically decomposed by a current.

Prof. Armstrong and Dr. Arrhenius contributed some critical remarks on the general theory of electrolysis, which, however, in their absence, were taken as read, and will be printed with the report.

Mr. Shaw communicated a Paper sent by Dr. Richarz, from Berlin, containing an account of some experiments on the polarisation E.M.F. of a voltameter with very small electrodes, wherein he switched the voltameter cell quickly from a charging battery to a galvanometer by means of a Helmholtz pendulum, and thus obtained values of the polarisation decidedly lower than had been previously obtained with point electrodes by Buff. Richarz seeks to explain the difference by neglected heat effects.

The time of Tuesday was so largely taken up with a discussion on lightning conductors that Dr. Fleming's two Papers "On a Form of Standard Resistance Coil," and "On a Commutator for Charging and Discharging a Condenser at a known Rate," had to be taken as read.

Mr. Glazebrook stated the results of his continued most careful investigation into the state of the old B. A. Standards of resistance. Examining them with the most minute accuracy and plotting their results over a certain range of temperature, their curves all nearly intersect at a temperature where they are supposed to be correct. They do not, of course, exactly intersect at a point, but they agree very well; and, what is of most interest, they have preserved their relative values among themselves ever since they were first exactly compared by Dr. Fleming in 1875 (?). All except one, which has recently begun to show distinct signs of aberration, probably by reason of some slight defect in insulation. Since these coils are the world's material standard of resistance at the present time, it is most desirable to know that they are constant; and, inasmuch as they are made of different materials and have preserved their relative values, it is practically quite certain that their absolute values have remained unchanged.

The Committee on Electrical Standards are undertaking experiments with a view to construct a reliable standard of electrostatic capacity, and are examining some air condensers constructed and measured some time ago by Dr. Muirhead.

Mr. Preece's Paper on C.-G.-S. units is really a communication to the Electrical Standards Committee, asking them to sanction the use of the term "joule" for the work done by a watt in a second, as proposed by the late Sir W. Siemens. The committee have acquiesced in the suggestion, and the Joule is therefore now 10 million ergs, or a coulomb-volt. They have also, at Mr. Preece's instigation, sanctioned the name "therm" for the water-gramme-degree-centigrade unit of heat, the absolute unit of heat being either the erg or the joule, according to taste. The joule will make a unit of heat of very convenient size, because 4·2 such units will equal 1 therm. In other words, the absolute specific heat of water will be henceforward 4·2, and the specific heat of other things in proper proportion.

Mr. Preece further proceeds to lament the unfortunate circumstance which has caused the ampere to be one-tenth of the C.-G.-S. unit of current instead of one unit. He is sanguine enough to hope even yet for a change in this matter, but the feeling of the committee was not with him, though they all felt the inconvenience of the present state of things.

Another matter which he has succeeded in inducing the committee to take up is a redetermination of the specific resistance of pure copper. It appears that copper is now supplied commercially by manufacturers which eclipses the standard as tested by Matthiessen, and which was known in his day as pure copper.

Sir William Thomson described a determination of the product μK for air, commonly called a determination of the velocity of electromagnetic waves "v". A certain condenser had its capacity measured electromagnetically at Glasgow with the use of one of Sir William's new standard current weighing instruments, and it was then measured electrostatically in London by Professors Ayrton and Perry. The resulting value of "v" comes out from the experiments so far made distinctly too low, something like 293 thousand kilometres per second, with a possible total error of $1\frac{3}{4}$ per cent.; as compared with the 299·5 thousand kilometres per second determined by Professor Rowland, with very perfect condenser, absolute electrometer and ballistic galvanometer. Most of the German determinations of "v" slightly exceed 300; most of the British determinations slightly fall below it. If the method now described is to give a reliable value, it will doubtless be repeated many times, and the somewhat large margin of error reduced.

In connection with absolute determinations of great accuracy, it is surprising how many difficulties come in, such as seldom have to be thought of in ordinary laboratory observations. Considering all the care that has been taken in the construction of standards of length, it is rather depressing to be told by Prof. Rowland that the standard metre is an uncertain quantity, and that the various metre standards in use differ by so much as one-tenth of a millimetre, or a hundredth per cent. People accustomed to speak glibly about obtaining an accuracy of a tenth or a hundredth per cent. in their measurements little know what they are talking about. Probable errors of as much as 1 per cent. in an absolute measurement are much more frequent than is by many persons suspected.

Mr. Glazebrook has been most carefully and for a long time examining the specific resistance of mercury in glass tubes, a measurement which has revealed unexpected difficulties and distinct though minute discrepancies from previous determinations. There can be little doubt that Mr. Glazebrook's results are the most accurate yet obtained, and he states that the true ohm is equal to the resistance of a square millimetre column of mercury 106·29 centimetres long.

We are here getting down to the limit of accuracy with which the standard metre itself is known.

Sundry minor communications may be hastily glanced through. A method of utilising an electric current for calorimetry by Prof. Stroud and Mr. Gee really belongs to the subject of Heat. Mr. W. N. Shaw exhibited an arrangement for measuring the average temperature of an ex-

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tended body, consisting of wires imbedded in a long ribbon of india-rubber which could be wrapped about the body, and the resistance of the wire measured. The wire is made in two branches, each of a different metal, so that a differential galvanometer balance can only be exactly obtained at one particular temperature, and the compensation needed to correct any outstanding error is used to obtain the temperature. It is said to give it to about $\frac{1}{500}$th of a degree. Mr. J. Brown, of Belfast, exhibited some pretty and curious branching figures made by an electric spark on an ordinary photographic dry plate. Mr. Lant Carpenter stated some particulars concerning the E.M.F. and internal resistance of Gassner's jelly-filled battery cells, as measured by Mr. Rimington; and last, though not least, Sir William Thomson described some experiments made in his laboratory by Mr. Tanakadaté on the magnetisation of soft iron bars of different lengths in a uniform field. This Paper the writer regrets not having heard.

And now we have cleared the course for the Lightning Rod Discussion, which excited a good deal of interest, and which really was a discussion, in which many prominent members of the section took part, and on which much more might have been said had there been time.

The discussion is being reported in this journal pretty nearly verbatim; but out of such a mass of matter it will be difficult for anyone to pick out the salient points of difference between the opposite camps, and it may be useful to bring them into more marked relief.

The opposite camps may be styled the Practical *versus* the Theoretical. On the one side we find Constructors of lightning rods, Members of the Lightning Rod Conference, Meteorologists, and Engineers: a miscellaneous body of great experience headed for the time being with efficiency and good humour by the President of Section G, who has necessarily in his official position an enormous number of lightning protectors under his supervision.

On the other side we find some laboratory experiments, and a theory of the alternating character of a discharge, combined with a mania for talking about self-induction or electromagnetic inertia, and for poking this idea into a lot of places where it does not naturally seem to fit; excluding its influence, however, from other places where one would expect to find it, such as the interior of an iron rod.*

If views and statements so founded are to make headway against the experience of practical men, and to gradually introduce reform into existing procedure, it must be by reiterated statement and discussion, and after gradually acquired further experience, under circumstances and conditions arranged to test the new views on a large scale. On the other hand, if the self-induction mania has no sound basis in fact, the surest way of destroying it is to bring it into the arena and expose it to conflict. Hence it is that the organising committee of Section A arranged for the opposite camps to meet and skirmish at Bath.

The combat was not waged to the death, the lists being cleared before the combatants were half exhausted, so that it is quite possible they may meet again on some other arena. Meanwhile, the points at issue may be summarised thus: selecting those statements of Mr. Preece and his supporters which seem most generally accepted, or likely to be accepted, on that side; and numbering the opposing statements so as to correspond with them. No statement is here quoted or suggested which to the writer seems entirely absurd; because absurd statements may easily be made in debate without sufficient thought, and because such statements are not likely to be generally or weightily accepted, even if pressed by their propounder.

Statements made in the Practical Camp.

1. Properly constructed lightning rods never fail. When existing rods fail it is because there is something the matter with them—usually an insufficient earth.

2. Leyden jar discharges have nothing oscillatory or alternating about them, or at least the existence of such alternations is an unproved assumption.

3. Even if Leyden jar discharges should turn out to be oscillatory, there is no reason why lightning flashes should be of the same character. Lightning flashes have an apparent duration, and transmit telegraph signals, deflect compass needles, and do other things which alternating currents could not do.

4. The one thing needful for an efficient lightning protector is conductivity, sufficient conducting power to convey the whole charge quickly and harmlessly down to the earth, with which the conductor must make elaborate contact.

5. No danger is to be feared from a lightning conductor if only it be well earthed and be sufficiently massive not to be melted by a discharge. All masses of metal should be connected to it, that they may be electrically drained to earth.

6. The shape of the sectional area of a conductor is quite immaterial; its carrying power has nothing to do with extent of surface; nothing matters in the rod itself but sectional area or weight per foot run, and conductivity.

7. Points, if sharp, should constitute so great a protection that violent flashes to them ought never to occur.

8. Lightning conductors, if frequently tested for continuity and low resistance by ordinary galvanic currents, are bound to carry off any charge likely to strike them, and are absolutely to be depended upon. The *easiest* path protects all other possible paths.

9. A certain space contiguous to a lightning rod is completely protected by it, so that if the rod be raised high enough a building in this protected region is perfectly safe.

Statements made in the Theoretical Camp.

1. Rods as at present constructed, though frequently successful, may and do sometimes fail, even though their earth is thoroughly good; the reason being that they offer to a flash a much greater obstruction—a much worse path—than is usually supposed: an obstruction to be reckoned in hundreds or thousands of ohms, even for a very thick copper rod.

2. When a Leyden jar is charged it corresponds to a bent spring, and its discharge corresponds to the release of the spring. Its discharge current alternates, therefore, in the same way and for much the same reason as a twitched reed or tuning fork vibrates. The vibrations decay in either case because of frictional heat production, and because of the emission of waves into the surrounding medium. A single spark of a Leyden jar, examined in an exceedingly fast revolving mirror, is visibly drawn out into a close succession of oppositely-directed discharges, although its whole duration is so excessively minute.

3. A lightning flash is a spark between cloud and earth, which are two oppositely electrified flat surfaces, and the flash corresponds therefore to the internal sparking between the two plates of a great air condenser. All the conditions which apply to a Leyden jar under these circumstances are liable to be true for lightning. Sometimes the resistance met with, either in the cloud itself or in the discharger, may be so great that the spark ceases to be oscillatory, and degenerates into a fizz or rapid leak; but there can be no guarantee that it shall always take this easily manageable form; and it is necessary in erecting protectors to be prepared for the worst and most dangerous form of sudden discharge. The apparent duration of a lightning flash is due to its frequently multiple character, and indicates successive discharges, not one long-drawn out one. Nothing that lightning has been found to do disproves its oscillatory character; because Leyden jar discharges, which are certainly oscillatory, can do precisely the same.

4. Although some conductivity is necessary for a lightning conductor, its amount is of far less consequence than might be expected. The obstruction met with by an alternating or rapidly varying discharge depends much more on electromagnetic inertia or self-induction than upon common resistance. So much obstruction is due to this inertia that a trifle more or less of frictional resistance in addition matters practically not at all.

It is very desirable to have a good and deep earth in order to protect foundations and gas and water mains from damage, and in order to keep total impedance as low as possible.

5. The obstruction offered by a lightning rod to a discharge being so great, and the current passing through it at the instant

* Prof. Lodge's original lectures "On the Protection of Buildings from Lightning," were reprinted in *The Electrician*, June 22 and 29, July 6 and 13, 1888.

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of a flash being enormous, a very high difference of potential exists between every point of the conductor and the earth, however well the two are connected; hence the neighbourhood of a lightning conductor is always dangerous during a storm, and great circumspection must be exercised as to what metallic conductors are wittingly or unwittingly brought near or into contact with it. When a building is struck the oscillations and surgings all through its neighbourhood are so violent that every piece of metal is liable to give off sparks, and gas may be lighted even in neighbouring houses. If one end of a rain-water gutter is attached to a struck lightning conductor the other end is almost certain to spit off a long spark, unless it also is metallically connected. Electric charges splash about in a struck mass of metal, as does the sea during an earthquake or when a mountain top drops into it.* Even a small spark near combustible substances is to be dreaded.

6. The electrical disturbance is conveyed to a conductor through the ether or space surrounding it, and so the more surface it exposes the better. Better than a single rod or tape is a number of separate lengths of wire, each thick enough not to be easily melted, and well separated so as not to interfere with each other by mutual induction.

The liability of rods to be melted by a flash can be easily over-estimated. A rod usually fails by reason of its inertia-like obstruction, and consequent inability to carry off the charge without spittings and side flashes; it very seldom fails by reason of being melted. In cases where a thin wire has got melted, the energy has been largely dissipated in the effort, and it has acted as an efficient protector; though, of course, for that time only. Large sectional area offers very little advantage over moderately small sectional area, such as No. 5 B.W.G.

7. Points, if numerous enough, serve a very useful purpose in neutralising the charge of a thunder-cloud hovering over them, and thus often prevent a flash; but there are occasions, easily imitated in the laboratory, when they are of no avail; for instance, when one upper cloud sparks into a lower one, which then suddenly overflows to earth. In the case of these sudden rushes, there is no time for a path to be prepared by induction, no time for points to exert any protective influence, and points then get struck by a violent flash just as if they were knobs. Discharges of this kind are the only ones likely to occur during a violent shower; because all leisurely effects would be neutralised by the raindrops better than by an infinitude of points.

8. The path chosen by a galvanic current is no secure indication of the course which will be taken by a lightning flash. The course of a trickle down a hill-side does not determine the path of an avalanche. Lightning will not select the easiest path alone; it can distribute itself among any number of possible paths, and can make paths for itself. Ordinary testing of conductors is therefore no guarantee of safety, and may be misleading. At the same time it is quite right to have some system of testing and of inspection, else rust and building alterations may render any protector useless.

9. There is no space near a rod which can be definitely styled an area of protection, for it is possible to receive violent sparks or shocks from the conductor itself. Not to speak of the innumerable secondary discharges which, by reason of electro kinetic momentum and of induction and of the curious recently discovered effect of the ultra-violet light of a spark, are liable to occur as secondary effects in the wake of the main flash.

Just one word on the subject of iron *versus* copper. The writer last year thought and stated that, in so far as the substance of the conductor was magnetised by a discharge, iron would obstruct a lightning flash or any other rapidly-varying current enormously more than copper does. But the fact is, that the substance of a conductor is, by sufficiently rapidly alternating currents, not magnetised at all. The current is tubular, keeps wholly to the outer surface, and magnetises nothing inside. Hence the magnetisability of the substance of the conductor is of no moment at all; and iron, therefore, will do every bit as well as copper. Mr. Preece's experience with half a mill on iron-wire telegraph-post protectors leads him to uphold iron as entirely satisfactory. So, on this one point, as well as on the necessity existing for a good earth, a portion of the practical and of the theoretical camps have been able to agree.

Immediately after the discussion Dr. Janssen exhibited some preliminary attempts at photographs of lightning taken with a double-nozzled camera, having two sensitive plates, one fixed, the other revolving 30 times a second.* The same flash was depicted on both plates, but on the moving plate it was separated into two or three distinct streaks, showing its multiple character. Each constituent, however, was as clear and distinct on the rotating as on the fixed plate, and had, in fact, exactly the same shape and appearance, so that one could be superposed on the other exactly; thus proving its instantaneous character. The rate of spin was naturally nothing like sufficient to exhibit the alternating character of each constituent.

It is to be hoped that many more photographs of lightning will be taken on this plan, because there are evidently many kinds of composite flashes, and it is an excellent way of analysing them and correcting the impressions, often erroneous, formed by the eye.

On the whole, the Bath meeting, though not largely attended by the temporary class of members and associates, may be considered, so far as Section A is concerned, as one of the most interesting and important that have ever been held—thanks largely to the excellent arrangements made by the Secretaries; and the discoveries of Hertz, referred to by the President in his address, mark a distinct epoch in our acquaintance with electromagnetic phenomena.

* *See* "The Eruption of Krakatoa," a pamphlet by E. Douglas Archibald, Tunbridge Wells; or the Report of the Krakatoa Committee.

HERTZ'S RESEARCHES ON ELECTRICAL OSCILLATIONS.

BY G. W. DE TUNZELMANN, B.SC.

(*Continued from page 627.*)

Nodes.—The vibrations in the micrometer circuit which have been considered are the simplest ones possible, but not the only ones. While the potential at the ends alternates between two fixed limits, that at the central portion of the circuit retains a constant mean value. The electrical vibration, therefore, has a node at the centre, and this will be the only nodal point. Its existence may be proved by placing a small insulated sphere close to various portions of the micrometer circuit while sparks are passing at the discharger of the coil, when it will be found that if the sphere is placed close to the centre of the circuit the sparking will be very slight, increasing as the sphere is moved further away. The sparking cannot, however, be entirely got rid of, and there is a better way of determining the existence and position of the node. After adjusting the two circuits to unison, and drawing the micrometer terminals so far apart that sparks can only be made to pass by means of resonant action, let different parts of the circuit be touched by a conductor of some capacity, when it will be found that the sparks disappear, owing to interference with the resonant action, except when the point of contact is at the centre of the circuit. The author then endeavoured to produce a vibration with two nodes, and for this purpose he modified the apparatus previously used by adding to the micrometer circuit a second rectangle *e f g h* exactly similar to the first (as shown in Fig. 7), and joining the points of the circuit near the terminals by wires 13 and 24, as shown in the diagram.

The whole system then formed a closed metallic circuit, the fundamental vibration of which would have two nodes. Since the period of this vibration would necessarily agree closely with that of each half of the circuit, and, therefore, with that of the circuit C C', it was to be expected that the vibration would have a pair of loops at the junctions 13 and 24,

* *See* a letter in *Nature*, July 12, 1888.

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and a pair of nodes at the middle points of cd and gh. The vibrations were determined by measuring the sparking distance between the micrometer terminals 1 and 2. It was found that, contrary to what was expected, the addition of the second rectangle diminished this sparking distance from about 3 millimetres to about 1 millimetre. The existence of resonant action between the circuit C C′ and the micrometer circuit was, however, fully demonstrated, for any alteration in the circuit $efgh$, whether it consisted in increasing or in decreasing its length, diminished the sparking distance. It was also found that much weaker sparking took place between cd or gh and an insulated sphere, than between ae or bf and the same sphere, showing that the nodes were in cd and gh, as expected. Further, when the sphere was made to touch cd or gh it had no effect on the sparking distance of 1 and 2; but when the point of contact was at any other portion of the circuit the sparking distance was diminished, showing that these nodes did really belong to the vibration, the resonant action of which increased this sparking distance.

The wire joining the points 2 and 4 was then removed. As the strength of the induced oscillatory current should be zero at these points, the removal ought not to disturb the vibrations, and this was shown experimentally to be the case, the resonant effects and the position of the nodes remaining unchanged. The vibration with two nodal points was, of course, not the fundamental vibration of the circuit, which consisted of a vibration with a node between a and e, and for which the highest values of the potential were at the points 2 and 4.

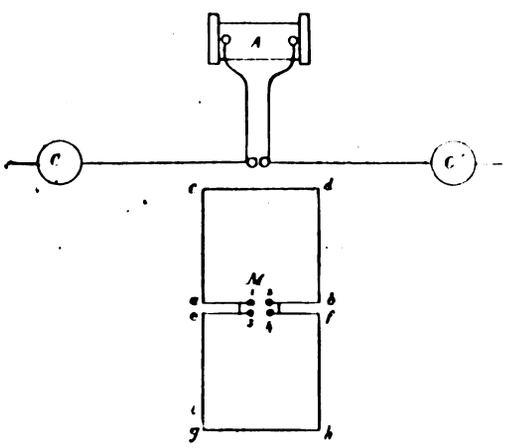

FIG. 7.

When the spheres forming the terminals at these points were brought close together slight sparking was found to take place between them, which was attributed to the excitation, though only to a small extent, of the fundamental vibration. This explanation was confirmed in the following manner:—The sparks between 1 and 2 were broken off, leaving only the sparks between 2 and 4, which measured the intensity of the fundamental vibration. The period of vibration of the circuit C C′ was then increased by drawing it out to its full length, and thereby increasing its capacity, when it was observed that the sparking gradually increased to a maximum, and then began to diminish again. The maximum value must evidently occur when the period of vibration of the circuit C C′ is the same as that of the fundamental vibration of the micrometer circuit, and it was shown that when the sparking distance between 2 and 4 had its maximum value, the sparks corresponded to a vibration with only one nodal point, for the sparks ceased when the previously existing nodes were touched by a conductor, and the only point where contact could take place without effect on the sparking was between a and e. These results show that it is possible to excite at will in the same conductor, either the fundamental vibration or its first overtone, to use the language of acoustics.

Hertz appears to consider it very doubtful whether it will be possible to get higher overtones of electrical vibration, the difficulty of obtaining such lying not only in the method of observation, but also in the nature of the oscillations themselves. The intensity of these is found to vary considerably during a series of discharges from the coil even when all the circumstances are maintained as constant as possible, and the comparative feebleness of the resonant effects shows that there must be a considerable amount of damping. There are, moreover, many secondary phenomena which seem to indicate that irregular vibrations are superposed upon the regular ones, as would be expected in complex systems of conductors. If, therefore, we wish to compare electrical oscillations, from a mathematical point of view, with those of acoustics, we must seek our analogy in the high notes intermixed with irregular vibrations, obtained say, by striking a wooden rod with a hammer, rather than in the comparatively slow harmonic vibration of tuning forks, or strings; and in the case of vibrations of the former class we have to be contented, even in the study of acoustics, with little more than indications of such phenomena as resonance and nodal points.

Referring to the conditions to be fulfilled in order to obtain the best results, should other physicists desire to repeat the experiments, Dr. Hertz notes a fact of very considerable interest and novelty, namely, that the spark from the discharger should always be visible from the micrometer, as when this was not the case, though the phenomena observed were of the same character, the sparking distance was invariably diminished. This effect of the light from the spark of an induction coil in increasing the sparking distance in the secondary circuit of another coil excited great interest when referred to by Prof. Lodge in the course of the recent discussion on Lightning Conductors at the British Association, and he pointed out that the same effect was produced by light from burning magnesium wire, or other sources rich in the ultra violet rays.

Theory of the Experiments.—The theories of electrical oscillations which have been developed by Sir William Thomson, von Helmholtz and Kirchhoff have been shown* to hold good for the open circuit oscillations of induction apparatus, as well as for the oscillatory Leyden jar discharge, and, although Dr. Hertz has not succeeded in obtaining definite quantitative results to compare with theory, it is of interest to inquire whether the observed results are of the same order as those indicated by theory.

Hertz considers, in the first place, the vibration period. Let T be the period of a single or half vibration proper to the conductor exciting the micrometer circuit; P its coefficient of self-induction in absolute electromagnetic measure, expressed, therefore, in centimetres; C the capacity of one of its terminals in electrostatic measure, and, therefore, also expressed in centimetres; and v the velocity of light in centimetre-seconds.

Then, if the resistance of the conductor is small,

$$T = \frac{\pi \sqrt{P C}}{v}$$

In the case of the resonance experiments, the capacity C was approximately the radius of the sphere forming the terminal, so that C = 15 centimetres. The coefficient of self-induction was that of a wire of length $l = 150$ centimetres, and diameter $d = 1/2$ centimetre.

According to Neumann's formula,

$$P = \int\int \frac{\cos \epsilon}{r} d s \, d s',$$

which gives in the case considered

$$P = 2 l \left(\log \frac{4 l}{d} - 0{\cdot}75 \right) = 1902 \text{cm}.$$

As, however, it is not quite certain that Neumann's formula is applicable to an open circuit, it is better to use von Helmholtz's more general formula, containing an undetermined constant k, according to which

$$P = 2 l \left(\log \frac{4 l}{d} - 0{\cdot}75 + \frac{1 - k}{2} \right).$$

Putting $k = 1$ this reduces to Neumann's formula, for $k = 0$ it reduces to that of Maxwell, and for $k = -1$ to Weber's. The greatest difference in the values of P obtained by giving these different values to k would not exceed a sixth of its mean value, and, therefore, for the purposes of the present approxi-

* Lorentz, Wiedemann's *Annalen*, Vol. VII., p. 161, 1879.

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mation it is enough to assume that k is not a large positive or negative number; for if the number 1902 does not give the correct value of the coefficient for the wire 150cm. in length, it will give the value corresponding to a conductor not differing greatly from it in length.

Taking P = 1902cm. we have $\pi\sqrt{CP} = 531$cm., which represents the distance traversed by light during the oscillation, or, according to Maxwell's theory, the length of an electro-magnetic ether wave. The value of T is then found to be 1·77 hundred millionths of a second, which is of the same order as the observed results.

The ratio of damping is then considered. In order that oscillations may be possible the resistance of the open circuit must be less than $2v\sqrt{P/C}$. For the exciting circuit used this gives 676 ohms as the upper limit of resistance. If the actual resistance r is sensibly below this limit, the ratio of damping will be $e^{\frac{rT}{2P}}$. The amplitude will therefore be reduced in the ratio 1 : 2·71 in

$$\frac{2P}{rT} = \frac{2v}{\pi r}\sqrt{\frac{P}{C}} = \frac{676}{\pi r} = \frac{215}{r}$$

oscillations. We have, unfortunately, no means of determining the resistance of the air space traversed by the spark, but as the resistance of a strong electric arc is never less than a few ohms we shall be justified in assuming this as the minimum limit. From this it would follow that the number of oscillations due to a single impulse must be reckoned in tens, and not in hundreds or thousands, which is in accordance with the character of the experimental results, and agrees with the results observed in the case of the oscillatory Leyden jar discharge. In the case of closed metallic circuits, on the other hand, theory indicates that the number of oscillations before equilibrium is attained must be reckoned by thousands.

Hertz compares, lastly, the order of the inductive actions of these oscillations, according to theory, with that of the effects actually observed. To do this it must be noted that the maximum E.M.F. induced by the oscillation in its own circuit is approximately equal to the maximum potential difference at its extremities; for if there were no damping these quantities would be identical, since at any moment the potential difference at the extremities and the E.M.F. of induction would be in equilibrium. In the experiments under consideration the potential difference at the extremities was such as to give a spark 7 to 8mm. in length, which must therefore represent the maximum inductive action excited in its own circuit by the oscillation. Again, at any instant the induced E.M.F. in the micrometer circuit must be to that in the exciting conductor in the same ratio as that of the coefficient of mutual induction p of the two circuits to the coefficient of self-induction P of the exciting circuit. The value of p for the case considered is easily calculated from the ordinary formulæ, and it is found to lie between one-ninth and one-twelfth of P. This would only give sparks of from $\frac{1}{2}$ to $\frac{3}{4}$mm. in length, so that according to theory visible sparks ought in any case to be obtained; but, on the other hand, sparks several millimetres in length, as were obtained in the experiments previously described, can only be explained on the assumption that the successive inductive actions produce an accumulative effect; so that theory indicates the necessity of the existence of the resonant effects actually observed.

(To be continued.)

ON THE APPLICATION OF ELECTRICITY TO THE WORKING OF A 20-TON TRAVELLING CRANE.*

BY W. ANDERSON, M. INST. C.E.

One of the travelling cranes in the foundry of the Erith Ironworks was originally constructed to be worked by hand, but preparations had been made for the application of wire-rope driving at some future time.

The crane is 39ft. 6in. span, and consists of a pair of wrought-iron girders resting on end carriages, each running on two wheels on an elevated line of rails. The gearing for hoisting for longitudinal and for cross traverse is secured on to the tops of the main girders; the hoisting chain passes from the barrel, which is at one end of the crane, over a pulley at the other, then back to pulleys in the cross traversing carriage which runs between the main girders, thence through a falling block, and finally to an anchorage under the barrel at the extreme end of the main girders. By this arrangement the crane occupies a moderate height, and the hook can come within 3ft. of each wall.

The inconveniences and wear attending the use of rope driving gear or of a long main driving shaft, and the dirt and special attention required by a steam crane, induced the writer to try whether electricity might not be used with advantage. Messrs. Elwell-Parker, of Wolverhampton, were communicated with, and these gentlemen undertook to supply the dynamo and a motor suitable for the peculiar requirements of a heavy crane.

The dynamo, which is considerably larger than is needed for the crane in question, is arranged to give up to 80 amperes at 120 volts, with 1,200 revolutions per minute. The armature is of the cylinder type, field-magnets shunt wound, resistance of armature ·07 ohm, and of the magnets 75 ohms. It is fixed in the main boiler house of the works, and is driven by a horizontal engine, having a cylinder 9½in. diameter, 12in. stroke, running at 180 revolutions with 50lbs. steam, by means of a link belt. The leads from the boiler house up to the conductor in the foundry, for a distance of 60 feet, are of 6 B.W.G. copper wire, while the conductor in the foundry is formed of an angle iron bar, 2in. × 2in. × ¼in., extending the whole 350 feet length of the shop; it has one face, roughly ground, and protected from rust by vaseline, and is secured to the iron pillars supporting the roof, being insulated by wood blocks. The return current travels along one of the rails on which the crane runs, the joints of the rails being united electrically by copper staples. The motor is one of Messrs Elwell-Parker's latest types, with single vertical magnet and a drum armature; it is shunt wound and constructed for 100 volts and 50 amperes, the armature resistance is ·056 ohm, that of the shunt 49·2 ohms. It is fixed on the working platform of the crane, beside one of the main girders. Its driving spindle carries a steel pinion, which gears into a double helical spur wheel, keyed on to a shaft which runs longitudinally on the top of the girder, and is connected by nests of three-bevel wheels, with friction clutch connections to the three shafts which command the several movements of the crane, the means of using the hand-power being still retained. Two sets of speed are arranged for each of the movements, namely :—

	Slow per min.	Fast per min.
Hoisting	3·4ft.	10ft.
Cross traverse	25 „	105 „
Longitudinal traverse	78 „	213 „

To provide against an undue current passing through the motor an automatic magnetic cut-out is fixed on the crane, and as an additional security a fusible wire is placed close to the dynamo to provide for the contingency of a short circuit. For the purpose of varying the power and speed to meet the requirements of the foundry, a set of resistance coils is provided governed by a special switch, by means of which different resistances can be introduced into the armature circuit of the motor, and the current can be cut off altogether; but so that it must be done by steps, and not suddenly. In starting the motor the reverse action takes place. The shunt coils of the magnets are connected to the two collectors so that the fields are always excited when the dynamo is running, whether the motor is working or not, the switch controlling only the armature circuit. The collector for the angle-iron conductor consists of a pair of insulated brass blocks pressed against it by means of a flat spring having a considerable range. An ordinary wire brush serves to collect the current from the rail; but the axle of one of the wheels is also connected to this brush to provide for the contact being in any way interrupted.

The handles for operating the several movements, the brake lever, the switch, and the automatic cut-out are all collected

* Paper read before the British Association at Bath, in Section G, September, 1888.

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EXPERIMENTS ON ELECTRIC FOUNDRY CRANE.—ERITH IRON WORKS, AUGUST, 1888.

Movement of crane.	Load on hook.	Total load on rails.	Volts at dynamo.	Amperes in circuit.	Watts at dynamo.	Watts at crane (mean).	Horse-power at crane (mean).	Speed of motor. Revs. per min.	Speed of crane movement. Feet per min.
Cross traverse—quick gear	.....	18 tons.	120	27	3240	3202	3·78	1166	105
Long traverse ,, ,, ...	.....	18 ,,	105	48	5040	4925	5·81	1100	201·3
Hoisting ,, ,, ...	.....	18 ,,	110	22	2420	2398	2 83	1166	9·92
Cross traverse ,, ,, ...	4 tons 12 cwt.	22 tons 12cwt.	98	47	4606	4493	5·3	1100	99
Long traverse ,, ,, ...	,, ,,	,, ,,	86	80	6880	6560	7·74	1050	192
Hoisting ,, ,, ...	,, ,,	,, ,,	90	76	6840	6551	7·73	1050	8·92
Cross traverse ,, ,, ...	9 tons 11¾cwt.	27 tons 11¼cwt.	130	65	8450	8229	9·71	1166	105
Long traverse ,, ,, ...	,, ,,	,, ,,	115	78	8970	8666	10 23	1166	213
Hoisting slow gear	,, ,,	,, ,,	103	58	5974	5806	6 85	1117	3·27
Cross traverse ,, ,, ...	14 tons 2¾cwt.	32 tons 2¾cwt.	112	44	4928	4831	5·7	1166	25·3
Long traverse ,, ,, ...	,, ,,	,, ,,	135	38	5130	5058	5·97	1333	89·3
Hoisting ,, ,, ...	,, ,,	,, ,,	115	73	8395	8125	9·59	1133	3·317
Cross traverse ,, ,, ...	19 tons 2¾cwt.	37 tons 2¾cwt.	135	51	6885	6752	7·97	1266	27·5
Long traverse ,, ,, ...	,, ,,	,, ,,	130	46	5980	5874	6·93	1250	83·7
Hoisting ,, ,, ...	,, ,,	,, ,,	98	86	8428	8058	9·95	1016	2·976

together, so that a single attendant can readily work the crane from one spot.

The crane was set to work in June last, and has continued to act satisfactorily ever since. The advantages of working by electricity are very great, especially in comparison to steam cranes. In large works a powerful dynamo would be established, and be driven by engines of an economical type. The steam from the main boilers is necessarily always available when the factory is at work, and the current can be easily carried into any part of the establishment. Steam cranes require the attendant to be at his post an hour or more before the works open, water and fuel have to be hoisted on to the crane, and the working is accompanied by dirt, steam, and smoke, the latter especially objectionable with overhead lights, or in shops where bright work is prepared or erected.

The duty realised is about 65 per cent. of the power developed in the driving steam engine. As far as can be judged at present, there is no special wear to apprehend. The conductors act satisfactorily though a considerable length is in the open air, and the dust, heat, and smoke of the foundry do not appear to affect the working.

The above table gives the electrical measurements made by Mr. E. W. Anderson, to whom the author is indebted for carrying out this comparatively novel application of electricity.

When first proposed the writer was not aware of the existence of any other electric crane, but he has since learned that Messrs. Mather and Platt, of Manchester, have had one working satisfactorily for some time, and that there is one also in France

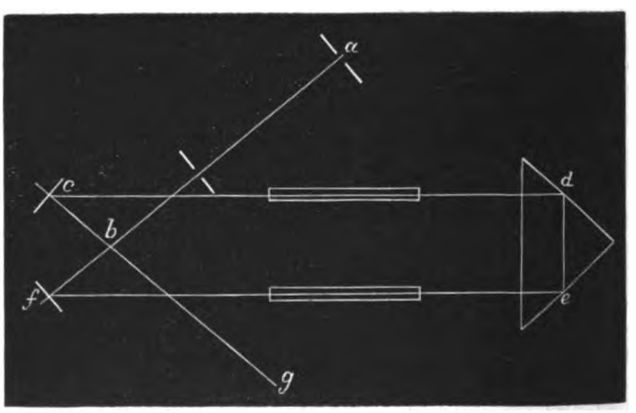
IS THE VELOCITY OF LIGHT IN AN ELECTROLYTIC LIQUID INFLUENCED BY AN ELECTRIC CURRENT IN THE DIRECTION OF PROPAGATION?*

BY LORD RAYLEIGH, SEC. R.S.

The question here proposed has been considered by Roiti (Poggendorff's *Annalen*, Vol. CL., p. 164, 1873) and by Lecher (*Rep. de Phys.*, Vol. XX., p. 151, 1884).† My experiments were made in ignorance of the work of these observers, and the results would scarcely be worth recording were it not that the examination seems to have been pushed further than hitherto. It may be well to say at once that the result is negative.

The interference fringes were produced by the method of Michelson, as used in his important investigation respecting "The Influence of Motion of the Medium upon the Velocity of Light."‡ The incident ray $a\,b$ meets a half-silvered surface at b, by which part of the light is reflected, and part is transmitted. The reflected ray follows the course $a\,b\,c\,d\,e\,f\,b\,g$, being in all twice reflected at b. The transmitted ray takes the course $a\,b\,f\,e\,d\,c\,b\,g$, being twice transmitted at b. These rays, having pursued identical paths, are in a condition to form the centre of a system of fringes, however long and far apart may be the courses $c\,d$, $e\,f$.

There is here nothing to distinguish the ray $a\,b$ from a neighbouring parallel ray. The incident plane *wave front* perpendicular to $a\,b$ gives rise eventually to two coincident wave fronts perpendicular to $b\,g$. With a wave incident in another direction the case is different. The two emergent wave fronts remain indeed necessarily parallel, both having experienced an even number of reflections (4 and 6). But there will exist in general a relative retardation of amount (for wave fronts perpendicular to the plane of the diagram) proportional to the deviation from the principal wave front. Hence, if the incident light comes in all directions, a telescope at g, focussed for infinitely distant objects, reveals a system of interference bands, whose direction should be vertical if the adjustments could be perfectly carried out in the manner intended.



The success of the method does not require the complete symmetry of the diagram. If the reflections at $d\,e$ are effected by a right-angled prism, it is necessary that $c\,d$, $f\,e$ be parallel to one another, but not that they be parallel to the surface b. Supposing all the surfaces to remain vertical in any case, the positions of b, f, and the incident ray $a\,b$, may be chosen arbitrarily. If the distance $d\,e$ between the parallel courses is not closely prescribed, *one* adjustment by rotation of the mirror C will suffice. In my experiments the optical parts were mounted upon a large iron plate, so that the movable pieces c, d, e could be shifted without loss of level. The incident ray $a\,b$ was defined by a small hole near the paraffin lamp, which served as a source of light, and by the centre of moderately large circular aperture perforated in a screen and illuminated, when necessary, with a candle. The mirror c was then rotated, until the rays $c\,d$, $f\,e$, were parallel. This was tested by observing the equality of their mutual distances near the extremities of their course.

If the distance between the parallel rays is prescribed, the

* Paper read at the British Association Meeting (Section A), at Bath, September, 1888.

† Mr. Wilberforce has experimented upon displacement currents in a dielectric (Camb. *Phil. Trans.*, Vol. XIV., p. 170, 1887).

‡ *Am. Jour.*, Vol. XXXI., p. 377, 1886.

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adjustment is more troublesome. The line *f e*, being fixed, sights are laid down defining the desired position of *c d*. These sights, as well as those before referred to defining the incident ray, have now to be brought to apparent super-position as seen by an eye looking along *d c*. For this purpose *two* conditions have to be satisfied by, and two motions must be provided for, the mirror c. One of these should be a movement of rotation, and the other of translation in a direction nearly perpendicular to the plane of the mirror. Thus the mounting may consist of a circular turntable resting upon the iron plate, the curved edge of which is guided by the sides of a V cut out of a flat piece of metal and clamped to the plate. In each position of the V the angular motions are easily swept over, and the double adjustment is effected without much diffitulty. Where the parallelism of the rays is secured, the insertion of the reflecting prism is all that remains. The adjustment of this is here effected with the eye at the observing telescope, which at this stage should be focussed upon the small aperture in the neighbourhood of the flame. By a motion of the prism parallel to its hypothenuse the two images are brought to coincidence,* and then the bands appear, if not at once, when the telescope is accommodated for infinitely distant objects.

The half-silvered central plate would be at its best if it reflected light of the same intensity as it transmits. I have generally found the reflection on the side next the air more powerful than upon the side next the glass, so that the ideal would require the geometric mean of the two reflections to be equal to that of the two transmissions. A very slight silvering is all that is wanted, such as from its want of coherence and brilliancy would be useless for other purposes; and the bands appear tolerably black, even though the interfering lights are of decidedly unequal intensities. There is, of course, also a reflection from the unsilvered surface of the plate. Owing to a want of parallelism in my apparatus this image was distinctly separated from the other. The two back reflectors were of flat glass, silvered by the milk-sugar process, and used as specula.

The imperfections of the surfaces disturbed the formation of the bands from full accordance with theory. The definition was usually better when the pencils were limited, as by the screens employed to define the incident ray, than when all obstruction was removed. The final adjustments for the distinctness and desired width of bands were made with the eye at the telescope by shifting the reflecting prism, and occasionally by slight displacements of one of the other reflectors. The tubes enclosing parts of *c d*, *f e*, and containing the electrotype (diluted sulphuric acid of nearly maximum conductivity), were closed at the ends by plates of parallel glass. The current entered by lateral attachments, so arranged that liquid (or gas) rising or falling from the platinum electrodes would not at first enter the operative part of the tubes. The diameter of tubes was about $\frac{3}{4}$in., and effective length about 11in.

It will be sufficient to give the details of one experiment. The two tubes were connected in multiple arc, and of course in such a manner that the current travelled in opposite directions. The magnitude of the whole current (say, from eight Grove cells) was of 1·5 ampere; so that the current density in amperes per square centimetre was

$$\frac{\cdot 75}{\pi \times \cdot 38^2 \times 2 \cdot 54^2} = \cdot 26.$$

Now, one of the interfering rays travelled 22in. or 56 centimetres with the current, and the other ray the same distance against the current. On *reversal* of the current no shift of the bands could be perceived under conditions where a shift of $\frac{1}{10}$† of a band must have been evident. Hence we may conclude that a current of the above-mentioned density does not accelerate (or retard) the propagation of light in the ratio of $\frac{1}{10}\lambda$ to 224 centimetres. In the liquid we may take $\lambda = 4 \times 10^{-5}$ centimetre; and if we reduce the result so as to correspond to density unity, we may say that in dilute sulphuric acid a current of one ampere per square centimetre does not alter the velocity of light by one part in 13 millions, or by 15 metres per second.

It would probably be possible to carry the test 10 or 15 times further by the use of much longer tubes and a more powerful battery; but there seems to be no sufficient encouragement at present to make the attempt. The case would, of course, be very different were anyone to show by *à priori* argument a reason for expecting an effect of this order of magnitude.

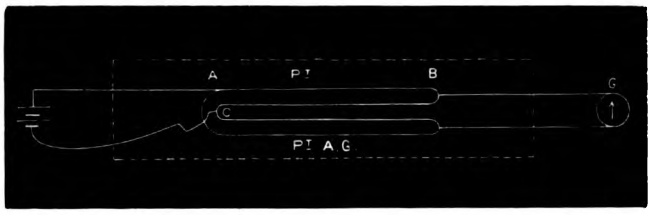
* It should be noticed that if the objects were at infinity, or if with the aid of a collimating lens an image of it were thrown to infinity, the two images as seen focussed through the telescope would overlap in any case; for it may be proved that whatever may be the position of the five reflecting surfaces the two emergent rays corresponding to any incident ray are necessarily parallel.

† Probably I might say $\frac{1}{20}$, but it is best to be upon the safe side. When the contact was maintained a slight shift was observed, but in a direction independent of that of the current.

ON AN APPARATUS FOR DETERMINING TEMPERATURE BY THE VARIATION OF ELECTRICAL RESISTANCE.*

BY WM. SHAW, M.A.

This apparatus is designed to measure to a high degree of accuracy the mean temperature of a large burette immersed in a water bath. A Wheatstone quadrilateral is formed by joining the ends of a platinum wire about 30in. long (resistance about 11 ohms) to those of a platinum silver wire, B, C, D, A. The platinum wire is base, and the alloy is silk-covered ·007in. in diameter. Its resistance is 13·5 ohms per metre. At A C and B D respectively, battery and galvanometer wires are soldered. The lengths of the wires are so arranged that for some temperature near 15°C. there is a perfect balance indicated in the bridge. The wires are laid in parallel lengths, and disposed upon a strip of pure India-rubber about $\frac{3}{4}$in. wide in the manner indicated in the figure. The India-rubber is painted with a solution of India-rubber in benzene, and a second strip, similarly painted, is laid down upon it, and the wires are thus completely enclosed; the strip continues 18 metres at each end beyond the junctions of leading wires, so that the whole length of strip is about 5$\frac{1}{2}$ft, and from the two ends the galvanometer and battery leads respectively project.



A very flexible quadrilateral is thus obtained in the form of a ribbon, which can be wrapped round any apparatus whose temperature is required. Since the two wires, which together form the quadrilateral, have different temperature coefficients, there is no balance except for one particular temperature, but the balance can be restored by shunting either the wire A B or the arm B C, by connecting a resistance box in a suitable manner with the projecting leads. The resistance of the shunt required to produce a balance can be employed to indicate the temperature when the instrument has once been graduated. The graduation of the apparatus exhibited was made for the author at the Cavendish Laboratory by Mr. J. W. Capstick, Demonstrator at University College, Dundee. The ribbon was wound round a metal cylinder, and the whole immersed in ice or water, and a number of readings of the shunt taken at different temperatures between 0deg. and 28°C. The conductivity of the shunt at different temperatures is very nearly represented by a straight line cutting the zero line at the neutral point 15·16°C. The maximum divergence from the straight line corresponds to the temperature difference of a fifth of a degree between 0deg. and 15·16deg., and to about a tenth of a degree between 15·16deg. and 28deg. In the graduation the temperatures are referred to the Kew standard by means of mercury thermometers previously compared at Kew. The temperature can be read with a suitable galvanometer to about the 500th of a degree.

* Paper read before the British Association meeting at Bath, September 1888.

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UNDERGROUND WIRES IN AMERICA.

Apart from their technical and scientific importance, the Papers which were read before the National Electric Light Association of New York, at its last half-yearly meeting, and which are being reprinted in this journal, possess a special interest for British Electrical Engineers, who are only just beginning to experience some of those difficulties which their comrades in America have been battling with for several years past. The Americans are so far ahead of us in electric lighting business that the overhead wire system has long been voted a public nuisance, and bidden to take itself underground. Electric Light undertakers in this country will naturally wish that they may have a touch of the same complaint. Meanwhile, they will learn a great deal from what is going on in the States both as to evils to be avoided and the way to mitigate those which are inevitable. Experience in America is on a very active and very extended scale; and by the time we need it, the solution of the problems of underground wiring and street distribution will have reached us, probably, from that part of the world. The statistics furnished by the President of the Association show the rapidity with which the electric light is being extended there; and as it is generally under an interdict in respect to overhead conductors, we may confidently expect that a safe and economical method of placing them underground will soon be discovered.

Conduit or subway systems have been largely adopted for telegraph and telephone wires, New York alone boasting of

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nearly 4,000 miles of these conductors so treated; but as regards electric light cables hardly any practical progress has been made in getting them underground, some solitary experiments on the part of the Brush Company being spoken of as affording encouragement to the other undertakers to do likewise. Broadly speaking, it may be said that the law has been obeyed in respect to telegraph and telephone wires, because obedience was easy, but that as regards electric lighting wires the law has not been obeyed simply because its enforcement would have been equivalent to a general confiscation, besides the considerable extinction of a popular illuminant. The appointment of Mr. WHEELER as inspector of the systems will conduce to a settlement of this vexed question between the municipal authorities and the electrical companies. Mr. WHEELER takes the sensible view that if the wires had been maintained in anything like decent efficiency and safety they would not have been interfered with. Certainly, from Mr. WHEELER's own report it is clear that the New York guardians of public safety and good taste are not excessively exacting. An enormous quantity of wires and poles, amounting, it is said, to nearly half the whole number, are dead and abandoned to their fate; and as the workmanship expended in their erection was generally as bad as it could be their present condition may easily be imagined. Where the owners are known they are served with a notice; and at the end of a week with another notice; and then the Bureau of Encumbrances is asked to interfere. This dreadful punishment is no doubt borne with resignation by the owners, even when it is inflicted; but as Mr. WHEELER does not tell us that the Bureau ever act on his recommendation to pull down the wires we can only repeat that the people of New York are a long suffering race.

That this is so becomes more apparent when we turn to Mr. WHEELER's remarks on the overhead electric light wires. One example will suffice. "All arc lamps that are so low as to be within the reach of pedestrians with umbrellas are reported as too low." This is a moderate demand, and, together with the inspector's remonstrances on the subject of "flagrant bad work," is gradually being attended to. Nevertheless the condition of the wires is described as still being outrageous, and the conduct of their owners hardly less so. The picture of the state of things which prevails in the chief city of the United States is so instructive that we cannot refrain from quoting Mr. WHEELER's own words for the benefit of people here who desire unlimited competition:—"The companies owning wires will not permit each other to make common use of the poles, but will chop off wires owned by others without notice. The telephone people object to the electric light wires on account of the induction. Where there is a line of electric light wires on their side of the street passing close to their poles, they do not allow them to be made fast. The result of the necessity thus made for extra poles is sometimes four lines of poles on one side of the street; hence most of the wires swing close to or against the other poles to which they are not attached, and linemen in climbing them have to crawl through all the wires which are not fastened to cross-arms."

Legal proceedings are being taken against one of the offending arc-light companies to compel it to place its wires which are proved to be dangerous in subways constructed for the purpose. Other companies are said to be on the point of doing this voluntarily; but, as we have already remarked, the experiment has yet to be tried, and we have no authentic evidence as to its probable result. Meantime, Mr. HEWITT, the Mayor of New York, let it be known to the members of the Association, whom he addressed at their recent gathering, that he did not intend to enforce the law in any precipitate or unbenevolent fashion. It is true the existing anarchical condition of the overhead wires is a scandal and a danger to society; but, says the worthy Mayor, although they are not pleasant to look at, and in places are so thick as to obscure the sky, they are for the present indispensable to our social and commercial interests, and "the man who would disturb them until something better is found out would be a barbarian" (loud applause). Still, like the Mayor himself, the wires would have to go; and he appealed to the knowledge and good citizenship of the electrical engineers present to hasten the perfecting of methods of insulation and distribution which would admit of the law being enforced without injury to their trade or inconvenience to their customers. A responsible electric light company was going to test the conduits by way of a beginning, and until the trials were completed wild horses would not compel him to order the other companies to be disturbed (louder applause).

With such a splendid accession to their debating strength, on Wednesday, no wonder the meeting came to a unanimous and highly agreeable resolution on Friday. It ran somewhat as follows:—"That the National Electric Light Association, after a full discussion of the subject, desire to express their hearty sympathy with the views expressed by his Honour, Mayor HEWITT; and take this opportunity of expressing their opinion that up to the present time no commercially practical method has been brought to their notice by which high-tension direct currents, such as are used for arc lighting, can be placed underground." What his Honour may have thought of this resolution we are only left to conjecture. His presence at the meeting does credit to the ingenuity of the Association; and the Mayor of New York has only himself to blame if they took him at his word too literally. For the present, then, overhead wiring for the electric light in New York has obtained a respite which perhaps is not wholly deserved, but which we believe will be turned to useful account. For, notwithstanding the formal resolution above referred to, several Papers were read at the meeting throwing valuable light on the subject, and tending to show that the difficulties are not so formidable as we are asked to believe. At all events, they are not regarded as insurmountable in this country. Mr. CROMPTON's method, which he described to the Society of Telegraph-Engineers and Electricians last April, seems so far to have been successful, and will no doubt be followed up, unless our American friends can supply us—as with their wider experience they probably will—with a better.

ELECTRIC LIGHT APPLIED TO NIGHT NAVIGATION UPON THE SUEZ CANAL.*

BY R. PERCY SELLON.

I.—The period embracing the concluding years of the last decade and the first years of the present one, during which a grave commercial crisis made itself felt, not only in this country but throughout industrial Europe, witnessed upon the great maritime highway which separates the Eastern and Western hemispheres a rapid increase of traffic and growth of activity.

In 1870, the year following the opening of the Suez Canal, 496 vessels of all kinds availed themselves of the facilities which this new route to the East afforded. Two years subsequently—in 1872—this number had reached over 1,000. In 1878 the number was 1,593, and by the year 1885 it had more

* Paper read before the British Association meeting at Bath, September, 1888.

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than doubled itself, reaching the remarkable total of 3,624 vessels, representing a gross tonnage of 9,000,000 tons.

This active traffic, however, soon gave rise to difficulties of various kinds. Shipowners complained of delays in making the passage of the canal, delays which became more and more marked as the number of vessels using the canal increased. The channel proper being insufficiently wide (except at the "tying up" stations, which are placed every five miles apart) to admit of vessels passing one another it becomes necessary for any vessel to "tie up" in accordance with signals from the nearest station—these stations being all in telegraphic communication with one another—while any vessel coming from the opposite direction gets past.

This in a canal 87 geographical miles long, and where the speed (except in the open Bitter Lakes) is not allowed to exceed six miles an hour, meant constant delays at "tying up" stations, the delays naturally increasing directly in proportion with the traffic.

Then a further cause of delay lay in the fact that vessels could only proceed by day, anchoring at either entrance to the canal—Port Said or Suez—or "tying up" at the nearest station if in mid-channel, from sunset to sunrise. Thus we find that in 1885 the average time consumed in making the passage of the canal amounted to 43 hours, though it frequently considerably exceeded this.

II.—To meet the difficulty thus presented, the Suez Canal Company set about various improvements; the cutting away of curves in the course, deepening and widening the channel at the "tying up" stations, and finally instituted experiments to determine the practicability of navigation by night by means of the electric light.

Fig. 1.

The question of the practicability of successful navigation by night in the Suez Canal by means of electric light is not so simple as would at first sight appear. To realise this one must consider that the canal has but an average width of 22 metres (23¼ yards) upon the water line, with shelving sides providing for a depth of water of some 8m. 70 to 9 metres (27—30ft.) in the centre, and with comparatively sharp curves at various points, as may be seen from the accompanying plan of the canal, Fig. 1; and that under such conditions vessels of 400 to 500 feet length, 40 to 50 feet beam, and drawing 25 feet of water, have to navigate the channel, encountering currents of varying force, the action of the wind, and greatly diminished influence of the rudder upon the vessel owing to the slackened speed.

It will be at once seen that under these circumstances it needs but a small deflection between the axis of the vessel and that of the channel to render the vessel liable to run aground. No small amount of judgment and experience thus become necessary on the part of the pilot who accompanies each vessel through the canal.

The problem was, to reproduce by electric light the conditions requisite to enable the pilot to successfully navigate during the night.

These experiments extended over the greater part of two years, with the result that in December of 1885 it was decided to allow vessels of war and those carrying mails, if furnished with electric lights in accordance with regulations laid down by the canal company, to proceed by night between Port Said, the Mediterranean entrance to the canal, and kilometre 54, about one-third of the distance along the canal.

The first vessel to avail itself of this permission was the ss. "Carthage," of the Peninsular and Oriental Steam Navigation Company, in the month of April, 1886, followed shortly afterwards by others, the prescribed passage being made by night by means of the electric light with perfect success.

These and subsequent trials encouraged the canal company to extend its authorisation to vessels of all kinds; and, at the same time, by providing beacons and light buoys to guide the vessels in their course by night, to permit of navigation throughout the whole length of the canal.

III.—The following is the text of the regulations on this subject issued by the Suez Canal Company in February, 1887:—

"(i.) From 1st May, 1887, steamers will be allowed to pass through the canal by night, subject to the same conditions as those which hold for navigation by day, and subject to the following further restrictions:—

"(ii.) Steamers intending to pass through the canal by night must satisfy the company's agents at Port Said or Port Tewfik, that they are provided:—(1) Forward, with an electric search light throwing a beam 1,200 metres; this search light must be placed as close as possible to the waterline. (2) With an electric lamp and reflector suspended above the bridge and capable of lighting a circular area of about 200 metres diameter.

"The agents of the company will decide whether the apparatus fulfils the requirements of the regulations, so that vessels provided with them may, without inconvenience, be authorised to navigate the canal by night.

"(iii.) If a vessel proceeding by night receives the signals to 'tie up,' it must, immediately upon this being effected, extinguish its electric lamps, retaining only the regulation signal lights indicating that it is 'tied up.'"

IV.—Passing now to describe the apparatus designed to fulfil these requirements. This consists essentially of three parts:—

(1) The source of electric power—a steam engine and dynamo electro generator.

(2) A projector search light fitted upon a platform large enough to accommodate a man to manipulate the light; the whole being attached to the stem of the vessel forward and close to the water's edge.

(3) An automatic electric lamp suspended above the bridge and capable of illuminating a circular area of 200 yards diameter round the vessel.

The accompanying diagrams illustrate these various pieces of apparatus, and also a vessel so fitted traversing the canal.

The engine (Fig. 2) is of Brotherhood's 3-cylinder type, fitted direct by means of a flexible coupling to a Victoria dynamo-electro machine, manufactured, as are also the electric lamps and other electrical apparatus, by the Anglo-American Brush Electric Light Corporation (Limited), of London. The engine and dynamo are fitted upon a cast-iron bedplate common to both. To ensure reliability of operation, and minimise labour in attendance, the speed of engine and dynamo is reduced to 600 revolutions per minute, at which the latter is capable of yielding an output of 65 volts by 70 amperes or 4,550 watts.

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This provides for a light in the projector search light equal to 12,000 candle-power, and at the same time supplies current for the automatic lamp of 6,000 candle-power over the bridge, when the latter is in use.

The projector search light (Fig. 3), fitted upon its platform and fixed during the passage through the canal to the stem of the vessel as near to the water's edge as possible, is used to light the course of the vessel to a distance of 1,200 metres (1,300 yards) ahead.

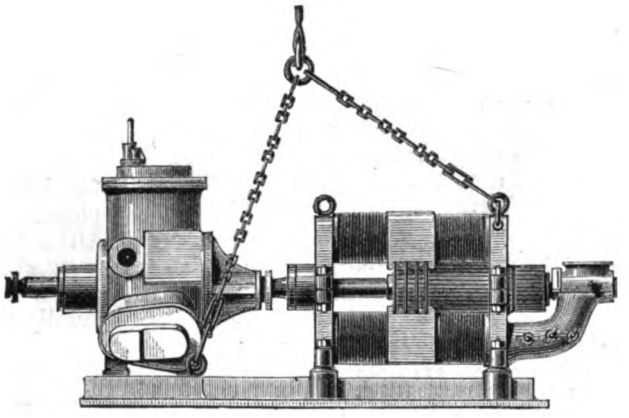

Fig. 2.

Actually, the firm of contractors above-mentioned have heard, from recent advices from the canal, that this light enables the pilot to see clearly as far as 1,600 yards ahead.

The projector proper, which is in many respects similar to the type in use for signalling and search purposes on war vessels, consists of an electric lamp of 12,000 candle-power, the light rays from which are concentrated upon a spherical

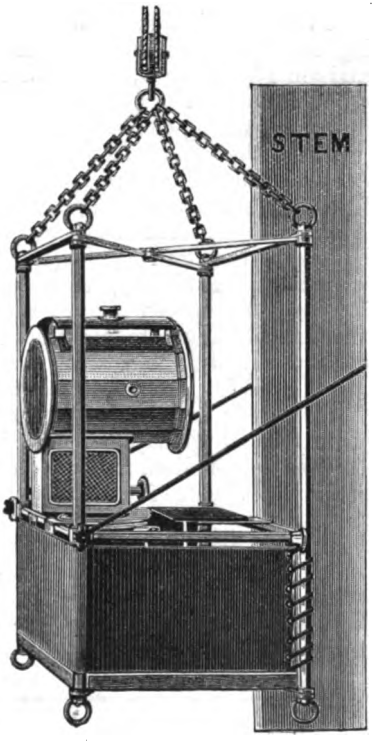

Fig. 3.

silvered mirror, made by Messrs. Chance, of Birmingham, fixed at the back of the instrument; this mirror reflects the rays, rendering them parallel, and projects them forward in a cylindrical beam; they are then made to pass through a series of plano-cylindrical lenses fitted in the front of the projector, so that the beam emerges in the shape of a fan, flattened horizontally. Fig. 4 illustrates this.

This beam, diverging to an angle of 20°, can by means of suitable adjustments provided for the purpose be directed upon any desired spot. At a distance of 1,200 metres ahead of the vessel the full width of the canal and the banks on either side, composed of the *debris* excavated from the channel, are illuminated as clearly as by day.

An attendant, seated upon the platform, attends to the manipulation of the carbons of the electric lamp, and at the same time regulates the position of the beam of light, elevating, depressing, or deflecting it on either side in accordance with the orders of the pilot upon the bridge, with whom he is generally in telephonic communication.

The placing of the projector close down to the water's edge, where the light is hidden under the bow of the ship, is a point of essential importance, since any direct rays of light intervening between the pilot and the distant object illuminated by which he steers the vessel, serves to dazzle his eye.

The automatic electric lamp is of 6,000 candle-power, enclosed within a lantern fitted with a concave reflector, and arranged to concentrate the light round a circular area of 200 yards. When slung up over the bridge of the vessel the area illuminated includes the whole deck of the vessel and the canal and its banks immediately on either side. This light is only intended for use when passing other vessels "tied up" at the stations, or to provide light around the ship when "tying up" so as to allow another vessel to pass.

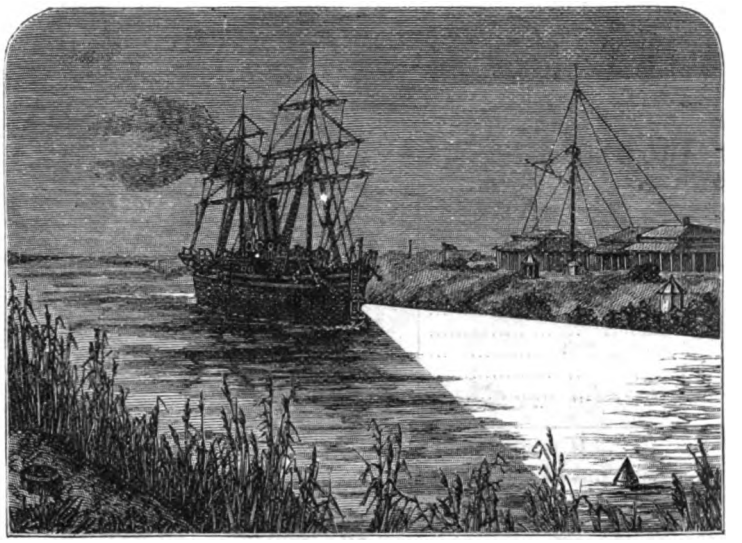

Fig. 4.

V. A large majority of mail and passenger steamers are now fitted throughout with the incandescent electric light. In fact, electric light has come to be regarded as a *sine qud non* to any first-class passenger vessel.

In such cases the steam engines and dynamo generators already in the ship are usually utilised to supply electricity for the special Suez Canal lamps, which latter may form part of the permanent equipment of the vessel. This is the case with many vessels of the P. and O., the Orient, and the North German Lloyd lines of steamers.

On the other hand, where a vessel which is not already fitted with the electric light desires to avail itself of the permission to traverse the canal by night, it can hire the necessary plant at either entrance to the canal.

The *modus operandi* is as follows:—

Several of the prominent coaling firms at Port Said have possessed themselves of a certain number of sets of portable electric lighting plant for the Suez Canal. These they hold in readiness for vessels to their consignment which may require the light, making an average charge for the use of this, which at the present time amounts to £10 per vessel for the passage through the canal.

On receiving a given signal from an incoming vessel that electric light is required, a tender is sent out to meet it, having

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on board the necessary portable plant. Coming alongside, the engine and dynamo are quickly hauled up, dropped on to some convenient spot on deck, and the engine connected with the nearest steam pipe—generally a branch from the system in use for steam winches forward; the automatic lamp slung up over the bridge; the projector floated round and made fast to the stem; temporary conducting wires run from the dynamo generator to the two lamps; and in less than an hour from the time of the tender coming alongside the ship is ready to make the passage of the canal by night. On reaching the opposite end of the canal the electric light plant is disembarked, and the vessel proceeds on her way.

It is with such a portable plant as has just been described, and which the accompanying figures illustrate, that the author was engaged in trials upon the Suez Canal in the early part of last year.

VI.—To realise the development which has followed upon the introduction of electric light for the purpose of night navigation, and to appreciate how real has been the benefit flowing therefrom, we have only to examine the following figures, which illustrate the number of vessels which have passed through the canal in this way at different periods since the first authorisation to use electric light in December, 1885; and which define the percentage of vessels so using the light in comparison with the whole traffic on the canal:—

Period.	Number of vessels which passed through the canal by night by means of electric light.	Percentage which these bear to the whole traffic.
From December, 1885, to 1st March, 1887, viz., 15 months	25	·7 per cent.
March, 1887	15	
April ,,	19	7½ ,,
May ,,	19	
June ,,	25	
July ,,	27	
August ,,	35	
September ,,	45	18 ,,
October ,,	49	
November ,,	62	
December ,,	75	
January, 1888	85	29 ,,
March ,,	111	34½ ,,
May ,,	139	43 ,,

VII.—It remains but to inquire, "What are the advantages arising out of the use of electric light on the canal, which have led to so striking and rapid a development?"

To the Suez Canal Company, on the one hand, it means that the capacity of their canal has been rapidly, effectively, and economically increased by nearly 50 per cent., an increase attained without an army of labourers, without a host of dredgers, without a lapse of years, without interruption to traffic; that while a traffic which reaches 7,000,000 to 8,000,000 tons is now annually attained, an increased traffic, equal to 11,000,000 to 12,000,000 tons per annum can be accommodated, while offering not only equal, but greater facilities to shipowners making use of the canal; that in the meantime the canal company, relieved of the pressure put upon them from outside, can pursue their works of improvement with greater deliberation and economy.

It is only fair to say, however, that the Suez Canal Company on their side have displayed a ready initiative and far-seeing confidence in the success of the scheme, by putting down a large number of light-buoys to indicate the course by night in the Bitter Lakes, of guiding lights along the banks, and an extensive gasworks at Ismailia for supplying the above with gas, at a time when to many an extended adoption of the electric light by shipowners seemed problematical.

To shipowners, on the other hand, it means in the first place a saving of time. I pick up the *Official Gazette* of the Suez Canal Company, published at Paris, for January of this year, and read as follows:—"The 'Moskwa,' of the Russian Mercantile Marine, using the electric light, entered the Suez Canal on 12th December at 6:15 p.m., and passed out on the following morning at 8:45 a.m.; total time occupied in the passage 14½ hours."

In another portion of the same *Gazette*, for the same month, I read as follows:—

"The mean time occupied in making the passage of the canal for all vessels during the month of November last was 36 hours 10 minutes."

Taking as average periods for the passage of the canal, 18 to 20 hours for all vessels using electric light, and 35 to 40 hours for all vessels not so provided—figures which the canal company's *Official Gazettes* and the author's own experience upon the canal, prove to be in accordance with actual facts—we find that the saving of time resulting from the use of the electric light approaches the 24 hours of a whole day.

What does this saving in time represent?

For vessels carrying cargo exclusively, of an average tonnage of, say, 2,500 tons, interest on capital, demurrage, coal consumption, wages, and provision for the crew, represent a sum of £30 to £40 per diem.

For vessels of war, where rapid communication between England and her possessions in the Eastern hemisphere, or the scene of her frequent wars in the Soudan or Africa is by way of the Suez Canal, the saving of 24 hours may entail consequences not easy to calculate.

For mail and passenger boats the results are naturally more marked than in the case of cargo steamers.

An interesting example of the practical value of the electric light is afforded in connection with the transport of mails to the East during the time when the cholera in Italy led to enforced quarantine of all vessels from Italian waters communicating with the shore in Egypt. It has been customary for the mails brought by the Peninsular and Oriental Company from Brindisi to be landed at Alexandria and sent overland to Suez to save the time taken by vessels in the canal. In order to avoid the delay of quarantine, the mail boats of the Peninsular and Oriental Company proceeded, without unshipping the mails, direct through the Suez Canal by means of the electric light, reaching Suez and transhipping the mails within the same time as that occupied by the overland route in the ordinary way.

The cost per 24 hours of a first-class passenger-carrying vessel, including insurance, demurrage, interest on capital, coal, wages, provision for the crew, and provision for the passengers, cannot be put down at less than £100 to £150.

Taking as an average saving effected by each vessel traversing the canal by night the sum of £70 to £80 (a figure which, in view of the proportion of mail and first-class passenger-carrying vessels to the whole traffic on the canal is well within the mark), and taking 40 per cent. of the vessels entering the canal as making use of the electric light (a percentage which it will be borne in mind has already been exceeded), we find that for 1,200 vessels having so availed themselves of the electric light the annual saving to maritime commerce will amount at a minimum valuation to close upon £100,000.

And to this must be added the personal comfort to all concerned derived in escaping some period of the excessive heat experienced upon the canal by day, the glare from the banks of yellow white sand, the tedium and monotony of the slow passage through a wide expanse of barren desert.

Without considering to what development this use of the electric light may ultimately attain in an age in which uncasing efforts are being made to economise time and space, it has been attempted, by the foregoing few facts and figures, to illustrate the advance recently made in one adaptation of electricity to the service of man.

St. Olave District Board.—At a meeting of the St. Olave District Board on September 18th an application was received from an electric lighting company for the sanction of the Board to an application for a provisional order to enable them to supply the electric light to the district.—Mr. Lafone, in moving that the letter be referred to committee, expressed a hope that the Board would not hinder this project. He felt assured that the electric light, by dispensing with the use of gas, would do much to lessen the death-rate of London.—The letter was referred to committee.

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VORTEX ANALOGUE OF STATIC ELECTRICITY.*

BY PROF W. M. HICKS, F.R.S.

Consider two bodies touching one another placed in an infinite fluid, and with a vortex filament, the ends of which are one on one surface, the other on the other. If, now, the surfaces be separated from one another there will be formed, at the point where they separate, a hollow vortex filament stretching from one to the other, with rotation equal and opposite to that of the original filament. As the bodies are moved apart these filaments will not in general take up a position of rest. If the strength of the original filament be very great, or if there be several of them, the resulting hollow vortex will, through instability, split up into a number of smaller ones. If the resulting number be very large they will ultimately take up some position of stable equilibrium. What the distribution in this will be I cannot say, but the following is one state of equilibrium, and probably, though I have not proved it, a stable one. The two sets of filaments will be mixed up with one another, and each will distribute itself according to the same law as the distribution of lines of force between the two bodies supposed equally and oppositely electrified.

In the case of the original filament, as the surfaces are further and further separated their sections become smaller and smaller. This is, however, not the case with the hollow filaments. Their section depends only on the pressure of the fluid and their circulation, and as these remain constant the areas of their sections also remain so. In such a hollow vortex the pressure inside sinks to zero. Consequently the portion of the surface on which it abuts experiences a diminution of pressure, a diminution which is the same at all distances. The two bodies are therefore attracted towards one another. Moreover, as the bodies separate further, the distribution of the filaments being the same as that of electrical lines of force, and the diminution of pressure for each line being constant, it follows that the force between the two bodies follows precisely the same laws as the force between two bodies supposed equally and oppositely electrified.

If another surface be brought into the presence of the others some of the filaments would abut on this. These would break off, rearrange themselves so that some of the filaments would end on it and an equal number start from it. Call those ends of the filaments positive at which the rotation looked at *from* the surface on which they abut is right-handed, and those ends negative at which the rotation is left-handed. The two ends of any filament will then always be of opposite name.

The analogy with electrical action is then close. Two bodies, A B, brought in contact, touch in innumerable parts, owing, possibly, to the different states of motion of the ether at their surfaces, a state of equilibrium is set up, consisting of a kind of sifting of vortex motion already subsisting, so that, on the whole, more lines go from A to B than *vice versa*. This is E.M.F. of contact. Separate the bodies, one has a number of positive ends of hollow filaments, and the other an equal number of negative ends. *The bodies are equally and oppositely electrified.* The force in its hydro-dynamical case and in its electrical analogues follows the same laws. Bring into the field another surface, C. The filaments rearrange themselves as mentioned above, the negative and positive ends abutting on C being equal. *This is induced electricity.* If the surface C consists of a large number of small unconnected surfaces, the filaments will arrange themselves in some manner depending on the sizes and distances of the unconnected parts, the field will be disturbed in a similar way to that in an electric field into which a different dielectric is placed. This is the analogue of electric strain in a dielectric. So far the ground is fully safe. The succeeding remarks must be regarded as speculative.

Returning to the case of the two separated surfaces A and B, what will happen if they be connected to a third surface—say, to fix ideas, a long, narrow cylinder or wire? It is not so easy to say certainly what the exact rearrangement will be. It would seem very probable that the hollow filaments near the wire would at once be replaced by circulation round the wire. In this case, the solid filaments must rotate as a whole round it; while at the same time, although this has not been proved, they will contract their ends, move along until they come together, form a ring, and get mixed up in the surrounding fluid.

This would correspond to the *current of discharge.* But notice that if this is so the fluid outside the wire rotates round the wire while a stationary state is being reached, and as we know that the field round a current is a magnetic field, it follows that the *analogue of a magnetic field is a flow along the magnetic lines of force.* It may, however, be further necessary that these streams must contain vortex filaments moving with the fluid, their axes at every point being perpendicular to the lines of force there.

If the field is determined by the flow of fluid independently of vortex motion, it is not easy to see the hydro-dynamical analogue of the induction of currents when, say, a wire moves across a uniform magnetic field. If, however, the vortex filaments, as above, are a necessary adjunct, it is conceivable how a movement of the wire across the lines of flow and amongst the filaments produces an instantaneous disarrangement which will travel through the vortical fluid with the velocity of propagation of transverse vibrations in a vortical fluid. That is in the ether, as Sir W. Thomson has shown, with the velocity of light.

It is difficult to see any analogue to the rotation of the plane of polarisation by a magnetic field.

* Abstract of Paper read before the British Association meeting (Section A) at Bath, September, 1888.

BRITISH ASSOCIATION.

DISCUSSION ON LIGHTNING CONDUCTORS.

(Concluded from page 648.)

The Hon. R. ABERCROMBY said he wished to be allowed to contribute to this discussion some facts which had been brought out from looking at about ninety photographs of lightning flashes in different parts of the world, which had been collected by a committee of the Royal Meterological Society of which he was secretary. A few of the most remarkable photographs he now produced for their inspection. He proposed to confine his remarks not to the whole theory of lightning flashes but only to such facts as bore on the present discussion. The first point was, is there any evidence in the photographs of a duplication of flashes—that is, of one flash rapidly following after another? He thought the answer to that must be that there is no certain evidence. He had a very remarkable photograph with him which might at first seem rather to negative that. (Fig. 3).* Here was one very bright flash, with no less than three sorts of repetitions of the bright line, in the one place. In another part of the same picture they had a thin flash, with another exactly parallel to it, only a little bit fainter. For reasons which it was difficult to give without showing the original picture, there was ground to suppose that that was due to a secondary reflection from the back of the glass (applause). One or two of the photographs were taken as paper negatives, but the bulk of them were taken on glass plates, and it was well known that if they received a bright object on the sensitive side of the plate, some of the light would go to the back and be internally reflected, and make another image a little fainter pretty close by. He thought they had often seen flashes coming very nearly after each other, but, so far, there was no photographic evidence of a flash coming exactly along the same path. But there was most decisive evidence of the tendency of flashes to be parallel to each other. He had a most magnificent photograph with him which had just been received from Massachusetts. In that, the whole air was filled with threads of lightning coming down like the roots of a tree from the sky. He thought it was very much a question where the area of protection would be when the whole air seemed to be pouring down lightning upon them. He had other photographs with him in which there were two or three flashes apparently following pretty much in the same path. Connected with this there was the inveterate tendency of a lightning flash to ramify. Sometimes they got in a photograph a comparatively smooth line; at other times it was like that which he had already shown them where the main flash seems to throw out threads in every direction. Something similar could be seen in an influence machine. Connected with that there was one thing he had not been able to find any notice of in any of the discussions or publications on lightning conductors. That is, what is the effect of rain or cloud on the passage of electricity? All laboratory experiments were taken, of course, in dry air, but every experimenter knew that the dust in a laboratory had a very considerable effect on the discharge of static electricity. His impression was that when lightning came down through rain or hail, or even through cloud, that the continuity of what are called potential surfaces, and all that sort of

* We regret that, owing to an accident, we are compelled to leave this and the two following figures over till our next issue.—ED. *E.*

† See *The Electrician*, Sept. 7, 1888, p. 556.

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thing, must be very much disturbed. So much did he believe in this, that—at the next meeting of the committee of the Royal Meteorological Society, which had collected, in this year of very frequent thunderstorms, an enormous amount of material bearing on this point, including instances where much damage had been done to buildings—he was going to suggest that they should send out a circular to find out, if possible, whether the buildings were struck during rain or when it was not raining. There was another point upon which photography gave very conclusive evidence, and that was that lightning flashes were by no means as instantaneous as they are usually supposed to be. Most people had seen lightning flashes that, to their eyes, appeared to last some time, but the evidence of the eyes in a bright light is a little doubtful. There are always subjective effects on the retina. Lightning does not always jump from cloud to cloud, or from a cloud to the ground, but goes meandering about in the air something like that [illustrating on the blackboard] (Fig. 4). It meanders about in the air without very much rhyme or reason; ties itself into knots, and flies about in a very eccentric manner. He thought it was perfectly certain that when it was tying knots like that, it could not be going with anything which in ordinary parlance might be called an instantaneous speed. Of course there was no such thing really as instantaneity. Besides, the ordinary flashes of lightning, some people had seen, and everybody had read about, what had been called a globular discharge of lightning, in which a ball of light about the size of a cricket ball goes dancing slowly down the street and eventually discharges. It was perfectly certain that between that very slow discharge, and the quicker discharges ordinarily spoken of as flashes of lightning, there must be intermediate rates of discharge. There was one evidence bearing on this question of the non-instantaneity of a flash which had been adduced as evidence, but which the photographs before the committee did not confirm. In fully half of the photographs the lightning does not cover the plate as a streak, but it is more or less of a banded nature, something like a ribbon (as in Fig. 3). It had been suggested that this motion that way might have been due to the shaking of the camera, but they had evidence that this was not the case. Only yesterday Dr. Janssen made a suggestion to him which furnished additional evidence in reference to the slowness of flashes. One of their most remarkable photographs, besides showing three white flashes on the picture, has a black flash (Fig. 5). That was a very curious thing, and he very early got the idea that that must be due to the inversion of the photograph which sometimes took place from over-exposure. Photographers knew very well that in some cases, instead of white coming out as white, it came out black. This was a well-known peculiarity of plates, developers and so on; but the difficulty was to understand why so few were thus over-exposed. Mr. Janssen had made to him a very valuable suggestion, that this might be the evidence, not of a peculiarly bright flash which over-exposed the plate, but of a slow-moving flash, which gave time for the plate to be over-exposed. Of course, it was impossible to say much from one case. He thought it was a remarkably brilliant idea, and he only brought it before them as a possible confirmation of what they were certain of from other things. The only other word he would like to say was with reference to some remarks of Mr. Preece's about the height of lightning clouds. Flashes could come from a cloud only 500ft. high; but that was a very low cloud, and in the majority of cases they certainly came from very much greater heights. In the one that he had alluded to, from the scale of the picture, he was perfectly certain that the height of that cloud was considerably over 500ft. At the same time, he might mention that lightning was rare much over 7,000ft. On the side of mountains much over that height, but still at a moderate height, they would always see the lightning below. Electrical disturbance is confined certainly to the lower 10,000ft. of the atmosphere. In connection with the practical bearing of that, he might mention that in Norway they had two kinds of thunderstorms. In the summer he believed the thunder clouds were high, and very little damage was done; on the contrary, in the winter time the thunderstorm clouds were very low, and the churches frequently get struck. On practical applications he could not offer an opinion; but he was quite certain that great good would result from that discussion (applause).

Lord RAYLEIGH (who was received with great applause) said he had recovered his equanimity a little during the time that Prof. Lodge and Mr. Abercromby were speaking, because during Mr. Preece's address one felt that "mathematician" was becoming almost a term of abuse. He supposed that it was as representing the mathematicians that he had been called upon to take a part in the discussion. No doubt there is a good deal of dislike on the part of the public to mathematics, a good deal of which, he expected, was the result of sufferings undergone in early youth over Euclid and similar instruments of torture. He remembered at Cambridge it was the custom often, after the "little go" was passed, to celebrate the occasion by the burning of Euclid (laughter), and he could to a certain extent understand the feeling, for he entertained very much the same sentiments himself towards Latin and Greek. But, seriously, whatever might be the failings of individual mathematicians (and he supposed no one would deny that some mathematicians were rather unpractical in their work), it was to mathematics one must go if one wanted to foresee what would be the operation of known causes under new and unfamiliar circumstances. There was no other means of going to work. Just as the engineers would have to apply mathematical principles, even if they did not go beyond the rule of three, to the calculation of a bridge, so they required mathematics, no doubt often of a more complicated and difficult character, to foresee what the influence of electrical and other forces must be. Mr. Preece spoke of the mistakes that mathematicians had made, and no one could deny that they had made plenty of mistakes. But he did not know that they would recognise Dr. Lardner especially as a great mathematician. He it was, he thought, who made the error about the impossibility of crossing the Atlantic. The only book of Dr. Lardner's that he ever read was rather an engineering book than a mathematical one (laughter)—it was on the steam engine. His thoughts went back to a well-known book, "The Life of Stephenson," by Smiles, in which a great authority of the day is said to have offered to eat a steam engine wheel for breakfast if the locomotive ever attained a speed of twelve miles an hour. That, he believed, was a great engineer, and not a mathematician (laughter). But enough of recriminations. They all knew that engineers had very important work to do, and most of them would admit, he thought, that there was work also for mathematicians to do which engineers were not so competent to perform. As to the more particular question, he had no special experience of lightning conductors, and could only speak from a general knowledge of electricity, no doubt to be applied in this case to very peculiar circumstances, so that everything that stood upon a merely *à priori* foundation should be put forward with very great diffidence. He must say, however, that Prof. Lodge's experiments had seemed to him to be likely to have most important practical applications to lightning conductors (applause). He could not see how experiments dealing with the thing of all others most like lightning that they could produce in the laboratory could fail to have such an application. Prof. Lodge asked one question, and he thought mentioned his (Lord Rayleigh's) name in connection with it, as to how it could happen that an oscillatory electric current—that was, say, an alternate electric current beginning at a finite magnitude and gradually dying away—could produce magnetising effects such as they well knew it did in some cases; and he instanced the very opposite behaviour of slowly dying away alternating currents in the experiments of Prof. Ewing and of others, in which such an arrangement was precisely the one adopted in order to get rid of even the last traces of magnetism. The question was a difficult one certainly, and he had intended, in fact, to make some experiments upon it himself; but he was inclined to think that the explanation might, perhaps, be sought in a circumstance very much akin to the one with which they were now dealing, namely, that the steel needle, which was to be magnetised, say, by the discharge of a Leyden jar flowing through a spiral enveloping the needle, was itself a conductor of finite dimensions, in which circumferential currents would be induced. These circumferential currents would, at first, at any rate, protect the interior of the iron from the direct magnetising action of the enveloping helix. They must think not only of the action of the oscillating current in the helix upon the various parts of the needle, but also of the action of the currents developed in the steel needle itself. It ought to be well known, at any rate it had been well ascertained, that at different depths in such a steel needle they would find very often different degrees and even different directions of magnetisation. It seemed to him possible that if this was thoroughly followed out they would be better able to understand what was certainly a fact—that a current whose whole value, in some cases measured algebraically, is zero, and is certainly alternating and gradually dying away, does, nevertheless, produce and leave behind it the effect of strong magnetisation. In connection with the development of atmospheric electricity, he would like very much to hear some meteorologist express his views upon that subject. Mr. Preece spoke of the energy which they had to draw upon in the condensation of large quantities of vapour into water. Doubtless there was no difficulty as to the total amount of energy which worked in the atmosphere, but the difficulty was to see how any of that energy took the electrical form. He was reading only the other day a pamphlet by Prof. Soncke, a man who had done very good work in other departments of science, in which he develops the theory that atmospheric electricity is due to friction between water and ice. There is no doubt that many clouds (cirrus clouds, he believed, nearly always) were ice clouds and not water clouds. They consisted of spicule of ice, and the fact is proved by the peculiar optical effects of ice crystals in producing various kinds of halos and corona. There was no difficulty, optically, in distinguishing an ice cloud from a water cloud. Dr. Soncke's view was that at a certain level in the atmosphere ice clouds and water clouds could meet, and that under those circumstances this friction must occur; and his view was that the atmospheric electricity was the result of such friction, and he quoted experiments by Faraday on the friction of ice and water which had a positive result. But that was perhaps not the main question before them. He would rather hear from some more experienced and practical men, those who had been at work on lightning conductors especially, any instances of the kind that Prof. Lodge asked for of actual failures of lightning conductors. It seemed to him that it was only by actual experience of lightning conductors that the question could ever be finally settled. The laboratory experiments must be most important as suggestions, but he thought no one would wish finally to adopt any system or to change any system of lightning protection without actual experience upon a large scale (applause).

Sir WILLIAM THOMSON said that he felt like a highly-charged Leyden phial until Lord Rayleigh had beneficently acted as a lightning conductor, and almost wholly relieved him in respect to the questions raised between mathematicians and engineers by Mr. Preece. He thought that they as mathematicians might have felt very angry, but they did not feel so, and he did not think that Mr. Preece had ever succeeded in making anyone very angry, and he was sure he did not intend to do so. He would just like to say this emphatically, that it was not a mathematician but a very great engineer who predicted that the Atlantic cable could not be laid. A good many sailors predicted that the Atlantic cable could never be laid. Some sailors thought it could be laid, and took part in it and did lay it. No mathematician ever predicted that it could not be laid; some, on the contrary, rather calculated beforehand that it might be laid. Their calculations, of course, were not of any value in the face of the practical experience which led to the laying, but he well remembered how one great engineer—the greatest engineering name of the day almost—had announced that it was impossible that gutta percha could stand the pressure, and altogether that the whole thing was a chimera, and that the Atlantic cable could not be laid. While that engineer was on board ship in the roadstead of Cherbourg in 1858, on the occasion of the Queen's visit to France, the news came across that the Atlantic cable

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had actually been laid, and it was like a discharge of lightning to him. It was only right that the mathematicians should be exonerated from the charge that they had predicted so many failures; because, as a matter of fact, they had not predicted any one failure in any one of the instances adduced; but he did not think that was a matter of very great importance now. He was, however, interested in what Mr. Preece had said, and also very much interested in Lord Rayleigh's remarks calling attention to the genuine alliance between mathematicians and engineers.

In respect to the very marked difference between Prof. Lodge and Mr. Preece he might say that he considered Prof. Lodge to be in the American stage with reference to the judging of the functions of inertia, and Mr. Preece to be rather in the English stage (laughter), as described on Friday evening by Prof. Ayrton. The functions of inertia were to prevent anything from getting into motion, and when in motion to keep it going; and both those functions are perpetually being performed in this electrical influence. He could not but think that if Prof. Lodge continued his work he would find the explanation of the discovery he had made, that iron wire affords a better discharge, or an easier path in the circumstances that he has minutely defined, than does copper. He hoped Prof. Lodge would pursue the investigation, keeping the circumstances in all respects as similar as possible, comparing, for instance, a thin iron wire with a thin lead or brass wire of precisely the same ohmic conductivity. Prof. Lodge had done a good deal already, but a good deal more might be done by taking a proper account of inertia and of the other point Prof. Lodge had very importantly accentuated that the energy must be got quit of somehow and somewhere. It must be got rid of either in the conductor or elsewhere; if got rid of in the conductor then there must not be energy enough to melt the conductor.

It was an interesting fact about the number of horses in a row, where the first and last in the row were killed and the others not injured by a lightning discharge which seemed to pass through them all. A very common lecture-room experiment was to give a Leyden-jar shock to a hundred or two hundred students sitting on the benches, making them all join hands and completing the circuit. He had no doubt that those next to the ends of the line experienced the shock much more potently than those in the middle of the line. There was one very marked influence here, and that was want of perfect insulation; but there was another influence, also potent—self-induction. The influence of self-induction might be tried, and it would be a very interesting experiment. He thought they might try this same thing with as nearly as possible similar insulation with the same number of people spread out in a large circle. Then self-induction would be much more influential in causing the discharge not to keep through the line of the comparatively good conducting bodies, but to spread through the floor or ground under them. Take the case of persons ranged in a row and receiving an electric shock. If the row is zigzag then self-induction will not have the same tendency to cause the lightning discharge to leave the line of the best conductors, as it will have if the conducting bodies are placed in a wide circle. He believed, the imperfect insulation of standing on the floor would be much more potent, and he should expect that those who were in the middle of the row would experience less of the shock in the case of standing in a wide circle than in the case of standing on similarly good conducting material in zigzag rows. At all events, that was an experiment worth repeating. Mr. Preece had spoken of the impossibility of conceiving of the enormous augmentation of potential in these actions. Take the name "inertia" which Mr. Preece used; he fully agreed in the judiciousness of that term. Apply the word "inertia" to the steam hammer and the hydraulic ram. You begin with a comparatively gentle force, its weight bringing down the steam hammer, till it produces an exceedingly intense action at the blow. Take the hydraulic ram, the well-known analogue for getting up a high potential for self-induction in an electric circuit, and then, he thought, they would see that Prof. Lodge's explanation of the phenomena he had brought before the meeting was altogether valid.

Exceedingly interesting questions had been put, and remarks made, about oscillatory discharge in ordinary lightning, and also with reference to the duration of the charge and to multiple flashes. He thought Prof. Lodge distinguished these more or less from one another. There might be a slow discharge. Mr. Abercromby had referred to a ball of lightning running about down the street and so on; and there was a curious description in Arago which Prof. Tait credited (although he himself scarcely thought it worthy of being credited) so far as to quote it in a lecture he gave at Glasgow some time ago. It described a ball of lightning coming in at the window, running about amongst the people, and brushing up against their legs like a cat, and after that going out by the chimney (laughter). This slow discharge by ball lightning had been described very graphically by many people. He never saw any description so minute as that of Arago's, and he must repeat that he scarcely believed it. It was a tailor who reported it, and he thought he must have been an imaginative tailor, and let his imagination run away with him when he described a ball of lightning rubbing up against his legs as if it had been a cat purring. In respect to the duration, what Mr. Abercromby had called attention to was probably the true explanation. When people see a ball, as it were, coming in by the door, passing along the floor, going up the wall and out of the window, he believed it was altogether a physiological fact. They had been looking in some direction or the other when the flash came. At the instant that the flash came there was an intense action on the centre of the retina, especially if they chanced to see the flash in the sky. Naturally, after such a startling incident all eyes are moved, and each person after seeing the flash looks about to see what has happened; looks along the floor, looks up the wall, or turns his eyes towards the fire-place or towards a window, and a spot of light (the persisting impression on the retina) follows (applause). So that he believed this marvellous ball of lightning could be seen by very person present going out of his own window or any window that he happened to look out of, or going away up the chimney if he had chanced to turn his eyes towards the fire-place (laughter). He thought Mr. Preece was perfectly right in speaking of the multiplicity of flashes of lightning. He had given some unmistakable experimental and observational evidence of it, which agreed altogether with what he had himself noticed. The first time he distinctly remembered noticing it was in the summer of 1840 at Frankfort, where he had the pleasure of seeing a great many thunderstorms. He then remarked what he did not remember noticing before, triple and quadruple flashes frequently,* but at such short intervals of time that one could not but think they were somehow connected, and yet at certainly long enough intervals of time to allow him quite distinctly to see that they were not one flash, but several flashes. It was impressed upon him then, and had been since, because he had frequently seen similar phenomena since that time. As Mr. Abercromby had said, it did not seem to be repetition of flash along one and the same course, but a succession of connected flashes; a sort of breaking down along many lines and all over the place. One flash seems to cause many others. It is something like setting up a set of bricks or toy soldiers; tumble down one of them and there is a commotion all along the line, with a sensible time interval. He thought something must be allowed for sound in this case. Light had been spoken of; the light of one flash tended to produce another flash; if there was a flash ready to take place between two knobs *here* [illustrating], a flash *there* would cause it to pass, according to an experiment which Prof. Schüster had shown him, and which had been referred to by other speakers. It seemed that the very fine oscillations of light actually put the air into a condition which was more easily disrupted than air which is not agitated by light; but that would not account for the time interval between the different flashes which was spoken of by Mr. Preece, and which he had noticed himself repeatedly. He thought this might depend on the velocity of the propagation of sound in the air. The first flash did produce certainly a tremendous disturbance in the air, a tremendous disruption of the air probably causing a very perfect vacuum in the place of the flash, and after that a knocking together of the air. He thought they could not account for an electric flash through air otherwise than by supposing a crack in the air suddenly filling up and that producing an exceedingly sharp elastic disturbance. It was quite possible that that elastic disturbance, propagated at a rate nearly equal to the ordinary velocity of sound to another place where the air is in a state of high-tension, ready to break down, caused it to break down. Thus it might be that one flash caused considerable numbers of others at intervals of a quarter of a second, or a few quarter-seconds from its initiation. That was a thing that might be experimented upon. Referring to the photographs exhibited by Mr. Abercromby, he had noticed a great multiplicity of flashes in one of them. Query, were they simultaneous? Perhaps Mr. Abercromby might say?

Mr. ABERCROMBY: We have no evidence; the photograph was sent to us without any particulars.

Sir WILLIAM THOMSON, proceeding, said the subject had always been a most interesting one, but as it was now coming within the range of experimental investigation, which could not have been the case before the photographing of flashes of lightning was practised, he thought it would be worth while to make experiments distinctly, to ascertain whether such a group of flashes as that is or is not simultaneous. There was a very ready way of doing it. Let them put up two or three or four cameras with revolving shutters. Suppose they had on each camera a shutter with one hole in it for simplicity, and revolving ten times per second, or with more holes and a smaller number of revolutions. In looking for lightning, consider one camera left exposed with a shutter arranged in that way; stop it the moment a bright flash is seen, and remove the plate and examine it afterwards. If the whole of a group of flashes took place within the time of exposure, all would be recorded on one plate: if not so, then, for example, only one flash out of a group of four might be recorded by that arrangement. But suppose there were four cameras side by side, each with a revolving shutter, one exposed when the other was cut off, then, with flashes occurring at certain intervals, one of them would be seen on one of the cameras, and another on the other, and so on. It would be easy to make any kind of time analysis they pleased, or by, in the first place, being content to lose with a single camera a considerable number of flashes, they would, by aid of a revolving shutter, be able to see whether they got groups or single flashes. But to do it properly they ought to have a sufficient number of cameras to lose nothing, and the result would tell its own tale as to groups of flashes, whether simultaneous or not (applause).

There were some very interesting points with regard to the magnetisation of steel needles by a helix in which there are electric oscillations. If he remembered right, Riess experimented on the subject some time prior to 1853. Riess found that when a Leyden jar is discharged through an insulated wire wound up in a helix in the ordinary way, steel needles are found sometimes magnetised in the direction that would be expected, from the direction of the main discharge, and sometimes in the contrary direction. He believed, as Lord Rayleigh had stated, that experimenters had actually found differences of direction of magnetisation in different individuals of a group or bundle of steel wires thus actuated, or rather thus exposed to this kind of magnetising action. If they had a very powerful current going in one direction, followed by a current of half that strength going in the opposite direction, a current of a quarter the original strength going in the first direction, and so on, then they might expect the needle to be left magnetised by the current going in that one direction, corresponding to the last time that it had magnetising force enough to magnetise or to reverse the magnetisation of the needle. So that he thought by repeating Riess' old experiment with the same degree of electro-magnetic inertia in different successive cases but with different degrees of ohmic resistance, and, therefore, different rates of extinction of the oscillation, probably a full investigation might be made.

* See Sir W. Thomson's Collected Papers, Vol. I., pp. 536, 548.

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He was afraid that he was occupying too much time, but there was still what seemed to him to be rather an important point, namely, the protection of buildings (applause). It was rather disturbing to find that a lightning rod has so little protecting power as, according to Prof. Lodge, experiments seemed to prove. With reference to the distinction between iron and copper he would ask Mr. Preece whether he had experimental evidence of any superiority of copper. It was an exceedingly difficult question. Mr. Preece had told them that his experience generally was that lightning conductors are efficacious either with copper or iron as their material. There were certainly a great many iron conductors; and he, himself, did not know any experiment which proved that they were less efficient. But they could not say anything certain at the present time. Experiment after experiment, as Prof. Lodge himself had pointed out, must be gone through before they could say which it would be safer to recommend for lightning conductors—iron or copper. There was one point upon which iron had greatly the advantage—that is, that it takes a great deal more heat to melt it. Take iron at a given price, and compare the cost of iron and copper; they could get four or five times as great a mass of iron as of copper for the same money. Take also the higher melting point of iron, and they would see that for the same expenditure upon the lightning conductor they would provide for the consumption of a great deal more energy within itself without destroying it by using iron than by using copper. Then the question of self-induction bearing on magnetisation must be considered before they could say for certain that in all circumstances the iron lightning conductor is as safe as copper. One conclusion seems quite sure—namely, that a sheet-iron house, a sheet-iron roof, with sheet-iron walls and sheet-iron floor, is the very safest place that we can possibly be in, or that gunpowder can possibly be in, during a thunderstorm. Here he might say something which perhaps was absolutely wrong, but he would hazard it. The subject was full of pitfalls: but he would venture to say that the magnetisability of the iron seemed in this case rather to prevent the danger—to prevent the current coming into the inside rather than to facilitate its coming into the inside. He thought he might safely say this: that within an iron funnel—an iron vertical funnel, say—and within a copper vertical funnel, the interior would be protected in the case of the iron funnel by the magnetic susceptibility of the iron; whereas in the interior of the copper funnel there would be no protection from this cause, although in each case there would be a very potent protection from the conductivity of the metal. However, he thought with what Prof. Lodge had put before them they knew quite enough about iron to say that an iron building would be as safe as safe can be—as safe as science can make it. He thought that was rather an important thing for powder magazines; and that the rule should be to have no special lightning conductors at all, but iron roof, iron walls, iron floor—wooden boards over the floor naturally to prevent people setting fire to the gunpowder by walking over sheet iron; and a complete roofing of iron. This iron magazine might be placed on a dry granite rock, or it may be placed on wet ground; it may be placed on anything they pleased, it might be placed on a foundation under water; no matter what the surroundings are, the interior will be safe. He thought that was a somewhat important practical conclusion which might safely be drawn from consideration of these electrical oscillations and the experiments regarding them, and the trials for mathematical theory of them, mathematical calculations of which they had heard so much (loud applause)

Prof. ROWLAND referred to the photographs in connection with Prof. Lodge's experiment. The question seemed to be whether that experiment actually represented the case of the lightning. He was very much disposed to think that it did not. In Prof. Lodge's experiment the whole of the circuit between the condensers was a material of copper and iron, whereas in the case of the lightning the greater portion of the flash was in the air, and, therefore, it might be an entirely different phenomenon in the case of the lightning from what it was in the case of Prof. Lodge's experiment. Furthermore, he was not entirely disposed to think that the length of the spark was an index of the resistance of the conductor in that case, for the reason that they did not know what the length of the spark was when there was an oscilating E.M.F. acting on it. He was not disposed to say that the discharge would take place at the first moment. There might be considerable oscillation, and finally the air might be broken down. The oscillation might take place before the spark goes, in which case the length of the spark might not be an index altogether of what they might call the temporary resistance of the conductor to the passage of the spark. The presence of iron might change the time of oscillation in the same way, so that it might give a different length of spark in that case from what it did in the copper. But he thought the fact should be remembered that in the case of lightning the greater proportion of the spark was in the air, which was a very bad conductor, and that therefore the passage of the lightning might not be oscillatory but might be of the nature of a swing, in which case a solid conductor or a conductor of copper would probably be better than a tube of iron. With regard to the photographs, he noticed many curious phenomena which he thought should be guarded against. He was happy to say that the best one, which might form the text of his remarks on the rest of them, was an American photograph. In that we had the whole plate exposed and the lightning in the centre of it. He did not suppose that all those were taken at once, but as Sir William Thomson had remarked the plate must have been exposed some time, and have had several discharges upon it. But looking at it he noticed that near the centre the line of discharge was perfectly sharp. As he wandered off towards the edge, he saw some phenomena which were very similar to those that he saw upon these other photographs, which therefore he would say was due to the astigmatism of the lens in some way. As they wandered from the centre the image was blurred, and they saw a number of hazy effects around the spark which might very well be due to the astigmatism of the lens.

M. DE FONVIELLE (who spoke in French) observed that Sir William Thomson had said most eloquently that Mr. Preece was taking the English side of the question and Mr. Lodge the American side, but he must say that Sir William Thomson himself had taken the French side, and he had proposed a revolutionary system which consisted in the building of iron houses. He took the liberty, though being a Frenchman, to disagree with the great electrician, and to stand with Mr. Preece as an English conservative, with reference to lightning conductors. Lord Rayleigh said that mathematicians and physicists should unite together, but he supposed Lord Rayleigh would agree with him in remarking that Mr. Preece was realising that alliance in a very remarkable manner, for on the one hand he dealt with a large number of experiments and observations of natural facts, and on the other hand he introduced statistics, or rather the calculation of probabilities, which was one of the highest branches of mathematics. The experiments done in laboratories were different from those which were presented by nature only so far as they were conducted on very widely different scales. He congratulated them on the aid they were now receiving from photography He should advise the meeting to delay its opinion for a time until the completion in Paris of the Eiffel Tower, which would be the most extraordinary lightning conductor in existence, being 1,000ft. high, and which would supply unprecedented observation and experiments. He must, moreover, state that Paris was practically free from calamities produced by lightning. They had erected a sufficient number of lightning rods, according to the principles so admirably advocated by Mr. Preece, and that was a strong evidence that Mr. Preece was altogether travelling in the right direction, quite irrespective of any mathematical or physical demonstration (applause).

Prof. GEORGE FORBES said as to the question which had been raised as between engineers and mathematicians, some people were apt to take a different view of what Mr. Preece meant from that which he did mean. He thought no man would be more likely than Mr. Preece to mean this, that when a mathematician started from a number of data and worked out mathematically a conclusion, that that conclusion was absolutely right could not be gainsaid; but what Mr. Preece would mean to say was that the mathematician might happen to take insufficient data for his premises, and so might eventually arrive at giving advice which was not the best advice which could be given. He thought that that was all that he meant. He thought that Mr. Preece would admit most readily that the conclusions of a mathematician were absolutely correct, and could not be wrong; but it was in the choice of the data that he might make a mistake. It reminded him rather of Lord Westbury's advice to a young lawyer. He is reported as having said, "In arguing a case never deduce wrong conclusions from your premises, the facts are at your disposal" (laughter). Let them keep before their minds in this discussion what the question was which they wished to determine. The question had arisen from Prof. Lodge having come with those experiments to prove that the views of the Committee on Lightning Rods were erroneous. The Committee on Lightning Rods had come to a definite conclusion to make a recommendation that copper should be used for the lightning rods, and Prof. Lodge had come to say that if iron was not better it certainly was as good, and that was the question which had to be decided. Now, Prof. Rowland had already said that it was not quite certain that the experiments which Prof. Lodge had brought forward were perfectly conclusive on this point. No one could fail to be deeply impressed with the beauty and the value of those experiments from a scientific point of view, but he thought it was quite a fair position for Mr. Preece to take up to say that at present they had not proved the fact that the conclusions of the Committee on Lightning Rods ought to be given up. He would illustrate what he meant in this way. They had heard one of Prof. Lodge's experiments very clearly put before them, in which they had an alternative path either of copper or of iron. Previous to those experiments, most persons would have expected that copper would have been the better conductor for the alternative path. Prof. Lodge assured them, as the result of his experiments, that copper was the worse of the two. He had not, however, given them an explanation of this fact—why it was so.

Prof. LODGE said that he did so in the section on Friday.

Prof. FORBES begged Prof. Lodge's pardon. He was going to say that until they heard the explanation of it they would not be in a position to see whether it extended to a flash from the clouds or not. The reason why he thought they were not fully able to accept this experiment as sufficing to abolish copper rods for lightning conductors was this: In the experiment Prof. Lodge had used two condensers, and he used a special case in which there were two sparks produced beside the alternative path. He had doubtless tried the experiment in a much simpler way, and more resembling the conditions which existed in the actual phenomenon. Supposing, instead of using those two condensers they used the two poles of the Holtz machine; or, instead of having two pairs of knobs, suppose they used only onepair of knobs. They might connect the poles of the Holtz machine with a large battery of Leyden jars, and they would get all the better effect. The arrangement then was that they got a spark between the two knobs of the Holtz machine. They put an alternative path in the course of the spark, and then they tested to see at what distance a spark was just possible to take place. He wanted to ask Prof. Lodge when that experiment was being performed whether an iron alternative path or a copper alternative path was best. The circumstances seemed to him to more resemble the circumstances in nature than the arrangement which he had described in his experiment, and he thought the conclusion was that the copper alternative path was the best, which would be an argument in favour of Mr. Preece's view.

Sir JAMES DOUGLASS said that the few remarks which he had to make upon this matter were in relation to experience with a large number of conductors in exposed stations now extending over about 40 years. He might say that his experience was comforting to the committee. It had been with lighthouse towers, and there they had

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been following out for nearly the last 50 years the advice of Faraday entirely. For protecting a lighthouse Faraday advised them to start with the base of the *metallic lantern*. The conductors were an inch and a half by three-quarters half round—that was to say, the half, of an inch and a half copper bar. They were carried down the interior of the tower on the internal surface of the wall, with branches to all metal work. He thought much of this was given in the report of the committee, but perhaps there was no harm in repeating it. The earth is obtained by a copper plate, 2ft. 6in. square and ¼in. thick, buried at a distance of 15ft. from the tower, and about 12ft. below the surface of the ground, generally securing damp contact. At exposed stations at sea the bar is carried down to about 8ft. or 10ft. below low water spring tides, so as to be always immersed in the waves. He might say that during 40 years perhaps seven or eight accidents had occurred, but no accidents of a serious nature, and in all cases when an accident had occurred they had been able to discover that it was due to a defect in the conductor (applause). Generally it had been found to be due to a mechanic, who had been working at the station, and having disconnected the conductor, had not properly reconnected it. Therefore, those were points that they felt confident were to be got over by more rigid inspection. More rigid inspection now was being carried out, and he for one would feel that he would be perfectly safe in any tower where this system was carried out, and where the conductors were properly looked after. Having the conductors carried down the interior of the building they had every opportunity of examining them, and he rarely visited a lighthouse without inspecting every communication up and down, and generally testing the conductor with a common linesman's instrument from top to bottom. There was one practical point on the question of iron *versus* copper, and it was this: the rapid corrosion of iron, compared with copper. It was quite possible with an iron conductor in an exposed station they might visit that station after an absence of seven or eight years and find very little of the conductor left. He had known bars of iron corroding at a very rapid rate in this country, and of course it was much more rapid in hotter climates. One point he had omitted to mention which would be comforting to Mr. Preece, that during 40 years where those conductors had been carried out on towers surrounded by dwellings, in only one case had an accident occurred to the dwellings, and then it was due to the imperfection of the conductor in the tower. It was not a case of the dwelling being struck from the outside (applause).

Mr. SYDNEY WALKER, speaking as a practical engineer, reminded the meeting that it was the engineer who would have to carry out the work, and he would get the blame if anything went wrong. He mentioned one instance of a chimney being destroyed at a colliery in Derbyshire. The proprietors said it was cheaper for them to have the chimney destroyed than to fix a lightning conductor, because the destruction of the chimney occurred so seldom. In the face of that it would be a very uphill battle to fight to induce people to take up lightning conductors, and therefore he would only too gladly welcome anything which would lessen their cost. He considered that the statements made by Mr. Preece in his address as president of Section G, after the experience and study of a great many years, was absolutely correct. If they had a conductor properly constructed, properly fixed, properly pointed, properly earthed, and properly inspected, the building it was attached to was absolutely protected. He did not think there was any instance of any building having been damaged where the whole of those conditions had been complied with. He thought the cases where destruction or damage had occurred had been where some of the conditions had been neglected; for instance, where the conductor was leaded into a tombstone, and he did not consider a tombstone good earth (laughter). It appeared that the problem they had to solve was exactly similar to the problem involved where the embankment of a huge reservoir of water placed for the benefit of a town was very liable to give way. If the water was allowed to come down its own way, it brought destruction in its path; if it could be carried off harmlessly into another channel or into the deep bed of the river, the town would be saved. But there was this difference in the case of the water—there was only one path to provide. Water has to come down, and there is an end of it; but in the case of lightning they had a double path to find. The lightning flash had to come from the cloud to the ground, and to get back from the ground to the cloud; and that was a point which, he thought, they were rather overlooking. It was here that the importance of a good earth became so apparent. If the conductor ended in a tombstone the return path was represented by the air space between the line of the conductor itself, any moisture that might be on the tombstone, and any portion of ground that this moisture brought into connection with the conductor and the cloud. Whereas, if a good earth were obtained, say such as gas or water mains, spreading out into the surrounding earth perhaps for miles, and in more or less good conductive connection with it, the return path was represented by the air space between this large surface of ground and the cloud; so that its electrical resistance would be very small indeed, compared with that offered where a bad earth ruled. And this had a most important bearing upon the question of side flash, since if the resistance of the conductor and of the return path were both very small, the whole of the work would be done in passing from the cloud to the conductor, so that there should be no appreciable voltage between any portion of the conductor and, say, a gas bracket, just as with electric lighting mains in parallel the voltage between one terminal of an incandescent lamp and the same side of the dynamo was usually very small indeed. If, however, the resistance of the return path were large, say equal to that of the outgoing path, as it may be if the earth is bad, then at any point in the conductor you may still have half the voltage of the cloud left, and should a gas bracket in fairly good connection with the mass of gas mains be within a certain distance of the conductor, this would open the very path it was requiring, and it could not help sparking into it, just as if, in place of bridging a pair of electric lighting mains whose difference of potentials was 100 volts by a lamp of 100 volts, it was bridged by two such lamps in series, there would exist between the junction of the lamps and either main, or either side of the dynamo, half the total voltage, so that a 50-volt lamp connected to that junction and either main must light up. With regard to the question of iron and copper, he was of opinion that electrically it did not matter which was used, as the resistance of the conductor, whichever metal it was composed of, should form only a small part of the total resistance of the circuit; but for durability copper was decidedly to be preferred. As Sir James Douglas had remarked, iron would not stand the weather, and he would also point out that iron would not stand the chemical action of the fumes issuing from the chimneys of iron and chemical and other works. He would like also to call attention to another point, though he did so with considerable diffidence. Dr. Lodge had stated that "Ohm's law was not in it." He ventured to think that Ohm's law *was* in it, if you called things by their right names. He suggested that "impedance," "self-induction" and "electro-magnetic inertia" were merely our old friend "back electromotive force." If you split a rod into a number of filaments in the way Dr. Lodge had suggested, and imagined that a current passed in each, each created its own magnetic field around it, which gave rise to an opposing E.M.F. in all the other filaments, and it was the algebraical sum of all these opposing E.M.F.'s which gave rise to the apparent increased resistance, and which had to be provided for, just as the back E.M.F. of an electro-motor had. He would only mention one other matter. Unfortunately, loss of life and property by lightning was not confined to buildings. It was well known that cattle and human beings were often struck in the open, for no apparent reason, and there had even been cases where animals had been struck when grazing in a valley, though the surrounding hills were untouched. He would suggest that this was due to electrical currents within the earth's crust, possibly in some cases induced by the motion of the cloud itself, the difference in conductivity of the different strata causing a kind of selection to take place, the result being that, notwithstanding the fact of the cloud being farther from the bottom of the valley than the surrounding hills, the increased difference of potentials, combined with the difference in conductivity, made the path by the valley the one selected, rather than that by the hills.

Mr. BROWN, of Belfast, suggested that if one were to use a revolving camera any flashes passing consecutively over the same path would be separated on the plate, and it would be easy to calculate the time interval between them from the rate at which the camera was revolving. He had used a revolving camera himself for the purpose of registering, and he was sure it would be quite easy to determine an interval of less than the thousandth of a second. In order to investigate the other question, as to the time interval between the streams of flashes as they appeared on the photographs shown, that could easily be done by setting up one stationary camera to photograph the thing in the ordinary way, having a second camera revolving on a vertical axis.

Mr. G. J. SYMONS, F.R.S., said he ought, perhaps, to offer some apology for speaking on this subject, but it was one to which he had devoted much of his attention for considerably over thirty years. In fact, as far back as the Aberdeen meeting in 1859 he was one who took part in a discussion upon lightning conductors—at which Sir William Thomson made, as probably he would remember, the very remark which had been repeated to-day, that when he suggested to the Glasgow manufacturers to set up lightning conductors they all said it would be "cheaper to insure." Lord Rayleigh had said that it was desirable to get the evidence of practical men; he had nothing to do with the construction or erection of lightning conductors, but all through his life it had been his hobby to investigate every accident that he could of damage by lightning, and in that way he had got experience which was possibly of some value. Then eventually, when the Lightning Rod Conference was formed, he was one of the delegates, and they did him the honour of making him Secretary, consequently he had a great deal of evidence brought before him; and he must say that the impression left upon his mind, as the result of the whole of his experience, was precisely in accordance with that of Sir James Douglas, namely, that, as far as he could judge, if people would only put up conductors precisely in accordance with the rules, and fulfil all the conditions, those conductors were absolutely safe. He had not a shadow of hesitation in saying so. He admitted that accidents had happened now and then to buildings which had conductors, but a reasonable explanation of every one of those accidents, to the best of his knowledge, was forthcoming; and they all knew how very much easier it was to produce destructive criticism than to construct a system. Prof. Lodge's experiments (and he yielded to no one in appreciation of Prof. Lodge as an experimenter) were, after all, simply laboratory experiments, and it seemed to him that what they wanted was something on an infinitely larger scale. He was not going to suggest how they could make artificial lightning, so that they might deal with the actual thing itself, although the idea had often occurred to him that a great deal of information upon the subject could be obtained if upon the summit of some of those hills which were most frequently struck a series of interrupted conductors was put up where the lightning would presumably strike, on a series of tall masts; without risk to human life, they might learn a good deal more than they knew at the present time. He certainly did feel most desirous, on the one hand, that if possible lightning conductors should be cheapened and rendered more generally accessible; but, on the other hand, that they should not simply, on the strength, as he said before, of those laboratory experiments, allow it to go forth from this great Association that there was any uncertainty in the protection of the public buildings throughout the country (applause). It seemed to him that a very serious responsibility attached to those who would make a suggestion of that nature. They had the experience, not only of this country, but, as M. de Fonvielle had said, of France; they had that of Germany, and that of Austria, and they had also the experience of the United States on an enor-

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mous scale. Tens of thousands of lightning conductors were erected, and millions sterling had been invested in their erection; and he must say that it would be with considerable regret that he should hear it go forth from that room, simply on the strength of some laboratory experiments, that all that had been done was to be regarded as almost worse than useless (applause). The discussion had already gone on so long that he should be sorry to enter into many points upon which he had made notes, but there were two or three upon which he should certainly like very briefly to say two or three words. He had forgotten who it was, but one of the speakers made, he thought, very justifiable allusion to the extraordinary story about ball lightning rubbing against his trousers, but as to the existence of ball lightning or some phenomenon of slow lightning, he had heard of it from so many persons in all parts of the country, and in all countries of the globe, that he could not dispute its existence. As for understanding it, he did not. He remembered quite well the experiments that were made (he was not electrician enough to say whether they were correct or not) at one of the meetings of the Society of Telegraph-Engineers by Mr. Varley, in which he actually produced something closely analogous to the phenomenon of ball lightning.* Then with respect to iron conductors, first of all there was, as Sir James Douglas said, the question of oxidation. He would be told, "Oh, it can be galvanised"; but he knew enough of galvanised iron to know that it was not an everlasting material by any means. Then another thing, as had been well pointed out, was that the gases coming out from many of our factories were seriously injurious. With respect to the area of protection, he knew that he was within the mark in saying that hundreds of cases had been investigated, and that there were not, as regards the area of protection laid down in the report of the Lightning Rod Conference, more than two instances, and those were a little doubtful, in which anything had been struck within that area of protection. The attacks all round were alarming. It was suggested that lightning could not be trusted to go down a thick copper rod, and that there was no such thing as a protected area. One would be afraid to go to church in a thunderstorm because the conductor on the top of the church would not protect them. Up to the present time there had not been a single case of a church having been struck which was provided with a good and efficient conductor. Churches were struck every year, because they either had no conductor or a bad one. Sometimes, as one of their friends said, the bottom of the conductor was let into a paving stone. At one of the cathedrals the conductor was led into a pickle bottle. Of course it was a great stupidity to allow a country blacksmith to put up conductors in that manner. There is no record of the failure of a properly-made and erected lightning conductor. Mr. Preece, in spite of all his attention (and he did work thoroughly hard upon this report), had not remembered all the details as to the upper terminal. The report suggested that what was called the upper terminal, that was the extreme top, should consist of a blunt point surrounded at about 6in. below the top by a small ring from which very sharp needle points should project. The idea of the delegates in designing that upper terminal was (he was afraid he did not use proper electrical language, because, he was not an electrician), that the acute points, the very sharp needle points down below, were to disperse the electricity, and act as a preventive; but if a disruptive discharge occurred, if the cloud came up so rapidly that the points could not get the potential down fast enough, and a disruptive discharge came upon the conductor, the absolute top of the conductor was there to receive it. The object of the blunt point was this: that if lightning fell upon a sharp point, it invariably heated it, and there were cases on record of the fused metal of the upper terminal igniting buildings. With respect to the proposed use of small wires he felt quite aghast, for this reason, that he had been in dozens of houses which had been struck by lightning, and almost the first thing that was found was that the bells went wrong. The fact was this, that the lightning as a rule got into the bell wires; it dispersed them in dust as a brown mark all round the walls of the room, and every wire was gone. If the old-fashioned conductors, which were as thick as his finger, were to be replaced by something analogous to bell wires, he wondered what was to happen after the first flash (applause).

Mr. WALKER, sen., said the last speaker had expressed a hope that experiments would be made by means of conductors elevated on a hill. He happened himself to have been in such a case. Three or four years ago he read a Paper before the Royal Meteorological Society, on an obelisk being struck. He happened to be half a mile from it, and he was rather inclined to think, from his experience then of what took place, that there were some storms in which no amount of precaution they could take would prevent destruction. The whole of the air on the occasion was an entire environment of light; there was no flash, and although he was half a mile from from it, the obelisk was the only thing that was struck. It broke off at the top; the lightning came out in 14 different places, and it ran out in one case to 100ft., and broke off some rock before it went down and ploughed up the ground in grooves. The theory was simply a theory that the lightning did not come down from the cloud but that it went up from the earth to the sky. Nothing had been said in that meeting to that effect, and it struck him that this must have come down in that form. As those streams [illustrating on the black-board] were merely continuations of the lightning flash, could they imagine any amount of earthy matters conducting that mass of electricity that came down from that column? He would like very much to see what could be done. That had been twice struck, and there was an agitation what to do in building it up.

Mr. PREECE asked if there was a lightning conductor.

Mr. WALKER said there was no lightning conductor upon it (laughter.) They wanted this Association to tell them what to do to prevent those things in future, and he was sure if that were done it would give them a very great deal of pleasure.

* See Proc. Roy. Soc., Vol. XIX. (1870-71) pp. 236–242.

Mr. TRUEMAN WOOD, referring to one of the photographs, said the so-called dark flash, whatever it was, certainly was not the result of over-exposure, as had been suggested, because the white flash, which was presumably on that theory less exposed, over-rode the black one, whereas, of course if the black part was the part of the plate which had received the most exposure, the black one would show over the white one. In a second photograph there was an exactly similar dark line which was evidently the result of *halation* or reflection from the back of the plate, and therefore he thought there could not be much doubt that the dark flash was really the result of *halation* or reflection from one of the other flashes.

The PRESIDENT then called upon Lord Rayleigh, Prof. Lodge and Mr. Preece to reply to the discussion.

Lord RAYLEIGH referred to a suggestion that Prof. Stokes once made, which he did not think had ever appeared in print. He was not quite sure whether he ought now to mention it, but he was encouraged by Sir William Thomson to do so. He thought there was no doubt, as Mr. Wood had said, that the appearance of the black flash did not suggest that over-exposure was the explanation. Prof. Stokes's view was this:—he thought that under the influence of a flash the atmospheric gases of oxygen and nitrogen were combined so as to produce considerable quantities of the oxides of nitrogen; that those oxides of nitrogen, formed along the line of the flash, were opaque to the invisible rays at the upper limit of the spectrum, to which most photographic action was due; and that this, when another flash occurred, illuminating the background of the cloud, would darken the place where the first flash had been; the mark of the flash would appear as a black line on account of its opacity to the general first light of the background (applause).

Prof. OLIVER LODGE said so many things had been remarked, and so much might be said on points which had not been commented upon, that one must exercise selection in what one mentioned. He would first say a few words suggested by the remarks of the various speakers. Mr. Walker, Mr. Symons, and Mr. Preece too, spoke as if he had especially attacked the report of the Lightning Rod Conference. But that he had not done at all; he had made great use of the report, and he thought that conference had done a very valuable piece of work. They had collected together all manner of details of destructions and of failures of lightning rods. The whole of the report is bristling with failures of lightning rods, so that he was at a loss to understand—no, he did understand—how they could say that rods never fail. They say that a "properly" constructed lightning rod never fails, because whenever a thing fails they always say there was something the matter with it (laughter). They generally say bad earth, but why a thing ought to have such extraordinarily good earth he never could tell. What was the difference between one end of the conductor and the other? You stick three points at *that* end, and you want a lot of roots at *this* end; suppose it was up-ended, why not have the roots in the sky and the points down below? Why should one end have to be treated so very carefully and the other end be left to itself? So far as protection is concerned the points at the top and the three points at the bottom ought to do equally well. Of course it may be inconvenient to have the ground ploughed up and things of that sort. You may have the ground and the water pipes broken if you have not good earth. They ought therefore to have a good deep earth; but even if they had no earth flashes ought not to spit off from the conductor to such things as safes and gunbarrels and rain-water gutters. It did that because it met with obstruction—impedance—he did not care what they called it—a spurious resistance. They might use the word resistance if they liked, but it was not what they ordinarily called resistance, it was like inertia. It was like having to move a great freely-suspended weight; there was no resistance to its motion; you knock it with a hammer, and expect it to fly to the other end of the room, but it scarcely moves. You may knock the hammer to pieces; you may do a great deal of damage, but you cannot move the weight suddenly. That was the kind of obstruction that was met with in a lightning conductor. As regarded failures of properly constructed lightning conductors, he wanted to know from Mr. Symons—there would be plenty of opportunities for continuing this discussion in print—why the Hotel de Ville at Brussels was set on fire by a lightning flash, because if anything was well protected, and even admirably and thoroughly protected according to orthodox principles, that building was so. He himself thought it was protected. When he said that a building was not completely safe he did not mean, and had never thought of meaning, that lightning protectors are of no use; they are of very much use, but they may occasionally, and he believed do occasionally fail. M. de Fonvielle referred to the great experience that Mr. Preece had had, and also of the experience gained in France of all sorts of conductors, telegraph posts, and things like that. It is true they did not fail much, but then a telegraph post, and an obelisk, and a lighthouse were the easiest possible things to protect. There was just one column, and if they stuck one conductor down, there was not much chance of its spitting, or its doing much damage, or anything else. In the case of the Monument, in London, he believed that the handrail of the staircase was the lightning conductor. He did not know how it would feel if it was struck; he dare say it had been struck, probably in the night when nobody was there; but it had never been damaged in the least. It was not so easy to protect powder magazines, or houses where there was escaping gas. If the lightning flash was only a little bit away from a leaden gas pipe, it would very likely fuse it and light the gas, and they would have the house burnt down. They might not know that it had been struck, but they would wake up in the morning and find themselves burnt. Prof. Forbes had asked him to say why he did not use one pair of knobs instead of two pairs of knobs to try the experiment. If Prof. Forbes tried it with one pair of knobs he would find that he could not do it at all. There must be two pairs of knobs somewhere. *Here* [illustrating] are the two knobs of the Holtz machine, and *here* the alternative path. How were they to get sparks between these knobs? If they were to put an alternative path to an air,

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space they must have another air-space somewhere to enable them to do it, but it need not be done exactly as he had done it. He would not go further into that point now, as the discussion could be continued in print, but he might put his views briefly thus :

These discharges are oscillating currents of extraordinarily great frequency—something like a million a second. For those currents it is only the outer surface of a rod that conducts, therefore its obstruction was due to the space surrounding the conductor, and it was not due to the material of the conductor. It is only the outside tube of the conductor that conveys any current, and therefore the conductor, whether iron or copper, did not get magnetised at all. It did not matter about its permeability, or about its conductivity much. The current is very great ; even from an ordinary Leyden jar the current produced when discharged through an ordinary tongs is about 3,000 amperes. The current in a lightning flash is, no doubt, enormous—he thought a million amperes for the time it lasted. That it was very great was shown by the heating powers and the destructive powers it had, though its duration is so extremely small ; and hence it is that the impedance being also very great, they had this large amount of ohms and the tremendous current, and so they got a tremendous difference of potential at the end and the liability to spit off.

Seeing that only the outer surface conducts, what is the good of the inside of the rod ? It may be able to conduct some heat away and so prevent melting, or it may not have time to do that. Probably there is no very great good in it, but if they were going to have a tube they had better have it spread out flat. Or, better still, have a strand of separated wires, or have a series of wires about the size of telegraph wires. Mr. Preece knew very well that the iron wire conductors on the telegraph posts protected them, and a house would be protected in a similar way, and cheaply, by putting a great number of common galvanised iron telegraph-wires up. That was his view ; but it was not authoritative. If what he said would be authoritative, and would go forth as a statement from that room, of course he would hold his tongue ; but, as it was, he simply said that which he thought true at the time. It was found that all the failures in the case of lightning conductors were due to the spitting off from them ; were due to this high potential ; were due to the impedance of it, the obstruction of it, to the fact that it does not conduct easily away as they would expect it to do ; not due to the melting of it. Mr. Symons, in his report of the Lightning Rod Conference, gave, in an appendix K, a list of conductors which had been melted by the flash, and he apologised for the shortness of the list. No apology was necessary ; the list was short because they very seldom got melted. If they analysed those which Mr. Symons gave they would find in every case but one that it was only the upper terminals which had been melted, not the full length of the conductor. There was only one case of complete destruction, and that was a bell wire, and even so it exerted a protective influence. So then we learn that when they are bell wires they are melted ; but he did not want the wires which were to be put up to be of the thinness of bell wires.

Iron buildings, as Sir William Thomson said, are practically safe for powder magazines, and the safest things they could make, but even with them some little care was wanted ; the iron must be in absolutely good connection all through. If there was a gap left anywhere there might be a spark in that gap. When an iron building is struck they would have the thing surging about in all directions, and they might get sparks in the most unexpected places, and for the most apparently ridiculous reason. It might be only half an inch long or a quarter of an inch long—that would be quite sufficient to light gas and do all the damage. There was in houses the danger of gas, and there is danger in powder magazines—not from sparks a yard long, those might be guarded against—but let there be a gap of a quarter of an inch, and they might get the sparks where they least expected them.

As regards the possible effect of sound waves—sound waves produced by these sparks—might he just call attention to one little experiment which was not his own, but which was first made by Dr. Guthrie ? It had been called attention to at the Physical Society afresh and independently by a Dr. Cook. There was a discharging Leyden jar which, as he had often said, gave ether waves of a calculable length : well, if a plate of fine powder is put near its spark it gets thrown into ripples. This modification of the experiment had been made by Mr. Chattock—he took a little tube like a resonant tube and sprinkled powder in it ; when the spark occurs near the mouth of that tube, there are ripples on the sand indicating that a series of longitudinal wave had traversed the tube—longitudinal waves which were extremely short—about a millimetre in length : sound waves being practically one millionth of the length of light waves. The oscillating heat no doubt of the spark was able to send longitudinal vibrations down the tube—sound waves about a millimetre long which threw the sand into ripples. It might be those longitudinal sound waves which Sir William Thomson mentioned, and which might in some way precipitate a discharge in the neighbourhood ; but no doubt there were other causes (loud applause).

Mr. PREECE said he introduced at the commencement of his remarks an unfortunate allusion. He compared Prof. Lodge to their old friend Balaam, and he said that there were three persons, or three quantities, mixed up in that transaction, Balak, Balaam, and the donkey ; but there was a fourth. Now there were a good many errors of translation in our Scriptures, and he was strongly inclined to think that the word "ass" should have been translated "phonograph." What really communicated with Balaam was a voice, and that voice was right. Balaam had made a mistake, as Prof. Lodge had made a mistake. The voice came directly from Heaven, and it was with the voice that he claimed relationship. There was very little for him to say. Prof. George Forbes had put his view of the question of mathematicians *versus* practical men very much on the right footing. It would be folly and absurdity on his part to call into question for one moment the conclusions of their masters in mathematics. They were all students, who lay at the feet of their Gamaliel at the end of the room, Lord Rayleigh. Everything Lord Rayleigh wrote, everything he said, and everything he did, was studied with the very greatest care, and he (Mr. Preece) would be very grieved if anybody left this room and thought that he had called into question anything that masters like Lord Rayleigh and Sir William Thomson, or Prof. Rowlands, had ever said. As regards Sir William Thomson, he was one of themselves. He was not a physicist—he might know a little about it (laughter) ; he was not a mathematician—he might know a little about that ; but what he was was an electrical engineer ; he was the head of the profession, he was the first electrical engineer in the world (loud applause). There was no doubt that we all made mistakes, engineers and mathematicians as well. What he meant to imply was this, that in the present day, what with Technical Institutes, what with the innumerable students that were sent into the world, specially into the electrical world, every year, they found some of those young fellows coming out with a smattering of mathematics ; they wrote Papers for the technical journals, and they thrust upon the electrical world conditions and conclusions arrived at by their mathematics with a coolness and an effrontery that were simply appalling. It was to try and check that sort of thing, that was growing to a very serious extent, that he had made the few remarks he had about the necessity of being excessively cautious in acting upon any conclusion that might be derived from mathematical development, unless (and mind, he had always put in this) confirmed by actual experience (applause). The true mathematician would never come to a conclusion, and never thrust his conclusion upon the world, unless he was sure of his ground, but the imperfectly trained gentlemen were too fond of throwing out conclusions, without the least confirmation by experiment or anything else. He would not occupy their time any more, because there would be other occasions when the points at difference between them could be argued. He might say that they had dwindled down to a very small thing indeed. As regarded the question of iron and copper, in answer to Sir W. Thompson, he would say that most—in fact, all—of those lightning conductors of which he had actual experience were of iron—(hear, hear)—and always had been, as most of them knew who had read the reports he had written. He was a great advocate of iron. He thought the use of copper to the extent that it was used introduced a needless expense into the erection of lightning conductors. His own impression was that every private house could be thoroughly protected, according to the recommendations of the Lightning Rod Conference, for at least a pound. Anybody could buy a coil of stranded iron rope, and if they took an iron rod about a quarter of an inch in diameter with the finial Mr. Symons had referred to, he believed that they could safely protect their houses with lightning protectors for a few shillings, instead of now, where copper was employed, indulging in the expenditure of a few pounds (applause).

The PRESIDENT said he was sure they had all heard with very great pleasure the discussion that had taken place, and it was with very great diffidence indeed that he felt called upon by his position, rather than by any desire to do it, to say a few words in summing up what seemed to him to be more or less the result of the considerations that they had come to. He was glad to say that he had had no experience of lightning. It was not an agreeable thing to have anything to do with. However, it was most closely allied, there was no doubt about it, to static electricity, which he had heretofore looked upon as one of the most beautiful of the vast forces of nature ; and he hoped now that their experiments in what had been hitherto called static electricity would gain fresh interest from the practical applications that were likely to be derived from it. He thought, as far as Prof. Lodge's position was concerned, it was very important to observe that there were a number of experiments that have taken place, especially in connection with some tramway lines, with telegraph instruments and with telephones, with effects that have taken place at terminal stations at considerable distances from the lightning, which required to be investigated, and about which they knew very little, and which had not been considered very much.

Mr. PREECE said he had meant to point out what Prof. Fitzgerald was now saying, that they had experienced sparks in their telephone exchanges and in their electric light installations where there was a mere metallic circuit. What Prof. Fitzgerald now referred to was the practice exactly, and it was a most interesting point.

The PRESIDENT said they were all very much obliged to Prof. Lodge for his experiments, because heretofore he thought there had been little or no experimental observation of this particular point, and it was a very important thing to see, especially if telephones were likely to become of very great use on a large scale, that during thunderstorms, if they could possibly do it, they should protect people from injurious effects owing to the presence of a thunderstorm, perhaps at a considerable distance from the person that was observing it. It was very analogous, it seemed to him, to Prof. Lodge's experiments, and they were very much to the point in that explanation ; but he was inclined to think that the experiment that he had performed was not exactly analogous, and in many ways was not at all analogous to a lightning flash. Mr. Preece had called attention to the fact that a lightning flash was very much more like a discharge between the plates of a condenser, much more like the breaking down in the insulation in a Leyden jar when it bursts through the glass. Prof. Lodge's experiments had not been on the effect of putting a point upon one of the plates of an air condenser, and if he did make some experiments on it he thought he would find there would be a considerable diminution in the amount of sparks.

Prof. LODGE : If you read my Paper you will find those experiments done, too

The PRESIDENT said he was afraid he had not studied the thing completely ; but the experiments that were alluded to to-day were not exactly analogous.

Prof. LODGE : No.

The PRESIDENT thought it would have been well if they had been

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told of experiments which were exactly analogous. There was a question with respect to the alternation of currents. He would call Mr. Preece's attention to this, that even though there might not be millions of alternations per second a great many of the effects of an alternating current would by produced by an extremely sudden current of very short duration—that the effects that had been observed were due to the very sudden change in the strength of the current. Now, the effects of a very sudden change in the strength of the current could be produced by a single spark, whether there was an alternation or not. So that a great number of the effects that Prof. Lodge had observed, and in reference to which he seemed to think it was necessary to have an alternation several million times a second, would be produced by a single sudden discharge of a millionth of a second.

Prof. LODGE: Not quantitatively.

The PRESIDENT: It might not be an exactly similar case with all of them, but a great number of the effects would be produced; and he thought a great number of effects, similar to those that Prof. Hertz had observed, would occur, where at a distance from a spark he had observed electro-magnetic effects. That might also cause electro-magnetic effects in the inside of the house due to a spark of electricity going to the outside of the house. He would like to make one more remark. Globular lightning would possibly be due to the dissociation of molecules of the air, and of there being a region of the air in which there were atoms going about by themselves, and combining amongst themselves and producing an illuminating part of the air, the original dissociation of the atoms having been produced by some electrical effect. He was not sure that it was worth considering, but it was a thing that was possible, he thought. In conclusion, he thought that the principal thing for them to pay attention to was that prevention was better than cure, and as M. de Fonvielle had called their attention to it, there was very little doubt but that the presence of a considerable number of lightning conductors unquestionably afforded a great deal of protection to the area within which they existed. As he had remarked, in the city of Paris they hardly ever had any accidents from lightning, and it had been observed on a larger scale that the existence of lightning conductors actually as a matter of fact produced a discharge which, to a great extent, probably neutralised the clouds, and thereby prevented the lightning flash occurring at all; so that it was very desirable that, if possible, the whole country should be covered with lightning conductors, and that they might have as many points as possible, and thus, as far as they could, prevent the occurrence of lightning. There was no doubt that when a flash occurred it was extremely disagreeable, and they had better adopt the old rule that "Absence of body was better than presence of mind," and avoid being near it if they could (app'ause). That led him to the point that Prof. Lodge had mentioned, which reminded him of the effects that they had in a room, when each person wished his neighbour to open the window in order that the draught might be upon his neighbour and not upon himself. Mr. Preece, he thought, would suggest that everybody in his neighbourhood should put up lightning conductors, and that he should not have a lightning conductor, in order that he should be protected by other people's lightning conductors. That would be a very pleasant arrangement, but he was afraid they could not have that exactly, and that the next best thing was for them to have as large a number of lightning conductors as possible, because he did not think there was any doubt at all, quite independently of any experiments of Prof. Lodge's, as far as he could see, that as a matter of experience lightning conductors had protected buildings, whatever the explanation of it was, and that there was no doubt but that they had been right on the whole. Perhaps there were improvements possible; perhaps they might be able to protect themselves from those unfortunate discharges that occurred in telephones and so forth; but as a whole lightning conductors had been a great protection to mankind from danger from lightning (applause). That was undoubtedly the result of their experiences.

Dr. JANSSEN, immediately after the discussion, made a communication in French on some attempts at photographing lightning which he had made with a double-nozzled camera, having one plate fixed and the other spinning on an axis, as suggested by Prof. Lodge in *Nature* at the beginning of July, apparatus of M. Marey being used to maintain the rotation. The results obtained at present were only preliminary, but they showed that flashes were often multiple, constituent flashes being well separated on the moving plate; while each flash itself was practically instantaneous, being quite unaltered by the rate of spin adopted, which was 30 revolutions a second.

THE CANCE ARC LAMP.*

The principal feature of the Cance arc lamp is a central screw, V, (Fig. 1) which is embraced by the female screw A, forming part of the positive carbon-holder B. The screw A tends to descend, but as the rods C C prevent it turning, it gives a movement of rotation to V. At the upper part of the lamp there is a second female screw, D, resting on the rim E, which forms part of the plate F. The plate F is supported by the cores G G of the solenoids H H. These coils are in series with the the main circuit. The springs R R are fixed to the lower ends of G G by means of stirrups, and regulating screws secure it to the lower plate of the lamp. The action of the lamp is very simple. When the current traverses the solenoids, the cores G G are projected violently against the plate F; F is consequently lifted and pressed against D, the screw V is rotated, A is lifted and the arc is struck. When the strength of the current is diminished by reason of the lengthening of the arc, the springs R R pull down the cores G G, the plate F falls, the screw V turns in the reverse direction, and the upper carbon holder is allowed to descend until the arc attains its proper length. In practice regulation is obtained by a very slight difference in the pressure of the plate F against the female screw D, and the positive carbon falls continuously and slowly, so that the arc is remarkably steady. The lamp is self-focussing, the fixity of the arc being obtained by the usual arrangement of pulleys and tackle. In Fig. 2 is shown the general appearance of the lamp without the globe. In Fig. 3 are given the details of the screw D, and Fig. 4 is a sectional representation of a solenoid and its core. The screw

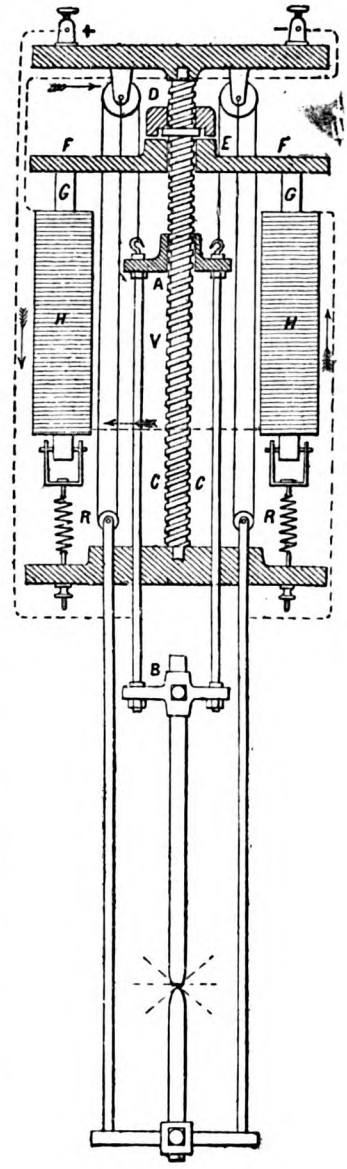

FIG. 1.

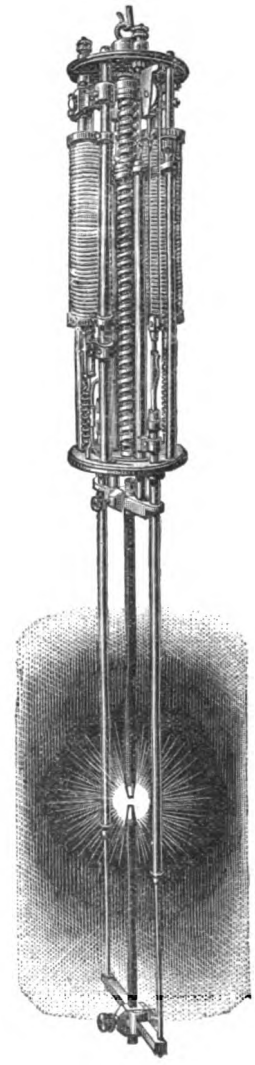

FIG. 2.

shown in Fig. 3 is made in two parts, D and D′, joined together by three small screws. The inside is not threaded, but is furnished with three slightly conical studs, K, which penetrate into the bottom of the grooves of the central screw, and prevent it from turning so long as the studs remain steady. The ring E is fixed to the central screw, and prevents D from falling lower than its upper surface. The carbon holder screw (Fig. 1) is constructed in the same way as D, and owing to this device of conical studs, the abnormal friction and jamming of ordinary screw arrangements is avoided. The solenoid H (Fig. 4) has an iron tube S at the top, inside which the core G G moves; the core G G is about 15 millimetres in diameter at the bottom and 6 millimetres in diameter at the top. The spring R is in a very accessible position, and it can be easily given the required tension by means of a regulating screw.

* Translated by permission from *Eclairage à l'Electricité*, by M. Hippolyte Fontaine, to whom we are indebted for the loan of the blocks.

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These few details show the minute care which has been bestowed upon this much-used lamp, of which the Bon Marché alone uses nearly three hundred. M. Cance recommends as a general rule that the lamps should be arranged in parallel, rendering them independent of one another and allowing incandescent lamps to be run off the same main.

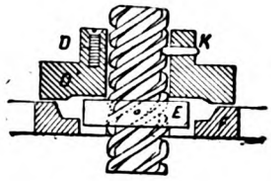

FIG. 3.

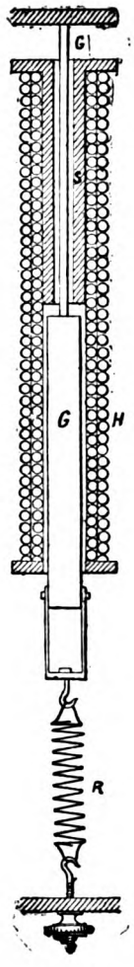

FIG. 4.

ELECTROMETRIC DETERMINATION OF "V."*

BY SIR WILLIAM THOMSON, PROF. AYRTON, AND PROF. PERRY.

The standard measuring instruments used were an absolute electrometer and a centiampere balance, with a resistance coil for measurement of potential. Their indications of potential in electrostatic measure and in electro-magnetic measure were compared by aid of two electrostatic voltmeters (A and B), which had been carefully compared in Glasgow, and which were used as intermediaries. The absolute electrostatic value of the scale of one of the intermediaries (A) was determined in London by Messrs. Ayrton and Perry, using the absolute electrometer. They consider that as neither of the two instruments is capable of very minute accuracy, their determination might be three-quarters per cent. wrong, but they believe that it may be quite trusted to be within one per cent. of the truth. The voltage of the other electrostatic voltmeter (B) was determined from a potential of about 80 volts between the two ends of a resistance of 600 ohms, with a current of about 133 milliamperes through it, very accurately measured by a centiampere balance. The 80 volts multiplied 16 times by the method of condensers in series described by Sir William Thomson to Section A at Aberdeen in 1885 gave the voltage of the B electrostatic voltmeter. As this instrument is not capable of very minute accuracy, the determination may have been wrong half per cent., but it may be trusted as probably not three-quarters per cent. wrong.

The comparison of these measurements then gave the voltage corresponding to electric potential reckoned in electrostatic units. The final result is that the electrostatic C.-G.-S. unit of potential is equal to 292 volts—that is to say, 292×10^8 C.-G.-S. units of electromotive force in electro magnetic measure; in other words, "V" is 292×10^8 centimetres per second. This result may, we believe, be trusted to as within $1\frac{3}{4}$ per cent. of the truth. It therefore seems that "V" cannot be greater than 297×10^8, nor less than 287×10^8. We present it merely as an approximate result, and look forward to measuring this very important physical constant within one-quarter per cent. by the purely electrometric method carried out by an absolute electrometer, and intermediary electrostatic voltmeters, capable of greater accuracy than the instruments which we have used hitherto.

* Paper read before the British Association meeting (Section A) at Bath, September, 1888.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *September 15th*, 1888.

During the three weeks that have just passed, New York has been the rendezvous for all those who are actively interested in the electric light and the telephone. The meeting of the National Electric Light Association, held during the closing days of August, was attended by about 400 gentlemen connected with electric lighting, and at least half as many more were drawn to the Convention by indirect relationships or by curiosity. By this time you have probably published some of the Papers which were read, but a few cursory notes of the meeting, as a whole, may not be out of place. Some idea of the intetests represented may be formed from the figures presented by President Duncan, of Pittsburgh, who estimated that there were at present 5,351 plants and stations operating 192,500 arc lights, and 1,925,000 incandescent lights, requiring a total of about 450,000 horse-power, besides 34 electric roads running, and 49 in process of construction, making a total of 83 roads, with 327 miles single track, and 467 cars, requiring a total of 9,000 or 10,000 horse-power. The President did not present any figures as to the mileage of overhead and underground wires, but it appeared from the statement made by Dr. Wheeler, expert of the Board of Electrical Control, later in the meeting, that New York had more wires underground already than any other city in the world, there being in operation underground about 4,000 miles of telephone and telegraph wires, several hundred miles of incandescent electric light conductors, and a considerable quantity of police and fire telegraph wires. The Metropolitan Telephone Company alone has 3,697 miles of single wire underground, and in September and October there will be put down about 12,000 miles more. During the Convention members were invited to inspect the drawing in of a large 8-conductor lead-covered cable for the local Brush company for electric lighting, but it may be mentioned here that it is not the intention to bunch the arc light wires in this way again. They will be run singly through the duct, which certainly seems to be the wiser plan. It may be said that underground wires occupied largely the time of the meeting, but there was very little that was new to be brought out. The opportunity was seized, however, by Mayor Hewitt, to make a very shrewd and able vindication of the policy he had pursued in not harassing the electric light companies with regard to the underground wire question. The members appreciated the points made by the Mayor, and will see to it that his remarks are pretty widely disseminated where they will do the most good. An interesting Paper was presented by Mr. Leonard, of Minneapolis, as to the advantages in the use of petroleum fuel. The showing was a favourable one in spite of some adverse criticism, and I fully expect to see an increase in the use of crude

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petroleum in electric light stations. There promises already to be a very large use of it in Chicago. It may, perhaps, be remembered, that at Lima, Ohio, the electric railroad burns crude petroleum under its boilers. Another interesting Paper was read by Mr. Lufkin, on the basis on which to calculate charges for motor service. Mr. Lufkin presented some noteworthy figures as to the actual running time for motors in different classes of service, and also made some points as to the relative value of electric power in large and in small units. He concluded, for example, that an electric light company could make money by presenting a customer with 30 small motors, charging him at the rate of $1 per month per motor for current, rather than let him buy a single 2 horse-power motor to operate the same machinery with shafting, with a charge of $18 per month for current. In other words, Mr. Lufkin was favourable to sub-division, and to furnishing power by small motors. He held that 50 cents per month for small moters driving sewing machines gave a better profit to the generating company than $10 per month per horse-power with the large motors, leaving out of consideration the advantage which the small motor possesses of keeping the work in better balance, avoiding the fluctuations due to the stoppage and starting of large motors. "One electric light company," he said, "making rather a specialty of these small machines, rents the motor and supplies the current for $1·25 per month per sewing machine, and reports that at this price the motor service pays them a better percentage of profit than their lamps. This company has some 200 small motors on its circuits." As to the actual time that the various classes of service are consuming current, Mr. Lufkin reported as the result of his investigation that in machine shops in no case would the service by motor exceed 65 per cent. of the contract. In laundries 75 per cent. service would be the exception, and the average might reach 50 per cent. Printing offices run about 40 or 50 per cent.; opticians 20 to 30, picture frame and moulding manufacturers 60 per cent.; nickel and silver platers and buffers about 45 to 50 per cent., and sometimes as low as 20; ice cream freezers 25 per cent., coffee mills 40 to 60 per cent., model and pattern makers 50 per cent., and running as low as 20; church organs 10 to 20 per cent., sewing machines 75 per cent. From such data as this it is comparatively easy to arrive at some idea of the basis of charge and as to the details of service. It cannot be said that the motor men as a rule are inclined to accept Mr. Lufkin's conclusions as to the preference that should be given the small motor, but his Paper was, on the whole, very well received, and was amongst the most useful and suggestive of those presented.

Following the Electric Light Convention came that of the National Telephone Exchange Association, presenting in many respects a marked contrast. That which strikes one in this country with regard to the electric lighting business is the predominance of young men in it; what may be called the superabundance of vitality which manifests itself on every fit or unfit occasion. In the telephone business they who control affairs are certainly not in their salad days, though there are to be found some very able juniors among them. In the electric lighting business, there has been, and even is to-day, a giddy and confusing whirl of competition, so that a company has to meet attacks in every direction, and is continually throwing its forces into open square formation. In the telephone business, as everybody knows, the struggle is not from the outside, but from the in. Nevertheless, at the last meeting here, there was not a little talk as to the competition which would arise a few years hence, when some of the leading patents expire, and when, in various ways, telephony will be more generally open to the public and to new capital. The subject was touched upon very ably by President Metzger in his opening address, in which he said "the competitor of the future will be no less relentless than the infringer of the past; watching every movement that you make, noting every step of progress, he is but waiting for the day and the opportunity to divide the business, or perhaps to absorb it entirely." Hence the timeliness of his exhortation to be prepared by efficiency of service, economy of operation, and general solidity and stability of construction, for the conflict which must inevitably come three or four years hence. It is not at all improbable that the men who are in the field to-day, with their experience, their familiarity with the subject, the wealth that they have acquired, and the various franchises and rights that they have obtained, may be able to hold their own, but a big struggle for the patents there will be, which may ruin the new comers, and cause the companies to go for many a quarter without dividends. The yield of the telephone patents has been so great as to excite covetousness in every quarter, and if we see already such a struggle made during the lifetime of the patents, what will it not be when the field is open to everybody?

Several Papers of interest were presented to the Telephone Convention. One of them, by F. A. Pickernell, dealt with the subject of batteries for transmitters, in which mention was made of the good results obtained from storage cells. Mr. Pickernell remarked:—"Many modifications of the Leclanché battery have recently been introduced, some of them having remarkably low resistances, but they all polarise more quickly than is desirable. I think that if we have not already a modified Leclanché battery that combines low resistance and constant E.M.F. we shall soon have one, and this will be beyond question the telephone battery of the future. I see no reason why a battery of this kind could not be made having an internal resistance of considerably less than 5-10ths of an ohm, and a constant E.M.F. of 1·48 volt." The Paper provoked an interesting discussion, in the course of which Mr. Lockwood remarked that the demand had come for a Leclanché battery of about twice the size of the present cell, and he was surprised that the companies manufacturing batteries were not already in the market with something to meet the want. A subject which attracted a good deal of attention, and was discussed in two Papers, was that of the interference of electric light and power circuits with telephone service. One Paper was read by Mr. M'Cluer, of Richmond, who has had to deal with the troubles induced by the big Sprague electric road there, and the other was read by Mr. T. D. Lockwood, who has long given the subject his study and attention.

It appeared from the Papers and the discussion that great relief had been afforded by the use of the common return wire, and that this was the device likely to be resorted to in the future, in order to meet the difficulties arising with the rapidly-growing number of electric light circuits, and especially with the new electric roads which are going in everywhere. Mr. Lockwood recommended that the telephone companies should exert their influence in favour of the double overhead wire on the roads, preventing, as far as possible, the use of the rail as a return. Interesting Papers were also presented by Mr. W. D. Sargent as regards Brooklyn, where the Telephone Company has 2,000 miles of conductor underground, supplying 1,913 subscribers, and by Mr. L. F. Beckwith, on the works in New York. Mr. E. F. Sherwood gave some statistics as to the Telephone Exchange in this city. He stated that the big new switch-board at headquarters in Cortlandt-street, consolidating seven exchanges, is wired for 5,100 subscribers, and 900 trunk wires. Each operator will attend to 50 or 75 wires, according to the bulk of business at each section of the board. Trunk-calling circuits to the other exchanges will also be in operation, each receiving trunk operator attending to 50 wires. The local battery of each operator's outfit will be two cells of storage, one for day and the other for night. The one in use during the day will be charged in the night from the main storage battery, and the night battery will be charged from the dynamo during the day. All wires to the exchange come underground, and they are carried from the cellar to a distributing board in the exchange by cables of 334 conductors. The consolidation will greatly reduce the complexity of handling business, and will also cut down the running expenses on the same quantity of work over £500 per month.

It is needless to add that both conventions were accompanied by innumerable festivities. One feature of each occasion was the attention given to it by the daily papers. Day by day the morning and evening papers devoted a large portion of their space to the reports of the proceedings, and those reports were, on the whole, very fair and accurate. The effect of all

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this in advertising the growth and prosperity of the two branches of electrical industry must be enormous, and the effects are, indeed, already seen in the greater respect and care with which electrical questions are discussed. It ought no longer to be difficult for any electrical invention of merit to obtain hearing and consideration in New York. The danger lies the other way.

As many of your readers are interested in the phonograph and graphophone, they will doubtless be glad to hear an amusing little incident which has just occurred here, illustrative of the use to which the apparatus may be put. An industrial exhibition is being held at Toronto, and it was proposed at first to have an address by Mr. Erastus Wiman, of our city, on commercial union with the United States. Mr. Wiman, as you known, is an energetic Canadian, who has made his home in this country, and is not only well to the front in commercial matters, but is actively connected with various electrical interests. One of Mr. Wiman's hobbies is the desirability of closer union between the United States and Canada, and his sentiments are not altogether palatable to everybody in the land of his birth. Under these circumstances, the Board of Managers voted against the address; when it was suggested that as the phonograph was to be exhibited, Mr. Wiman should eloquently express his ideas on that instrument before it left New York, and that they should then be ground out in Canada. In some way the Mayor of the city got wind of the project, and wrote to the managers requesting that no politics be imported from the United States on the phonograph. I understand that Mr. Wiman, therefore, was requested to change his subject, but it is reported here that he did after all contrive ingeniously to say what was in his mind, and, of course, it was impossible to discover what was in the cylinder until it actually repeated its little speech on Canadian soil. If this sort of thing goes on, there is no telling where it will stop, and we shall soon have established in every country a Government bureau for the examination of phonograms on their arrival. For instance, I understand that O'Donovan Rossa's paper is stopped when it reaches Ireland; but what is to prevent the O'Donovan from talking into the phonograph a bloodthirsty speech calling for Saxon gore, passing it through the mails, and then having it ground out again to an excited audience at Tipperary? If a man can do this, will it be worth while to exile him?

I think it has already been reported in your columns that the Westinghouse Company has purchased the patents of the Tesla alternating-current motor. It is now stated that they propose to take up the question of electric power, introducing these motors on their alternating circuits as soon as possible, and that they are also making experiments with it for street railroad service.

The condition of the Western Union Company continues excellent, and the executive committee have just recommended the payment of the usual quarterly dividend of 1¼ per cent. The income of the company shows a steady upward tendency, the receipts of the test offices for the first week in this month aggregating $232,000, an increase of no less than $44,000 over last year.

Under date of August 24th the Richmond *Whig* devotes 2½ columns to a *résumé* of the work done on the Sprague Electric Road in that city, which has recently been attracting so much attention all over the world. This well-known newspaper is quite jubilant over the fact that Richmond is a Mecca to which the eyes of all interested in electric power are turned, and it reports that large numbers of visitors daily inspect the road, with the object of introducing electricity for street car service somewhere else. The road is carrying, it states, on an average, about 8,000 passengers a day, and its success is so marked that the old horse car line is to be made an electric road, while a contract has also been made for the Manchester and Richmond line. I hear, by the way, that the Sprague people have just closed their twenty-sixth contract for the equipment of electric roads. This is a pretty good record, from the fact that on the 1st of February the Sprague Company did not have a single road in operation. The truth is all the electric railway companies are busy, and we are going to see a very rapid development in this field.

Ex-Governor A. B. Cornell, of this State, has recently been attacking the high-tension lighting companies, and recommending that the use of arc lighting circuits with current of high E.M.F. be altogether prohibited. Mayor Hewitt, being interviewed on the subject, says that Mr. Cornell does not know what he is talking about, and that he is also influenced by his interest in a company using low-tension current.

CORRESPONDENCE.

THE THEORY OF LIGHTNING CONDUCTORS.

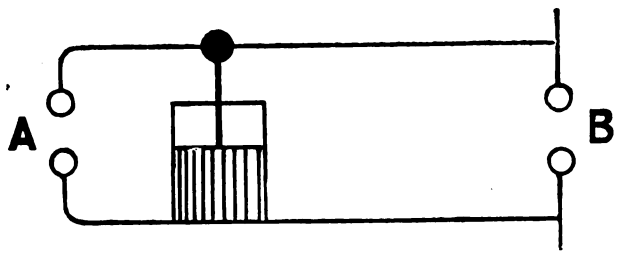
TO THE EDITOR OF THE ELECTRICIAN.

SIR: The enclosed letter received from Prof. Hughes seems to me of general interest, and I have therefore obtained his consent to its appearing in your columns.—Yours, &c.,

19th Sept., 1888. OLIVER J. LODGE.

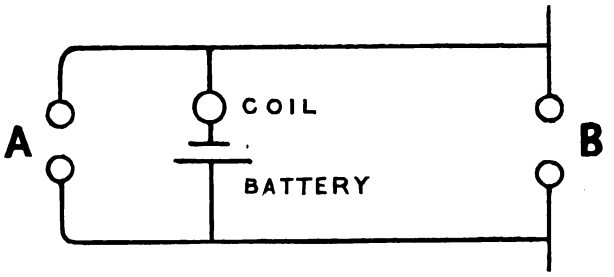
"DEAR PROF. LODGE: I returned to London last evening after several weeks' holiday on the Continent, and found your most interesting Paper on the 'Theory of Lightning Conductors,' which you have kindly sent me.

"I have only had time to glance rapidly over the Paper, but intend to give it more serious attention as soon as time permits.



I noticed a typographical error, as regards the date of Prof. Guillemin's Paper in *Comptes Rendus*. Page 225, 8th line, says see *Comptes Rendus*, 1886; this should have been 1866.

"In your experiment of the recoil kick, page 226, you say, 'The jar discharges at A in the ordinary way, and simultaneously a longer spark is observed to pass at B, of two long leads.' This quite agrees with many of my experiments, only I have always regarded this as Faraday's extra current, and that the longer spark at B was *not simultaneous* with A, but later; due, in fact, to the extra current produced by the *previous* passage of the spark at A. And I think you admit this in your following paragraphs.



"My experiments on the extra current had, however, a different object, and hence a difference in the result. Thus:—In place of your Leyden jar I used a coil and a 1-cell Daniell battery, and I used a special thermopile of my own at B, to observe the amount of heat produced by the passage of a spark at B:—

"1st. No spark occurred on closing the circuit at A, but on opening A the extra current from the coil would rush through B, giving, of course, with a coil a strong spark.

"2nd. If we suppress the coil we still have a spark at B on opening A. In fact, it is impossible to close the battery circuit with the shortest possible connections, say, 1 centimetre, but

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that the extra current on opening rushes through B, giving strong measurable results.

"I take it for granted that this is well known, theoretically since Faraday. But here the effect on B is not *simultaneous* with the closing of the circuit, but an after effect or extra current, the result of a previous passage of a current through the circuit A; and this makes me ask if your spark at B can possibly be *simultaneous* with that of A?

"No doubt when I read your remarkably interesting Paper with greater care I shall seize better your true meaning.

"I regret that I shall be unable to visit Bath and take part in the proposed discussion on Lightning Conductors, but as the subject is one of great interest, I hope next winter you will bring the subject forward again by a Paper to the Society of Telegraph-Engineers, for which I am sure the Council and Members would be most grateful.

"With thanks and best wishes.—Sincerely yours,

"D. E. HUGHES.

"108, Great Portland-street, W., Sept. 5th, 1888."

OVERHEAD AND UNDERGROUND WIRES IN NEW YORK *

BY W. S. WHEELER.

In 1885 the Legislature of the State of New York enacted a law providing for the establishment and organisation of a commission to provide a plan by which electrical conductors in the cities of New York and Brooklyn could be placed underground without interfering with the efficiency of the electrical service.

The results of the investigations of the commission were summed up in their second report, dated June 30th, 1886, as follows:—

The principal systems of electrical subways may be divided, first, as to their material composition, and second, as to their mechanical construction, and the manner in which the wires are placed in them.

As to the material composition, subways are:—

1. Of insulating material, such as wood, glass, concrete, &c.
2. Of conducting material, such as iron.

As to mechanical construction, subways are generally speaking:—

1. Tunnel systems.
2. "Drawing in" systems.
3. Solid systems.
4. "Dropping in" systems.
5. Combined systems.

Tunnel systems, or those where space is provided underground sufficient to allow the passage to and fro of men who place the wires within the subway, could be recommended, were unlimited time and money at the disposal of the commission; but the expense of such a system and the crying need of immediate action preclude the adoption of such a plan. If ever underground railroads become a feature of our city transportation, then, perhaps, the tunnel can be used for some of the future trunk line cables.

In Paris, where the foundations of the city are honeycombed in all directions by large sewers, such a plan is practicable and admirable, but not to be thought of in New York.

Drawing in systems, or those where manholes are provided in the streets, connected by tubes or pipes, through which the wires can be drawn, are next in prominence and convenience to tunnel systems.

In Chicago there were seen in successful operation nearly twenty miles of conduits of the "drawing in and out" pattern of various materials, containing all kinds of wires, as follows:—

Eight miles of the Dorsett system of concrete conduit divided into ducts, and containing in the separate ducts wires of the city telephone, telegraph, fire service, and electric light wires, and wires of different telegraph companies.

Four miles of the Johnstone system of iron conduit divided by metal shelves, and carrying the wires of the Postal Telegraph Company.

One mile of 3in. iron pipes, four in number, carrying the wires of the Western Union Telegraph Company.

Three miles of iron pipes, carrying the wires of the Bankers' and Merchants' Telegraph Company.

In Philadelphia a comprehensive "drawing-in" system of iron was seen, containing electric light and telephone and telegraph wires.

In Boston some two miles of such "drawing-in" iron systems are in operation.

In London 9,000 miles of wire are underground, bunched into cables and drawn into 3in. iron pipes.

Solid systems, or those where wires are permanently embedded in insulating material, and incapable of being reached except by tearing up the streets and the insulation, have been found to work with more or less success. The Commissioners saw several miles of this conduit in successful operation in Chicago by the Telephone Company there, where wires were buried in an asphalte or coal tar cement, laid in a wooden trough.

Several miles of similar conduit are in use in Washington for electric lighting, and there are other instances of the successful operation of this description of conduit.

In this city of New York there are several systems in use underground, each more or less satisfactory to those employing it.

A prominent example is the Brooks system used by the Metropolitan Telephone and Telegraph Company. It consists of an iron tube in which cotton-wrapped wires are drawn, and the tube filled with oil, the oil acting as an insulating medium. It is kept at a desired pressure—the tubes constantly full by means of a standpipe. They use a 2½-inch iron pipe, and the system is cheap, costing less than 11dols. per mile of wire, because into such a pipe they can draw 300 telephone wires. Wires for telephone purposes, and those used in the American District and other call boxes, are of a very light intensity, and do not need as heavy insulation as do all other kinds. This system is claimed to give perfect satisfaction for telephone conductors.

The Western Union Telegraph Company has many wires already down in this city, laid in 3-inch iron pipes, into which they draw cables manufactured from okonite or kerite insulation. These pipes are lead-jointed, are laid in Broadway, and have manholes occasionally for taking out the wire.

To sum up as to the form of subway, and the manner in which the wires are to be placed in it:

We are convinced that from the standpoint of an electrician simply it may be said, that almost any plan or system can be made work, from a single lead-covered wire laid directly in the earth to a great tunnel upon whose walls the insulated conductors can be hung. Within certain broad limits any system is electrically practicable; retardation and induction can be overcome. It is only when we face in this city the mechanical, engineering and chemical questions of interference with water-pipes, gas-pipes, and sewer-pipes, of obstructions from vaults, or danger from steam-pipes, of the action of sewer and illuminating gas, that the necessity for careful discrimination presents itself.

Leaving out of consideration all tunnel systems as too expensive, we must also discard any system which calls for the simple laying of insulated cables in the earth. They would not stand the chemical action of the gases and acids; the streets would be continually torn up for new connections and repairs. We are thus shut up to the question of electric subways or conduits, in which the wires or cables, insulated or otherwise, must be placed, and which once laid down should meet all the demands of the present and near future.

Of conduits it may be safely predicted that, so far as the experience of this and other cities is a test, some form or other of a "drawing-in" system is most convenient. The life of the best cable is by no means satisfactorily decided, and, of any particular cable, to predict how long it would last would be purely speculative. Of wires not contained in cables it may be said that they are equally more uncertain in their length of life and usefulness. At all events, for purposes of distribution it is desirable that the wires should be easily approached at frequent intervals, and the Commission cannot countenance any plan that looks to the disturbance of pavements more than is absolutely necessary.

It may be that through lines of wire could be better protected laid in permanent beds of insulating material; but a "drawing-in" conduit system allows space to be provided for new wires without the frequent tearing up of pavements.

The Commission can therefore give their approval to a "drawing-in" system with frequent manholes, as the general form of subway best adapted to meet the requirements of the electrical service of the present.

Up to this time it was the general impression, which had not been contradicted by experience, because there was none, that the conduits must be built of a non-conducting substance, and not of metal, because the latter would be liable to chafe through the insulation on the wire and cause a ground, and because the companies using the more delicate currents—particularly the telephone company—declared positively that the presence of the large mass of surrounding metal would interfere by induction with the working of their wires.

The best known plan at this time for building ducts of insulating material, and without the use of metallic tubes, was the Dorsett system, which had been laid to some extent in Chicago.

This consists of a bundle of parallel tubular ducts about two and a-half inches in diameter, built of blocks formed of a combination of coal tar, pitch, and fine gravel, cast with tubular openings running through them from end to end. These blocks were placed together, end to end, with the holes in line so as to form continuous tubes or passages, and were cemented together by pouring a mastic

* Abstract of a Paper read before the National Electric Light Association at New York.

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softer than was used in making the blocks, into the cracks between them. The blocks were made to adhere to this by warming their ends with hot irons and allowing them to cool after this mastic is poured in. To prevent the melted mastic from closing the ends of the passage, tubular pieces of metal or paper were inserted in the ducts at the ends of the blocks, making a sort of internal sleeve coupling. The conduits so formed terminate in brick manholes at the street crossings.

The objections to this material, as it was afterwards found, are that it is brittle, porous, requires care in laying, and, having no elasticity, cracks with changes of temperature, so that it is not likely to be made water-tight with average workmanship.

A conduit was laid in New York upon this plan on Sixth-avenue from Twenty-third to Fifty-eighth streets, a distance of 1·6 mile. And the objections were then found, as far as arc circuits were concerned, that its numerous joints were liable to open, and it might leak as mentioned above.

The next plan proposed for New York was to use a similar mixture without requiring it to be made so hard, with the object of preventing its cracking, and to preserve the openings or ducts by casting this bituminous mastic or mixture of bitumen and sand around long pasteboard tubes. But no tubes could be found which would not absorb moisture, and the heat of the mastic caused the ones tried to swell up and disintegrate. The manufacturers of indurated fibre wares were confident that satisfactory tubes could be produced, but it required special machinery and a long time for experiments. Tin and sheet iron linings were then suggested, but objected to, on account of the difficulty of making good joints. Zinc, however, was considered unobjectionable, and an experimental tube of the Averil system, consisting of soldered zinc tubes in bituminous mastic, was laid in the yard of one of the manufacturers, but it was found that the heat of the mastic melted the solder of the tubes. This difficulty was met by substituting a lap or fold over seam, and then it was found that the heat of the mastic also affected the nature of the zinc, impairing its durability. On account of the certainty of the zinc tubing rusting and finally crumbling away, it was next thought best to insure the permanence of the bore of the ducts by substituting for the soft mastic some substance which would set, after being poured in, and become hard and durable. For this purpose, a hydraulic cement concrete filling was substituted for the mastic. And then a line was laid in Fifty-eighth-street. In laying, the thin zinc tubing was found very frail, liable to be dented in handling, and therefore undesirable. But the idea of the concrete was that it would maintain a hard, solid, smooth bore even after the thin sheet metal lining had rusted out.

After a thorough investigation and discussion of all the different materials, and the advantages and disadvantages of each, it was finally concluded that a conduit or subway for electrical conductors underground is merely a mechanical protection for the wires to be placed therein, and should afford the very best protection possible to be procured, while the electrical protection or insulation may be safely left to the manufacturers of cables and wires to be placed in subways.

It was decided that the use of metallic tubes would not seriously interfere, by induction, with the working of the wires, and were to be preferred, because the continuous conducting shield so formed will carry off any escaping current, and prevent damage to other cables. Accordingly, conduits of iron gas pipe embedded in concrete were put down, and these seem to be about the best kind so far constructed. They are best, first, because there are plenty of workmen who understand gas pipe fitting and laying concrete, and because they are durable and entirely non-combustible. The purpose of the cement is to prevent the iron from rusting, which it does very effectually. If in time the pipes are destroyed by rusting from the inside, the solid hydraulic cement concrete will remain, furnishing a permanent duct with a hard, smooth bore.

The manholes used in connection with these various kinds of ducts have nearly all been built of brick laid in hydraulic cement, and capped with an iron casting to form a seat for the water-tight lid. The lids are usually bolted down upon a rubber gasket, but unlike the Edison manholes, instead of being held by a single thrusting screw which passes through a crossbar, presses down upon the centre of the cover. Some of the lids have been made funnel-shaped, so as to cause water to drain away from the edge and collect in the centre. By this means the liability to leakage at the gasket is diminished, because there is less chance of water standing over the joint. The facility of opening the manholes afforded by this method of fastening the lid with a single screw is of great value in reducing the labour and time required to open and close a line of conduit when laying a wire, and is a material advance in the solution of the problem.

In regard to moisture in the conduits. In the iron tube plan, which is the best, there is, of course, no leakage, because the tubes themselves are water-tight, could even be made air-tight, and because they are covered with cement, which is in itself water-tight. The manholes are made of water-tight materials, and there should be no leakage under the lid. Lookers-on find that a great many of the manholes have a great deal of water standing in them; this is simply because the lids are not fastened down, but simply laid in place by the builder, often without any gasket, and the manholes fill with rain and stay full until cleaned out for use. When cleaned and closed properly they appear not to receive any water by leakage. To satisfy myself of this I had an ordinary brick manhole which had been thoroughly cleaned and dried by letting the sun shine in, on a bright day, marked on the inside with lime all the way round under the cover and then closed. This marking was to show whether any water came through the joint of the cover, in which case it would have run down over the lime mark and discoloured it, or whether it soaked in through the bottom or sides. But after a rainfall sufficiently heavy to test the leakage, the hole was opened and found perfectly dry and the lime undisturbed. This proved that there was neither leakage through the brickwork nor under the cover.

There is, however, another source of moisture which is hard to overcome, the condensation of vapour from the air which the manhole and ducts contain. Every time a hole is opened it refills itself with warm air, containing more moisture than it can keep when cooled down to the temperature of the masonry; consequently, as soon as the lid is screwed down this fresh air deposits a dew on the inside of the manhole. As it is impossible to open and dry out a manhole without putting in new air, which will condense in turn, no amount of cleaning will overcome this difficulty. The presence of moisture tends to corrode exposed wires, and therefore the question of whether it is better to protect the splices and make the insulation of the wires so that they will not be injured by this moisture, or to dry out the entire system of conduits by a system of ventilation, is unsettled. But this question, fortunately, is one of minor importance.

Having decided the question of the kind of conduit to use, the commission proceeded to have subways constructed according to these plans. It was decided best, as a matter of expediency and to prevent accident, that electric light subways should be distinct from those intended for telephone and telegraph service, and it has, therefore, been the practice of the authorities in New York to build subways for one class of conductors upon one side of the street, and reserve the other side for those of other service.

The telephone people were the first to realise that underground wires were sure to be ultimately a success. Their business had grown enormously, they had reached about the capacity of their pole lines, and it was not easy to get the use of additional streets, because the streets were crowded with wires, both their own and those of other companies. It was found that the growth of the telephone business was practically put an end to by the fact that no more room could be found in which to string wires. House-owners were charging a rental of one dollar per wire per year, which, in some cases, amounted to a very large rental in the case of a building, and the telephone people had reached the point of refusing subscribers. They came forward, and were the first to declare for underground wires.

After some resistance, the telegraph and electric light companies have come to the conclusion that it is as well for them to comply with the demands of the public and place the bulk of their conductors underground. And, as a matter of fact, in the city of New York to-day there is but one single company out of the large number doing business here which refuses absolutely to comply with the provisions of the Subway Acts, and nine-tenths of the opposition and outcry have been caused by this company.

At the present time the total construction of single duct in the city of New York amounts to 420 miles. In these subways there are already in operation some 4,000 miles of telephone and telegraph wires, and some hundreds of miles of incandescent electric light conductors. Cables for arc lighting are to be drawn in on Broadway from Fourteenth to Thirty-fourth streets by the Brush Electric Illuminating Company within the present week.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

13,342. J. V. SHERRIN. London. Improvements in commutator brushes or equivalents therefor. September 15, 1888.

13,402. S. A. VARLEY. London. Improvements in the construction of secondary batteries. September 17, 1888.

13,473. J. SHERRIN and J. V. SHERRIN. London. Improvements in and connected with electric primary batteries and motors, and in their application to launches and other vehicles. September 18, 1888.

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13,519. F. Teague. London. An improved electric motor. September 19, 1888.
13,529. A. Reckenzaun. London. Improvements in electric meters. September 19, 1888.
13,530. C. E. S. Gilbert. London. A combination switch-holder for incandescent lamps. September 19, 1888.
13,584. E. Meyer. Glasgow. Improvements in electrical tell-tales. September 20, 1888.
13,598. R. R. Hutchinson. London. Improvements in electric motors. September 20, 1888.
13,615. G. B. Satterlee. London. Improvements in or relating to cases for electrical batteries or cells. September 20, 1888.
13,621. S. Z. de Ferranti. London. Improvements in electric meters. September 20, 1888.
13,622. S. Z. de Ferranti. London. Improvements relating to meters for the measurement of alternating currents of electricity. September 20, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

Note.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the dates in italics, give notice at the Patent Office in the prescribed form of such opposition.*

September 22, 1888.

10,009. G. H. Wright. London. Improvements in electric railway signals. July 16, 1887.
13,080. W. Fritsche. London. Improvements in and relating to dynamo-electric machines. September 27, 1887.
15,385. E. Hermite, E. J. Paterson and C. F. Cooper. London. Apparatus for disinfecting impure liquids by electrolytic action. November 10, 1887.
15,532. S. Joyce, jun. London. Improvements in and relating to the use of electricity as a source of explosive power. November 14, 1887.
15,555. W. M. Mordey. London. Improvements in and pertaining to electric motors and their application for charging secondary batteries or accumulators. November 14, 1887.
15,583. B. J. B. Mills. London. Improvements in electric tramways and railways (T. A. Edison, United States). November 14, 1887.
15,660. A. J. Thomas. London. Improvements in electric clocks. Novemder 15, 1887.
15,801. W. H. Beck. London. Improvements in incandescent electric lamps (A. M. Michel, France). November 17, 1887.
16,458. A. A. Campbell Swinton. London. Improvements in electric telephones. November 30, 1888.
3,979. W. G. Johnson. London. Improved construction of plates and arrangement of fastenings for connecting them in voltaic order for medico-electrical purposes. March 14, 1888.
6,075. E. E. Ries. London. A new and improved method of utilising electricity for heating and lighting buildings, railway vehicles, and other places, and for operating brakes and signals on railway trains. April 24, 1888.
9,662. A. J. Boult. London. Improvements in or relating to electrical type-writers (J. F. McLaughlin, United States). July 3, 1888.
11,411. A. W. Meston. London. Improvements in armatures for dynamo-electric machines. August 7, 1887.
11,779. E. E. de Facien. London. Improvements in galvanometers. August 15, 1888.

PATENTS SEALED.

September 21, 1888.

12,111. W. P. Thompson. Liverpool. Improvements in electric fuses for mines (E. Dumas, Paris). September 7, 1887.
12,325. W. Fairweather. Glasgow. Improvements in telephonic apparatus (the Western Electric Company, United States). September 12, 1887.
7,805. H. J. Allison. London. Improvements in the method of and apparatus for the production, transmission and distribution of electrical current (C. E. Fritts, United States). May 29, 1883.
8,596. J. Y. Johnson. London. Improvements in automatic telegraphy (E. J. Mallett, U.S.A.) June 12, 1888.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

13,960, 1887. Coleman, A., and Jackson, H. F. Combined spring jack and lightning arrester for use with a test board for telephone wires, &c. (Price 8d.)
14,390, 1887. Morris, R. Electric firing fuse. (Price 8d.)
14,658, 1887. Fletcher, G. E. Electric indicators. (Price 8d.)
10,691, 1888. Boult, A. J. (McLaughlin). Electrical transmitting instruments. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

Direct Spanish Telegraph Company (Limited).

Report and accounts of the Directors for the half year ended 30th June last, to be presented at the general meeting of shareholders, to be held at Winchester House, 50, Old Broad-street, London, E.C., on Tuesday, 2nd October, 1888, at twelve o'clock :—

1. The accounts for the half year ended 30th June show, after providing for debenture interest, a balance to the credit of profit and loss of £5,529. 19s. 4d.

2. The traffic receipts show an increase of £851. 2s. 6d. as compared with the corresponding half year of 1887.

3. Both the Company's cables and the land lines in connection with them have continued in good working order throughout the half year.

4. The special wire erected by the Spanish Government between Bilbao and Madrid, referred to in the last report, has now been put at the Company's disposal for the exclusive use of their Bilbao cable traffic.

5. In consequence of the fleets of several nations assembling outside Barcelona, on the occasion of the opening of the Universal Exhibition in that city by the Queen of Spain in May last, it was necessary to take special precautions for the protection of the shore end of the cable. The cost thus incurred, as well as that of the new cable house at Barcelona, is being charged to revenue.

6. After putting the sum of £2,500 of the balance of profit and loss to the reserve fund, which now amounts to £11,028. 5s. 7d., there remains £3,029. 19s. 4d. Out of this amount the Directors recommend the payment of the dividend at the rate of 10 per cent. per annum on the Preference Shares, and a dividend at the rate of 5 per cent. per annum (free of income tax) upon the Ordinary Shares, carrying forward £274. 7s. 4d. to next account.

The dividend warrants will be issued on 3rd October.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
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The Maxim-Weston Electric Company.

We give below the text of the report of the Directors to be submitted to an extraordinary general meeting of the shareholders on October 3rd, together with letters from Mr. Watt and the late accountants to a financial contemporary :—

The Directors take the earliest opportunity of laying before the shareholders a statement of the position of the Company's affairs. Immediately after the election of the new Directors on 19th July last, the Board met at the Company's Office in Queen Victoria-street, and Mr. John Marks was elected Chairman. No assistance was rendered to the new Directors by the Managing Director, Mr. Hugh Watt, or by any of the officers of the Company, and it soon became clear that it was quite impossible to carry on the business of the Company with the then existing officials. The Directors were on several occasions unable to obtain admittance to the Company's Offices, Mr. Wright declined to fulfil his duties as secretary, and the clerks, though paid their salaries out of the funds of the Company, declared they were in the service of Messrs. Hugh Watt and Co. On the 3rd of August last the Board decided to have the affairs of the Company investigated, and the principal books were accordingly sent to the office of Messrs. Boyce and Ramsay, Chartered Accountants, 2, Metal Exchange-buildings, with instructions to investigate and report to the Board. On the same date Mr. Watt caused the books and papers remaining at the office to be sent to the Company's works, where they were deposited in confusion amongst the machinery. On the following day, August 4th, Mr. Watt handed in his resignation, which was immediately and unanimously accepted. Mr. Wright, having refused to obey instructions, was informed that his services as secretary would no longer be required. Mr. Samuel J. Boyce was then appointed secretary of the Company, and in compliance with Mr. Watt's request that the offices should be at once vacated, the registered offices were transferred to No. 2, Metal Exchange-buildings, Gracechurch-street, E.C. The Directors now feel that by the exercise of energy and patience the Company's affairs have been extricated from the confusion in which they found them, and they are enabled to lay before the shareholders a fairly accurate statement of the position of the Company. The Directors are also pleased to state that they have already effected a reduction in management expenses of over £1,000 a year. Upon the change of management, instructions were given to the Works Manager to stop all unnecessary and useless expenditure at the works, and to take the stock at cost price, and to give an approximate value of the plant and machinery. This has been completed, and the report of Messrs. Boyce and Ramsay is now in the hands of the Directors. By this report it will be seen that the assets were stated in the balance-sheet, at 31st December, 1887, at about £17,445 in excess of their value, and that the results of the trading have not been truly stated in the past. The Directors, after examination, have verified the statements contained in Messrs Boyce and Ramsay's report, and it is for the shareholders to look the facts fairly in the face and come to a speedy decision as to the future of the Company. The Directors have already made a claim upon Mr. Watt for the repayment of various sums to which they consider the Company are entitled. Notwithstanding the present unsatisfactory position of the Company, the Directors are strongly of opinion that, with honest and attentive management, a good and profitable business may be carried on. The Company possesses valuable patents, and good plant and machinery adapted to the requirements of the business, a state of things only to be attained by years of experience and the expenditure of a large capital. They also have a large and valuable stock. Installations have been erected in various parts of the country, and numerous applications are being made for estimates from all parts of the Kingdom, showing that the Company's system is appreciated. Under these circumstances, the Directors earnestly urge upon the shareholders the desirability of providing sufficient working capital for carrying on the business, as by that means alone can a new and prosperous business be developed. The Directors therefore recommend that the capital of the Company should be reduced by the cancellation of 2s. 6d. per share upon the existing 5s. shares, and that to provide working capital the 188,000 shares remaining unissued should be issued at 2s. 6d. each. With this object in view, the Directors have convened an extraordinary general meeting of the shareholders, to be held on Wednesday, the 3rd October, 1888, to which the necessary propositions will be submitted. They propose to issue the new shares of 2s. 6d. each immediately after the confirmation of the proposed resolutions, payable—sixpence on application, sixpence on allotment, and the remainder by instalments of sixpence each at intervals of three, six and nine months. It is hoped that as many shareholders as possible will attend the meeting, in order that they may have an opportunity of conferring personally with the Directors, but those who are unable to attend are invited to fill up and return the accompanying form of proxy and also the request for an allotment of the new shares.

TO THE EDITOR OF THE FINANCIAL NEWS.

SIR: You published in your issue of this morning, under this heading, a paragraph "Accountants Explain how the Results of Past Trading have not been Truly Stated." As we are the accountants referred to, will you allow us to say that the explanation you print as emanating from us is not accurate, and does not coincide in many ways with the report made by us to the directors? As you can only have been furnished with information by a shareholder, you no doubt have the means at your command for correcting the errors appearing in your report.—We are, Sir, yours, &c.,

BOYCE AND RAMSAY.

2, Metal Exchange-buildings, 95 and 96, Gracechurch-street, E.C., September 25, 1888.

SIR: The attention of our client, Mr. Hugh Watt, M.P., has been called to the article in your paper of this date, giving extracts from the statement of the position of the company's affairs issued to the shareholders by the directors, and he has requested us to state that such statement, as far as it relates to him, is altogether inaccurate. But as the matters in difference between our client and the company are about becoming the subject of proceedings in a court of law, we refrain from going into the same at present. Our client is, however, most desirous at once to contradict the statements made by the directors. We shall therefore be glad if you will kindly give insertion to this letter.—We are, Sir, yours, &c., MICHAEL ABRAHAMS, SONS AND CO.

London, September 25th, 1888.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended September 21, 1888, amounted to £4,956.

DIRECT SPANISH TELEGRAPH COMPANY.—The Board of this company have, upon the audited accounts for the half-year ended June 30 last being submitted to them, decided to recommend the payment of the dividend at the rate of 10 per cent. per annum on the Preference shares, and a dividend at the rate of 5 per cent. per annum upon the Ordinary shares, free of income-tax.

EASTERN TELEGRAPH COMPANY.—This company announce the payment on the 15th October next of a dividend of 3s. per share on the Preference shares of the company, less income-tax, for the quarter ending 30th September, and an interim dividend of 2s. 6d. per share on the Ordinary shares, free of income-tax, in respect of profits for the quarter ended 30th June last. The register of transfers will be closed from the 8th to 15th October, both days inclusive.

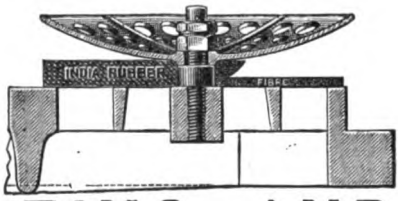
THE EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—The accounts of this company for the half-year ended June 30th last show, subject to audit, a balance of profit of £79,165, after the payment of the interim dividend for the first quarter, and charging the cost of the completion of the Singapore-Saigon cable renewal, amounting to £15,401. The directors have declared a dividend for the quarter ended June 30th of 2s. 6d. per share, free of income-tax, payable on October 16th prox., and have decided to carry the balance of £47,903 forward to the next account.

TELEPHONE COMPANY OF AUSTRIA.—The directors of this company have declared an interim dividend at the rate of 6 per cent. per annum on the Preference shares of the company for the six months ending 30th instant.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended September 21st, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £4,065.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Sept. 26, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Sept. 26, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	48 49	2 16 3	Jan., Apr., July, Oct.	49⅜	44⅜
2,614,820	Stock	10/0	Do. Preferred	79½ 80½	3 8 4	,, ,,	81	73⅞
2,614,820	Stock	nil.	Do. Deferred	17⅞ 18⅛	...	February	18¼	15
130,000	£10	3/0	Brazilian Submarine	13⅛ 13⅜	5 4 8	Mar., June, Oct., Dec.	13 1/16	13⅛
16,000	10	9/0	Cuba Submarine	13¾ 14¼	5 19 4	February and August	14⅛	13⅞
6,000	10	10/0	Do. Preference	18 19	5 5 3	,, ,,	...	...
12,931	5	4%'87	Direct Spanish (£4 paid)	4 4⅛	3 11 1	March & September	4⅛	...
6,000	5	5/0	Do. Preference	9½ 10½	4 15 3	April and October	...	...
60,710	20	2/0	Direct United States	10⅝ 10¾	3 13 6	Jan., Apr., July, Oct.	10⅝	10½
380,000	10	4/6	Eastern	12¼ 12½	4 16 0	,, ,,	12 1/16	12¼
70,000	10	3/0	Do. 6 per Cent. Preference	14½ 15½	3 19 0	,, ,,	15	14⅝
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	3 18 0	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅞ 13⅛	4 19 1	Jan., Apr., July, Oct.	13⅛	12⅞
22,050	10	8/3	German Union Telegraph and Trust	9 9½	7 7 4	January and March	...	...
179,177	10	3/0	Globe Telegraph and Trust	7⅛ 7⅜	4 14 11	Jan., Apr., July, Oct.	7⅜	7
178,992	10	3/0	Do. 6 per Cent. Preference	14 14¼	4 4 3	,, ,,	14½	14
150,000	10	5/0	Great Northern	13⅜ 14¼	5 5 3	Jan., July, and April	14¼	14
17,000	25	37/6	Indo-European	38 40	6 5 0	April and October	39½	...
33,348	10	3/0	London Platino Brazilian	6 6½	...	May and November	...	...
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	...	...
338,225	Stock	13½%	Submarine	135 145	10 0 0	February & August	...	...
30,000	10	6/0	West Coast of America	7⅜ 8½	6 1 3	January and July	7⅜	...
150,000	Stock	8%	Do. Debentures	114 119	6 14 6	June and December	...	...
88,321	10	nil.	West India and Panama	1⅝ 1⅞	...	...	1⅝	1 11/16
34,563	10	*10/0	Do. 1st Preference	12 12½	...	April and October	12 1/16	12¼
45,181	15	9/0	Western Brazilian	12 12¼	5 0 6	March & September	12 1/16	12
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 121	5 15 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	£5 7s. '87	Consolidated Telephone and Maintenance	1/16 1/8	...	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	1/16 1/16	3 9 0	...	...	...
80,000	5	10/0	United	13 1/16 13½	5 11 1	June and December	13⅝	13 5/16
50,000	5	2/6	United River Plate	5⅜ 5⅝	...	April and October	5 1/16	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3½ 3¾	...	...	...	...
23,692	5	nil.	Do. (fully paid)	4¼ 4½	...	February & August	4 7/16	4 1/16
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅜ 2⅝	...	...	...	...
312,000	½	5% '86	Maxim-Weston	1/16 1/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	38½ 39½	6 1 7	March and July	39⅜	39
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 3	February & August	17¼	16⅝

* On account of arrears of dividend.

THE TRUSTEES, EXECUTORS & SECURITIES' INSURANCE CORPORATION (Limited).

CAPITAL, £2,000,000.

FIRST ISSUE OF £1,000,000 FULLY SUBSCRIBED. PAID UP, £300,000. UNCALLED, £700,000.

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The principal objects of the Corporation are :—

1. Performing the duties of Trustee, Executor and Administrator.
2. The Insurance of Bonds, Shares and all other Securities lodged with the Corporation against risks of all kinds.
3. The Issue of Warrants and Certificates against Securities deposited, and making and procuring advances on such Warrants.

The Office of Trustee or Executor is to private persons usually a thankless post, involving much anxiety, time and money, and frequently leads to serious actual loss; whilst death, illness and change of residence necessitate frequent fresh appointments, and consequent expense to the parties interested. The Corporation undertakes all the duties of Executor, Trustee or Administrator for reasonable remuneration proportioned to the work and responsibility in each case.

The Corporation insures existing Trustees and Executors against all risks attending those positions, where the business is conducted by the Solicitors to their Trusts under the supervision of the Corporation, it not being the desire of the Corporation to interfere in any way with the duties of the family solicitor.

The Corporation acts as Trustees for the Debenture Holders in Public Companies.

For terms, &c., application should be made to the General Manager at the Company's Office.

GEORGE PEARSON *General Manager and Secretary.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

During one of the discussions in Section A at the late meeting of the British Association it was recognised that the question of the magnetisation of steel by the oscillatory discharge of a Leyden jar required elucidation. We print this week, however, a letter addressed by Prof. Ewing to Dr. Oliver Lodge, in which the question receives a very simple and complete explanation. We may add that we have in our possession some MSS. of earlier date by Dr. J. Fleming, in which the same problem is considered, and practically the same conclusion is arrived at. This Paper we shall publish in due course.

Ever since the shareholders of the Maxim-Weston Electric Lighting Company received their dividends of 7½ and 5 per cent., in 1886 and 1887 respectively, we have felt curious to know how it was done. That an explanation would some day be given we were well assured, and at length our curiosity has been gratified. From the report of the accountants who have just concluded an examination of the Company's affairs on behalf of the newly elected Board, we gather that the process was substantially as follows: In 1885 a "reserve fund" amounting to £3,606 was created, apparently by adding together the items for premium on new shares issued and the balance left on the books after the reduction of the capital which had just been effected. In the following year this fund was entirely absorbed by the amounts which were written off from the various debts owing to the Company, no less than £2,074 being written off from the "agency" account alone. The "reserve fund" therefore disappeared from the balance-sheet of 1886, and being utilised for the reduction of book debts a large portion of the total revenue appeared as net profit, enabling a dividend of 7½ per cent. to be declared. In 1887 no provision whatever was made for loss on book debts, and nothing was written off the patent account, whilst, according to a subsequent valuation, the value of the stock, plant, furniture and fittings, &c., was over-estimated to the extent of about £8,700. Under these circumstances a dividend of 5 per cent. was declared. It must, of course, be recollected that this is to some extent an *ex parte* statement, and it is possible that the ex-directors may be able by-and-bye to put a different face upon the affair.

Unfortunately, however, the payment of a dividend—whether fairly earned or otherwise—is by no means the most serious grievance of which the shareholders complain. At the extraordinary general meeting which was held on Wednesday last the present chairman of the company laid before the shareholders a series of remarkable allegations reflecting upon the conduct of his predecessor. Amongst the least notable of these was the statement that, although Mr. Hugh Watt received a salary of £1,200 per annum as managing director—in addition to a commission of 5 per cent. on the sales—yet the amount of time and attention which he actually gave to the company's affairs was not sufficient to reduce the rate of remuneration below the handsome figure of £20 per hour. Altogether, it would be difficult to imagine a more utterly unsatisfactory state of things than that which has long existed, both as regards the external and (as it now seems) the internal affairs of this company. Its action in connection with the proposals for lighting the City called forth our most vigorous protests at the time; and this is not the only instance in which we have had reason to believe that its proceedings have been seriously detrimental to the interests of electric lighting.

As to the still more serious and explicit charges which the new Board has not hesitated to bring against Mr. Watt, this is not the proper time for us to comment on them. It is scarcely to be supposed that Mr. Watt will allow judgment to be delivered against him by default, and we therefore anticipate a searching investigation into the whole history of his connection with this unfortunate Company.

According to the *Indian Engineer*, Mr. W. F. Melhuish, of the Indian Telegraph Department, has effected an improvement in duplex working of some considerable value. In the ordinary methods of working duplex the capacity of the wire is only increased so long as no correction is required by either of the receiving clerks; but directly a word misses fire the remaining pair of signallers are reduced to enforced idleness whilst the correction is being made. The actual value of duplexing a line, therefore, depends very largely upon the skill and discipline of the staff. Mr. Melhuish's invention is intended to obviate this difficulty, and to enable either pair of clerks to send or receive at will. It seems by no means impossible that, with a reasonable amount of ingenuity, something of the kind may be accomplished; but we should prefer to hear a little more about the method employed before we express any decided opinion on the subject. The information at present given by our contemporary extends only to the fact that it involves "an additional instrument or two, and a rearrange-

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ment of batteries." This is good, but perhaps not quite good enough.

We print elsewhere the clauses of a Bill which will be introduced in the next session of Parliament, and is entitled "An Act to Amend the Patents, Designs, and Trade Marks Act." The object aimed at is to secure the registration of patent agents, and to prevent any unauthorised person from habitually acting in that capacity; the Bill is not, however, intended to prevent any individual inventor from drawing his own specification. On the whole, we are scarcely inclined to agree with our contemporary the *Engineer*, which has entered a vigorous protest against its passage into law. Our contemporary draws a moving picture of the hardship which would be inflicted upon a "poor inventor" if he were debarred from obtaining the friendly assistance of some more experienced penman in drawing up his specification. This argument appears to us to be singularly weak. There is nothing in the Bill to prevent anyone on occasion from preparing another man's specification either gratuitously or otherwise. It is merely stipulated that nobody shall, in any sense of the term, "describe himself" as a patent agent unless duly registered by the Board of Trade. There can be very little doubt in the mind of anyone that under the present *régime* a considerable number of men do so describe themselves whose knowledge of patent law or of any technical subject is entirely inadequate to the duties which they assume. So long as anybody is entitled to take a room in Chancery-lane and stick up "Patent Agent" (or more often "Patent Office") over his doorway this will necessarily continue to be the case. For our own part, although we foresee some difficulty in its practical application, we are quite in sympathy with the Institute of Patent Agents in their desire to impart a sense of honour and dignity to their profession from which it is at present almost entirely excluded.

The subject is one which it is impossible to discuss in all its bearings within the limits of a note, but we may just indicate that our own feeling in the matter is that the work of the patent agent can only be done effectually by being specialised to a far greater extent than it is at present. We should like to see a considerable increase in the number of agents who devote their attention especially to a limited range of subjects. The services of an agent who can acquire and deserve a reputation for being a thorough master of the technical and patent office literature of any particular department will always be worth paying for. In our own profession there are already a limited number of agents who make electricity a speciality, and this we regard with satisfaction as a step in the right direction. Returning to the general question of registration, and judging from the correspondence which has appeared in the columns of our engineering comtemporary, it would seem that a strong feeling against the Bill exists in some quarters. Not much time is now left for the expression of public opinion, and if our readers hold any decided views for or against the measure we shall be very pleased to hear from them on the subject

It is certainly a very singular fact that up to the present time so very little use has been made of the electric motor on ship-board. Considering the fact that all steamships of any importance, whether in the navy or in the merchant service, are now invariably provided with an electric light equipment, and considering, moreover, that on board a modern man-of-war we sometimes meet with upwards of a score of separate steam-engines, it is simply astonishing that electric motors are not already in universal use. We publish elsewhere an extract from a very able Paper, written by Lieut. Murdock, of the United States Navy, in which this question is dealt with, and some further comment on the subject will also be found in our American Notes. We believe that in the English Navy certain experiments have already been tried in this direction, but with what result we do not know, though certainly little or nothing has yet been done. If the experiments were not considered a success we have no hesitation in saying that this must have been due to faulty design or manipulation, and we look forward with confidence to the superannuation of the majority of the supplementary steam-engines now employed, and to the advent of the electric-motor as an indispensable auxiliary for the distribution of motive-power on ship-board.

We learn with satisfaction that an opportunity will shortly be afforded of testing the practicability of the series system of electric traction in this country upon a working scale. The Series Traction Syndicate are now engaged upon the construction of a line at Gravesend some three miles in length, with which rapid progress is being made. The system adopted is, as regards its leading features, identical with that known in America under the name of Short-Nesmith, and which was described and illustrated in our issue of April 29, 1887, p. 549; but we understand that the Syndicate hold several other patents relating to the question of series traction, including the important telpherage patents of Fleeming Jenkin and Ayrton and Perry, and improvements in detail will no doubt have been effected. If the difficulty of the somewhat numerous contact points can be dealt with successfully, we feel confident that this system will have a future of great importance.

In our issue of September 14th we published an abstract of a Paper by Dr. Van der Weyde, containing a very severe attack upon Mr. Harold Brown in connection with his recent experiments on the effects of alternating and continuous currents on dogs. Our readers will, perhaps, recollect that the learned doctor was of opinion—for reasons which were duly set forth in the Paper—that the E.M.F. of the alternating current which killed the dogs could not have been much less than 80,000 volts, instead of 300 volts, as Mr. Brown supposed. He also accounted for Mr. Brown's error by the assertion that the voltmeter was connected in series with the ammeter. Our readers may easily have gathered, from the comments which we made at the time, that we did not attach a very high value to Dr. Van der Weyde's opinions, or to the calculations on which they were based; on the other hand, the positive statements as to the error in the connections seemed worthy of attention, more especially as the results of the experiments were of so

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unexpected a character. In the current number of the New York *Electrical Review* we find, however, a letter from Mr. A. E. KENNELLY, which completely rehabilitates Mr. BROWN'S position, and in our estimation invests the experiments with an importance which they did not before possess. Mr. KENNELLY takes some trouble to show that Dr. WEYDE'S figures are fallacious, and that his ideas as to ammeters and voltmeters in general are erratic. With this, however, we need not concern ourselves further. As to the alleged mistakes in the E.M.F., it is sufficient to be assured that Mr. KENNELLY himself assumed the responsibility of measuring the voltage—a fact which had not before transpired.

MR. KENNELLY has also carried out a series of experiments of the same character at the Edison laboratory, with results which are briefly summarised as follows:—

> "For contacts of duration from 30 to 60 seconds, the lowest continuous-current voltage that has been fatal has been 276 in one case and 400 in another. The lowest alternating voltage that has been fatal in that time is 140 (applied after a continuous shock).
>
> "For contacts of between 15 and 30 seconds' duration, the lowest fatal alternating voltage has been 176. No continuous case furnished. For contacts of from 3 to 15 seconds' duration the lowest fatal continuous voltage has been 590. The lowest fatal alternating voltage 158.
>
> "For contacts of less than three seconds the lowest fatal continuous voltage has been 800. The lowest fatal alternating voltage 418.
>
> "It has also been observed that there is very much less struggling of the animal under the influence of an alternating current, even when not attended with fatal results, than appears with the direct current, and when the shock has not been fatal the effect of the alternating current has been to produce greater nervous depression than has been visible with the continuous current."

We therefore take it to have been conclusively proved that an alternating current is fatal *to a dog* at a very much lower potential than a continuous current. At the same time, we think that, with reference to human beings, the weight of evidence is at present at least slightly in favour of the reverse supposition.

Lighting of the Avenue Theatre.—The Avenue Theatre is now lit by electric light, over 1,000 lamps being employed.

Monte Carlo.—The *World* says that the electric light will supersede gas at Monte Carlo this winter, both in the public thoroughfares and inside the Casino.

City and Guilds of London Institute Old Students' Association.—The fourth annual dinner of the above association will be held at the Holborn Restaurant, on Saturday, October 13th, at 7 p.m.

Suakin.—The Eastern Telegraph Company's steamship "John Pender" has recently been rendering good service at Suakin by throwing the light of her electric projector on the nocturnal proceedings of the Arabs.

West Hartlepool.—Messrs. W. Gray and Co. have recently acquired a new ship building yard in West Hartlepool, having an area of about four acres. The yard is to be lighted by twenty-eight 2,000 candle-power Brush lamps.

Cowpen.—A special meeting of the Cowpen Local Board was held on Monday last to consider the tenders which have been sent in for lighting the district with electricity. We understand that it was decided to accept one of the tenders.

Wellington (New Zealand).—The City Council of Wellington have completed arrangements for lighting the city with the electric light, and a contract is to be signed shortly. It is expected that the greater portion of the city will be lit by November 30.

Hapton.—The streets of Hapton, near Burnley, have recently been experimentally lighted by 50 candle-power Edison-Swan incandescent lamps. The experiments, it is said, have been most successful, and arrangements are in progress with the local board with the view of making the system permanent.

Eastbourne.—The Eastbourne Electric Light Company has now offered to light the Esplanade for £32. 10s. per lamp per annum, but the Lighting Committee is still unable to see its way to pay more than £30. Now that the difference has been reduced to such moderate dimensions, it will be a great pity if the lighting is abandoned.

London Society for the Extension of University Teaching.—At the Chelsea Town Hall Mr. W. Lant Carpenter, B.A., B.Sc., will give ten lectures on "Electricity in the Service of Man," illustrated with experiments and lantern photographs, on Fridays, at 8 p.m., commencing October 12, 1888. Single tickets for the course 4s., tickets to admit three 10s. The inaugural lecture on Friday, Oct. 12, will be free; subject, "Electrical Energy and its Uses."

The Electro-Harmonic Society.—We are happy to announce that the concerts of this society (of which there were held four in the first and five in the second series) will this season be six in number, and will take place on the last Friday evening of the months, as follows:—October 26th, 1888, smoking concert; November 30th, 1888, ladies' night; January 25th, 1889, smoking concert; February 22nd, 1889, ladies' night; March 29th, 1889, smoking concert; April 26th, 1889, smoking concert.

Electrical Engineering Diploma.—From our advertisement columns last week it will have been observed that the Glasgow and West of Scotland Technical College grant an electrical engineering diploma. The opportunities of finding employment in the Glasgow engineering works whilst studying at the Technical College, or during holidays, were never better than they are at present, for the Clyde is busier in shipbuilding, &c., than it has been for years. The engineering classes commence this week.

Lambeth Vestry.—At the last meeting of this Vestry a letter was read from Messrs. Bircham and Co., solicitors to the Metropolitan Electric Supply Company, giving notice of the intention of the company to apply to the Board of Trade under the Electric Lighting Acts, 1882 and 1888, for a license to supply electricity for lighting and other purposes within the area over which the Vestry have jurisdiction, and asking for the consent of the Vestry to the application. The application was referred to the Electric Lighting Committee.

Metropolitan Board of Works.—At a meeting of the Metropolitan Board of Works on Friday last, a letter was received from Messrs. Bircham and Co., on behalf of the Metropolitan Electric Supply Company (Limited), stating that they intended to apply to the Board of Trade, under the Electric Lighting Acts, 1882 and 1888, for a license authorising the company to supply electricity for lighting and other purposes within the area described in a plan accompanying the letter. The letter was referred to the Works Committee.

The Anglo-American Brush Corporation at Bournemouth.—Energetic measures are being taken by the Anglo-American Brush Electric Light Corporation to establish a central station at Bournemouth for the early supply of electric light to the in-

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habitants of that town, and we gather that the undertaking will be pushed forward as quickly as possible. We also understand that the Brush Corporation propose to establish central stations in various provincial towns where they have for some time past been pushing the interests of the electric light.

Barnet in Darkness Again—At 10 o'clock last Friday night the electric lamps at Barnet suddenly went out, and the streets were left in darkness, the only light to be seen being that coming from the windows of hotels and private houses. The night was very dark and somewhat foggy, and the inconvenience caused to pedestrians by the sudden deprivation of light was severely felt. The origin of the mishap was not known outside the electric light works, beyond the scanty information vouchsafed by one of the contractor's *employés* that something was wrong with the engine. It was not until midnight that the light was again available.

Electricity in Collieries.—At the twenty-first annual congress of the trades unions of the United Kingdom at Bradford, Mr. Beith, of Pontypridd, read a Paper on "Electrical Power, and its Application to the Coal Industries." Mr. Beith traced the history of the gradual growth of electric traction from the days of Jacobi to the present time, when 87 per cent. of the energy given to the dynamo is returnable at the motor. Mr. Beith was of opinion that the great efficiency of direct haulage electrical plant must eventually bring it to the front, and mentioned, as an instance, the successful application of electrical power to the pumping machinery erected by Messrs. Immisch at St. John's Colliery, Normanton.

The Royal Victoria Hall.—The artisan's classes at this institution reopened on Monday, October 1st, and comprise arithmetic, physiology, physiography, shorthand, chemistry, astronomy, English literature, mechanics, machine drawing, electricity, &c., many of the classes being in connection with the Science and Art Department. On Tuesday, October 2nd, after a lecture entitled "Science in the Saucepan," by Prof. Carlson Lambert, the certificates gained by the students last session were presented by Sir P. Magnus. The lecture arrangements for the rest of the month are as follows:—October 9th, "The Largest Bridge in the World," by Prof. Kennedy; October 16th, "Some Great Cities of the World," by Mr. A. H. Gilkes; October 23rd, Mr. W. Spralling; October 30th, "Colour Sense and Colour Blindness," by Dr. Collins.

A Submarine Torpedo Boat.—The Paris correspondent of the *Daily News* says that experiments are being made on the Seine, near Issy, with an electrical submarine torpedo boat made for the Minister of the Navy, and at his own expense. The boat is constructed of sheet iron, shaped like a cigar, having a length of 4·5 metres, and a diameter of 1·6 metres. Current is generated by Schanschieff's bisulphate of mercury battery. The motor is of the Edison type. The boat can be made to dive and to take an undulating course in the water. Large scissors project from the prow, which are intended to cut torpedo wires. Compressed oxygen is stored in tubes of peculiar construction, and in sufficient quantity to make it easy to keep the boat some time under water. This model has been adopted by the Russian Navy a short time after it had been tested at Cronstadt.

The Hanover-square School of Electrical Engineering.—At this school the following gentlemen recently obtained their certificates as the result of the examination conducted by Mr. H. R. Kempe, of the Engineer-in-Chief's Office, G.P.O.:—F. Thomson, 99 per cent. of full marks; E. M. Blakely, 97 per cent.; H. F. Laughton, 87 per cent.; W. N. Legge, 86 per cent.; W. W. H. D'Aeth, 85 per cent.; H. C. Hodges, 83 per cent.; F. A. Pocklington, 82 per cent. No certificate is granted for less than 70 per cent. of full marks, and the candidates had also to satisfy Mr. W. W. Beaumont as to their knowledge of steam engineering. The scheme of instruction of the advanced class has been re-organised under the auspices of the new senior instructor, Mr. Charles Capito, M.I.M.E., &c., with the view of meeting still more completely the requirements of the profession. Some of the above gentlemen have already obtained appointments.

St. George's, Hanover-square, Vestry.—At the last meeting of this Vestry, the Clerk submitted a letter from Messrs. Deacon, Gibson, and Medcalf, on behalf of the London Electric Supply Corporation, stating that they desired to apply to the Board of Trade for a license to authorise them to supply electricity in this parish, and submitting copy of the draft license. A letter was also submitted on behalf of the Metropolitan Electric Supply Company, stating that it is intended to apply to the Board of Trade for a license to supply electricity for lighting and other purposes within the parish, and submitting form of license. The Clerk remarked that the question of electric lighting had been before the Commissioners of Works. Mr. Southon said this was a question of such a large and delicate character that he did not think they were prepared to go into it at the present moment. He proposed that the receipt of the letter be acknowledged; it would bear further consideration. The proposal was adopted.

Birmingham.—According to the *Birmingham Daily Gazette* the scheme, promoted some little time ago by Messrs. Chamberlain and Hookham, of New Bartholomew-street, for supplying the electric current to large blocks of buildings in Birmingham, not only for lighting purposes but as a motive power for machinery, is now assuming a definite shape. The supply is offered on the following basis:—There will be no maximum charge, but the actual quantity of electricity supplied will be measured by meter and charged at the rate of 8d. per unit per quarter. Consumers can have their premises wired and their electroliers supplied by any firm they may select, or the company will themselves undertake the work. The incandescent lamps will be provided and maintained by the consumer. Messrs. Chamberlain and Hookham are prepared to sell or let on hire motors varying from one man-power to 15 horse-power, but the quarterly charge for driving these motors would depend entirely on the hours they are to be used and the power transmitted to them. A very respectable list has already been secured of tradesmen and others who have expressed their intention of using the electric light in some form or another on their premises.

The Registration of Patent Agents.—The following clauses are those in the Bill entitled, "An Act to Amend the Patents, Designs, and Trade Marks Act, 1889," which refer to the registration of patent agents:—(1) After the 1st day of July, 1889, a person shall not be entitled to describe himself as a patent agent, whether by advertisement, by description on his place of business, by any document issued by him, or otherwise, unless he is registered as a patent agent in pursuance of this Act. (2) The Board of Trade shall, as soon as may be after the passing of this Act, and may from time to time, make such general rules as are, in the opinion of the Board, required for giving effect to this section, and the provisions of Section 101 of the principal Act shall apply to all rules so made as if they were made in pursuance of that section. (3) Provided that every person who proves to the satisfaction of the Board of Trade that on the 1st day of July, 1888, he had for twelve months been *bonâ fide* practising in the United Kingdom as a patent agent shall be entitled to be registered as a patent agent in pursuance of this Act. (4) If any person knowingly describes

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himself as a patent agent in contravention of this section, he shall be liable on summary conviction to a fine not exceeding £20. (5) In this section "patent agent" means exclusively an agent for obtaining patents in the United Kingdom.

St. Albans.—At the last meeting of the Town Council of St. Albans Councillor Westell moved for a committee to make inquiries as to the probable cost of lighting the city by electricity. Other corporations in various parts of the country had taken over the lighting powers, and had derived considerable profit from it; but in St. Albans one gas company had a monopoly. St. Albans would be in a unique position in regard to electric lighting, because the river could be used to generate the electricity, and there could be enough power derived from the water course to provide more electricity than the city would consume. If the Council took the matter up early they might be enabled to prevent the powers from getting into the hands of monopolists.—Councillor Slade seconded the resolution. He said that the same matter was considered by the Council a few years ago, but the electric light was then in its infancy and more expensive than now. They would now find it could be supplied more cheaply than gas. It would not be wise for a progressive city like St. Albans to be behindhand in this matter. If the electric light were found by the committee to be cheaper than gas, it would be the duty of the Council to introduce it for public lighting. The inquiries should not cost any money to the ratepayers.—Councillor Murray also supported the resolution, which was agreed to.

The Lighting of the Dartmouth Training Ships.—The electric light, recently introduced on Her Majesty's naval cadet training ship "Britannia," at Dartmouth, says the *Western Morning News*, gives much satisfaction. Replacing oil lamps, it is not only a more brilliant light, but it is much cleaner and more safe. Unpleasant odours are avoided, the light is steady, less labour is required, and there is likewise a saving effected as compared with the former method of illumination. There are throughout both the "Britannia" and "Hindostan" 460 incandescent lamps, each of 16 candle-power. The machinery is located in the after end of the "Hindostan." The dynamo is one of Siemens's latest pattern, giving 400 amperes at 80 volts at 400 revolutions. The dynamo is driven by one of Willans and Robinson's patent high-speed compound engines of 50 horse-power, the large boiler, one of the locomotive tubular type, being from the works of Messrs. Hornsby, Grantham. For the night lights (when the dynamo has ceased working) current is supplied through accumulators of Elwell and Parker's make. The room in which the accumulators are stored is well adapted for the purpose, being very airy and thoroughly ventilated. The whole of the circuits are under the control of the artificer in the dynamo room, where there are two switch-boards, with fusible cut-outs on each. It is intended to provide shortly a duplicate dynamo for use in the event of an emergency. To each cabin-lamp a switch is attached, so that the light can at any time be turned off independently of the others. The large cadets' dining room is lit with 33 lamps, and there is an average of five or six lights in the 17 study rooms. Captain Bedford, C.B., has shown great interest in the introduction of the electric light on the ship. The total cost of the installation has been upwards of £3,000.

Dublin.—A special meeting of the Dublin Municipal Council will be held in the Council Chamber on Monday, the 22nd October, at the hour of 1 o'clock in the afternoon, "to consider and do, or cause or direct all necessary acts to be done, upon or in relation to the after-mentioned business—namely, to consider, and, if deemed expedient, to adopt a resolution authorising an application by the corporation, as local authority for the City of Dublin, to the Board of Trade, for a provisional order to authorise the Corporation as such authority to supply electricity for any public or private purposes within the area of the City of Dublin."—The *Irish Times* says that the new station of the Alliance Gas Company for the purposes of electric lighting is now nearly completed, and will shortly be ready for work. The premises have been erected on a very suitable site in Hawkins-street, and are in every way adapted for their purpose, being lofty and roomy. A number of boilers have been placed in position, and the dynamos are being fixed. It is expected that the company will be able to supply their customers with the electric light from the new station in the course of a fortnight.—Referring to the same subject, Messrs. J. K. Fahie and Son, electrical engineers, write to the editor of the *Irish Times* as follows:—

"Sir: Referring to a paragraph in your issue of to-day under the above heading, as there appears to be some apprehension that the gas company have 'a concession' for supplying the electric light in the City of Dublin, will you kindly allow us to point out that there is no such thing as a concession for this purpose. The gas company enjoy no more privileges in this respect than ourselves or any other firm engaged in the electric light industry. More than this, under the Electric Light Act of 1882 the company dare not erect overhead or underground wires without the consent of the local authority, and seeing that the Municipal Council are at present seeking powers to deal generally with the lighting of the city by electricity, it is hardly likely that this consent will be easily obtained."

The Anglo-American Brush Company and the Lighting in the City.—The Anglo-American Brush Electric Light Corporation have resumed their negotiations with the Commissioners of Sewers with a view to the lighting of the City of London, and in connection therewith they have prepared for private circulation a memorandum setting forth the circumstances attending the past negotiations. In connection with the epidemic of crime which at present prevails, they remark that in the United States, where the electric light has been largely adopted for the streets, the police officers testify to its utility in the prevention of crime and the protection of life and property. On the general question of the development of electric industry they make this observation:—"Hitherto England has taken an important part in, and derived enormous benefits from, the industrial advance of other countries, but in regard to electric lighting the public at home have not only been deprived of the use of improved methods of lighting, but English manufacturers and contractors have on the Continent been forestalled by foreigners—not because they have lacked capacity to do the work, or enterprise or energy to initiate it, but because they have been unable to produce evidence that their systems have commanded support at home, where they should be better known. It was English people who carried out most of the important gasworks on the Continent; and they were able to do so because the gas industry had been fostered and encouraged at home. Electric lighting, on the other hand, which at best has an uphill battle to fight, has been hampered by the Legislature and discouraged by the municipalities. The Brush Corporation therefore speak in the interests of an industry which, under favourable conditions, promises to assume considerable dimensions, in urging on the Commissioners of Sewers of the City of London that this opportunity may not be lost of bringing to an issue the experiments and negotiations which that body so long ago initiated and have encouraged in the past, and of showing what can be done under methods approved and controlled by their own advisers."

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NOTES ON THE REDUCTION OF BALLISTIC OBSERVATIONS TO ABSOLUTE MEASURE.

BY A. E. KENNELLY.

A ballistic galvanometer has to be employed in measurements of a magnetic field with the aid of an area-sweeping conductor, and in many cases where the quantity of electricity to be measured occupies a short but appreciable time in passing through the circuit, since it is essential that the whole period of passage be small compared with the period of vibration of the needle, or, in other words, that the whole electro-magnetic impulse be delivered to the needle before the latter has had time to sensibly alter its position.

We know that the total quantity of electricity, Q, passing, no matter how irregularly, during a small interval, through a ballistic mirror galvanometer, and producing a throw of d scale divisions from zero, is expressed to the first degree of approximation by the formula

$$Q = \frac{d}{2lg}\sqrt{\frac{IH}{m}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where g is the galvanometer constant, or the number expressing the moment of the electro-magnetic couple set up on the needle by unit current strength in the coil.

H is the strength of the magnetic field in which the needle normally swings.

I is the needle system's moment of inertia.

l is the distance from the mirror to the scale centre, expressed in scale divisions.

and m is the needle's magnetic moment.

The angle of deflection is here assumed to be small, and the damping effect due to air friction and electro-magnetic induction is neglected.

As it would be difficult to calculate the needle's moment of inertia, I, even if its mass and form were known, since ballistic suspensions are generally built up in heterogeneous fashion, it is necessary to eliminate I by observing the mean period of the needle's vibration, the time of one semi-vibration (the time between any two immediately succeeding zero passages) being

$$T = \pi\sqrt{\frac{I}{mH}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

These give us the equation

$$Q = \frac{dHT}{2lg\pi} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Finally, we can eliminate the factor $\frac{H}{g}$ by passing a constant current of known strength, c, directly through the galvanometer, and noting the deflection d' as soon as it is steady, when we know that very approximately

$$\frac{H}{g} = \frac{2cl}{d'} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

and substituting in (3) we have equation (1) reduced to the form

$$Q = \frac{cdT}{\pi d'} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

This calculation, which is in all essential particulars the one usually given in text-books, involves three measurements in addition to the observations of d itself, namely, cd' and T. The two latter cannot be regarded as constants, for they are often found to vary for the same galvanometer from hour to hour, and thus require for purposes of accuracy frequent redetermination, as any error made in determining these quantities enters by direct multiplication into the result. Under the most favourable conditions the formula will give results usually at least 3 per cent. in defect, owing to the reduction of the throw d by the disregarded damping.

The correction for this damping effect cannot be rigorously stated in finite terms, but can be found for any practically required degree of accuracy.

The rule for the first degree of correction, as usually recommended, is very simple. Let d'' be the most succeeding elongation of the image on the same side of the scale as d. Then, since the difference $d - d''$ is due to damping effect that has been operative over nearly four times the distance that existed between d and the original zero, increase d by $\frac{d-d''}{4}$.

This correction is always rather too small, especially with galvanometers with considerable damping, but when the latter is small for throws of 200 divisions or under the corrected value of d is usually within 1 per cent. of the truth.

To carry out the next degree of approximation, therefore, requires a fourth measurement, that of the decrement of the needle's vibrations, a quantity which for the same galvanometer and suspension is nearly constant. It is found that the rate of decrease in the elongations is always proportional to the elongation itself at the point considered; or, in other words, that the successive elongations on one side of the scale plotted as ordinates to abscissæ in time follow approximately a logarithmic curve. Obviously, if there were no damping, the image would oscillate continually between + true d and − true d on the scale. Supposing this to be possible, the observer would have in the path of the image before him almost the exact projection on the scale plane of an imaginary luminous satellite revolving in a circular orbit of radius d, with the scale zero as centre, and period 2 T; in other words, the image would execute a simple harmonic motion. Owing, however, to the damping effect, the imaginary satellite is always resisted by a force varying as the velocity, and attracted towards the scale zero with a force varying directly as the radius vector. Under these conditions, the satellite's orbit will no longer be a circle; but will approximate closely to an equi-angular or logarithmic spiral, that being the curve traced by a logarithmically decreasing radius vector revolving about a fixed centre with uniform angular velocity, and the actual path of the image is therefore approximately the orthogonal projection on the scale of the imaginary orbit executed as a contracting spiral, say, in the horizontal plane between the observer and mirror, round the scale zero, as origin with uniform angular velocity.

It follows that the ratios of any pairs of elongations separated by equal numbers will be equal. Thus, the ratios of the 1st and 3rd, 2nd and 4th, 7th and 9th, &c., elongations, are all equal. The following is a series of descending elongations observed with a ballistic galvanometer at the Edison Laboratory, which has a mean period of complete vibration, adjustable between 25 and 45 seconds, and a scale distance of 97·5 centimetres, or 1,510 scale divisions.

−		+	
		243	I.
II.	220·5		
		211	III.
IV.	191·7		
		183·6	V.
VI.	167		
		159·8	VII.
VIII.	145·7		
		138·3	IX.
X.	126·8		
		121	XI.
XII.	110·5		
		104·9	XIII.
XIV.	96·3		
		91·8	XV
XVI.	83·7		
		79·1	XVII.
XVIII.	73·6		
		69·5	XIX.

Thus, the ratio in this series of $\frac{I.}{IV.}$ is 1·268,

that of $\frac{III.}{VI.}$ is 1·263,

that of $\frac{V.}{VIII.}$ is 1·260.

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The logarithm to the base ϵ of the ratio of any pair of consecutive elongations on opposite sides of the scale is, of course, constant, since the ratio is constant, and is called the Naperian logarithmic decrement, being generally represented by the symbol λ. Thus, λ is the $\log_\epsilon$ ratio $\frac{I.}{II.}$ or $\frac{II.}{III.}$, &c., and for the above series has a mean value of 0·0695. The ratio $\frac{\lambda}{\pi}$ is always the cotangent of the angle formed by the radius vector of the imaginary satellite and the geometrical tangent to its orbit at any point. Thus, $\frac{0·0695}{3·1416} = 0·02212$, the cotangent of 88° 44′, which is the angle between the radius vector and tangent for the imaginary orbit corresponding to the above series. This angle would, of course, be 90° in a circular orbit, so that the smaller we find λ the less does the spiral deviate from the circle and the less the damping effect on the needle.

It is evident that λ is the Naperian logarithm of the ratio of radii vectors in the imaginary orbit separated by an angular distance of π, also that 2λ is similarly the $\log_\epsilon$ ratio of radii vectors separated by 2π, or one complete revolution, and generally that radii vectors angularly distant $n\pi$ bear a ratio whose natural logarithm is $n\lambda$.

So that if D be the value of the throw d corrected for damping, then D must be the initial radius vector of the imaginary orbit, and since d coincides with the radius vector after the latter has described a right angle (approximately), the observed throw d will bear to the corrected throw D the ratio of radii vectors distant $\frac{\pi}{2}$; that is, the ratio whose natural logarithm is $\frac{\lambda}{2}$.

Thus
$$\log_\epsilon \frac{D}{d} = \frac{\lambda}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

or
$$D = d\epsilon^{\frac{\lambda}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

expanding $\epsilon^{\frac{\lambda}{2}}$ by Maclaurin's theorem and rejecting all terms involving second or higher powers of λ, we have very nearly the relation
$$D = d\left(1 + \frac{\lambda}{2}\right) \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Thus in the above series of elongations where $d = 243$ and $\lambda = 0·0695$

D would be $243\left(1 + \frac{0·0695}{2}\right) = 243 \times 1·0348 = 251·5$.

Equation (5) now takes the form
$$Q = \frac{c\,T\,d}{\pi a'}\left(1 + \frac{\lambda}{2}\right) \quad . \quad . \quad . \quad . \quad . \quad (9)$$

This correction is the one generally adopted in electromagnetic measurements, and is sufficiently accurate for almost all practical purposes. It is well to notice, however, that the value of D so obtained is only a close approximation, and not absolutely exact, for two reasons. Firstly because the whole theory of the equiangular spiral orbit assumes that the magnetic couple tending to bring the needle to rest varies directly as the angle of deflection, while we know that this force varies actually as the sine of that angle; hence the theory only applies rigorously to indefinitely small angles of throw. The error resulting from the discrepancy is, however, with a Thomson galvanometer, exceedingly small. Secondly, because the maximum elongation of the image on either side of the scale, owing to the deviation of the orbit from circularity, takes place before the radius vector of the imaginary satellite actually enters the plane of the scale. Thus the throw d is produced when the vectorial angle swept out is $\cot^{-1}\frac{\lambda}{\pi}$ in the above series; for example, when the radius vector had described 88° 4′, or was yet 1° 16′ from the scale plane.

Taking this latter consideration into account, the equation of correction becomes
$$Q = \frac{c\,T\,d\,e^{\frac{\lambda}{\pi}\tan^{-1}\pi}}{\pi a'}{}^{\lambda} \quad . \quad . \quad . \quad . \quad (10)$$

It is hardly ever necessary, however, to employ this formula.

To avoid the time and labour necessary for the determination of T and λ, which are required for the reduction of Q by this formula, two other methods of reduction have been published, and attributed to Sir William Thomson and Prof. Rowland respectively. Both these methods compare the throw d obtained from the unknown quantity Q with another throw, θ, obtained from a known quantity, q. Then, since both throws involve damping correction proportionately, this latter is entirely eliminated, and
$$Q = \frac{d\,q}{\theta} \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

The one method obtains the known quantity q from an induction coil of known constants, and by the interruption of a known current passing through its primary circuit. The other method obtains q from an earth inductor by revolving a coil of known constants in the earth's magnetic field H of known strength.

These methods, therefore, though rendering unnecessary the measurements of T and λ, still require the measurement of the known current in the one and of the known field H in the other, although, of course, those measurements may be made once only for many different measurements of Q.

There is, however, a third very simple and accurate method of obtaining q, which does not seem to have yet been published, and that is by means of a condenser of known capacity charged by a known electromotive force. A good standard condenser should be accurate within, say, 0·5%, and a Clark standard cell employed to charge it can, when duly corrected for temperature, be certainly depended upon to that degree of accuracy, so that if e be the electromotive force of the cell in volts, and k the capacity of the condenser in microfarads, the quantity of electricity q, in electro-magnetic units, obtained by the charge, will certainly be $10^{-7} e k$ under those conditions within 1 per cent.

With this condenser method, only the throw θ is required in order to obtain Q by direct proportion, and all measurements of magnetic fields by means of area sweeping conductors may thus be reduced to the simple relation
$$H = a\,d \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

where H is the field whose intensity is to be measured, d is the throw obtained by moving the conductor in that field, and a is a constant depending on the dimensions of the field-searching conductor, the resistance of the galvanometer and connections, the capacity of the condenser and the amount of the condenser throw, the complete formula being—
$$H = \frac{d\,e\,k\,r \times 10^2}{A\,\theta} \quad . \quad . \quad . \quad . \quad . \quad (13)$$

where r is the resistance of the field exploring circuit and A the effective area described by the field searcher, the other symbols having their above significations.

The condenser method furnishes also in itself a convenient means of determining λ when independently necessary. Let the discharge of the quantity q through the galvanometer produce a throw of θ divisions, as above.

Just as the image reaches the scale zero on its way to the next elongation on the opposite side, let the condenser be again discharged through the galvanometer. With a slowly moving needle this is not a difficult matter. Then, if there had been no damping the image would be brought instantly to rest at zero by this second discharge; owing, however, to the loss of momentum through damping, the impulse given by this discharge will more than neutralise the momentum of the needle, and will give it a slight recoil resulting in a small throw δ, say, on the same side as d. Then,
$$\lambda = \log_\epsilon \frac{d}{d + \delta} \quad . \quad . \quad . \quad . \quad . \quad (14)$$

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For if ρ be the radius vector of the imaginary satellite at the commencement of its orbit, m its mass, and ω be its angular velocity, then the actual velocity of the satellite at starting would be $\rho\,\omega$ if the orbit were circular, but the orbit being spiral the initial velocity is $\frac{\rho\,\omega}{\sin\beta}$, where β is the angle $\cot^{-1}\frac{\lambda}{\pi}$ included between the radius vector and tangent. Consequently the initial momentum is $\frac{m\rho\,\omega}{\sin\beta}$.

When the image is next passing the scale zero the vectorial angle is π and the radius vector is $\rho e^{-\lambda}$, so that the momentum retained by the satellite is $\frac{m\rho\,\omega e^{-\lambda}}{\sin\beta}$.

The momentum retained by the satellite after the second discharge at this point will be the difference of these two momenta or the momentum lost by damping.

Thus, if ρ_1 be the initial radius vector of the new orbit after the second discharge, then

$$\frac{m\rho_1\omega}{\sin\beta}=\frac{m\rho\,\omega}{\sin\beta}(1-e^{-\lambda}), \quad . \quad . \quad . \quad (15)$$

whence

$$\lambda=\log_\epsilon\left(\frac{\rho}{\rho-\rho_1}\right); \quad . \quad . \quad . \quad . \quad (16)$$

but $\rho=d\,e^{\frac{\lambda}{2}}$ approximately,

and $\rho_1=\delta\,e^{\frac{\lambda}{2}}$;

so that

$$\lambda=\log_\epsilon\left(\frac{d}{d-\delta}\right). \quad . \quad . \quad . \quad . \quad . \quad (17)$$

For example, the throw from a condenser charged by a standard cell gave with the above-mentioned galvanometer a throw, d, of 243 divisions, and a recoil, δ, after the second discharge of 18·0; so that λ from these observations would be

$$\log_\epsilon\frac{243}{243-18\cdot0}=\log_\epsilon 1\cdot080=0\cdot0769.$$

A more elaborate and much more accurate method for determining λ by means of a series of similar recoil throws is given by Clerk Maxwell.

HERTZ'S RESEARCHES ON ELECTRICAL OSCILLATIONS.

BY G. W. DE TUNZELMANN, B.SC.

(*Continued from page 665.*)

Dr. Hertz was at first inclined to suppose that as the micrometer circuit was only broken by the extremely short air space limited by the maximum sparking distance under the conditions of the experiment, it might therefore be treated as a closed circuit, and only the total induction considered. The ordinary methods of electro-dynamics give the means of completely determining the total inductive effect of a current element on a closed circuit, and would, therefore, in this case have sufficed for the investigation of the phenomena observed. He found, however, that the treatment of the micrometer circuit as a closed circuit led to incorrect results, so that it, as well as the primary, had to be treated as an open circuit, and, therefore, a knowledge of the total induction was insufficient, and it became necessary to consider the value both of the E.M.F. induction and of the electrostatic E M.F. due to the charged extremities of the exciting circuit at each point of the micrometer circuit.

The investigations to which these considerations led are described by Dr. Hertz in a Paper "On the Action of a Rectilinear Electrical Oscillation upon a Circuit in its Vicinity," published in Wiedemann's *Annalen*, Vol. XXXIV., p. 155, 1888.

In what follows, the exciting circuit will be spoken of as the primary, and the micrometer circuit as the secondary. Hertz points out that the reason that the electrostatic effect cannot be neglected is to be found in the extreme rapidity with which the electrostatic forces change their sign. If the electrostatic alternations in the primary were comparatively slow they might attain a very high intensity without giving rise to a spark in the secondary, since the electrostatic distribution on the secondary would vary so as to remain in equilibrium with the external E.M.F. This, however, is impossible, because the variations in direction follow each other too rapidly for the distribution to follow them.

In the present investigations the primary circuit consisted of a straight copper wire 5 millimetres in diameter, carrying at its extremities hollow zinc spheres 30 centimetres in diameter. The centres of the spheres were one metre apart, and at the middle of the wire was an air space $\frac{3}{4}$ centimetre in length. The wire was placed in a horizontal position, and the observations were all made at points near to the horizontal plane through it, which, however, did not, of course affect their generality, as the same effects would necessarily be produced in any plane through the horizontal wire. The secondary circuit consisted of a circle of 35 centimetres radius of copper wire 2 millimetres in diameter, the circle being broken by an air space capable of variation by means of a micrometer screw.

The circular form was selected for the secondary circuit because the former investigations had shown that the sparking distance was not the same at all points of the secondary, even when the conductor as a whole remained unchanged in position, and with a circular circuit it was easier to bring the air space to any part than if any other form had been used. To attain this object the circle was made movable about an axis passing through its centre perpendicular to its plane.

The circuits of the dimensions stated were very nearly in unison, and they were further adjusted by means of little strips of metal soldered to the extremities, and varied in length until the maximum sparking distance was obtained.

We shall follow Dr. Hertz in first considering the subject theoretically, and then examining how far the experimental results are in accordance with the theoretical conclusions. It will be assumed that the E.M.F. at every point is a simple harmonic function of the time, but that it does not undergo reversal in direction, and it will further be assumed that the oscillations are at any given moment everywhere in the same phase. This will certainly be the case in the immediate neighbourhood of the primary, and for the present we shall confine our attention to such points. Let s be the distance of a point, measured along the circuit from the air space of the secondary, and F the component E M.F. at that point along the circular arc $d\,s$. Then F is a function of s, which assumes its original value after passing once round the circle of circumference S. It may, therefore, be expanded in the form

$$F=A+B\cos\frac{2\pi s}{S}+\ldots\ldots+B'\sin\frac{2\pi s}{S}+\ldots\ldots$$

The higher terms of the series may be neglected, as the only result of so doing will be that the approximate theory will give an absolute disappearance of sparks where really the disappearance is not quite complete, and indeed the experiments are not delicate enough to enable us to compare their results with theory beyond a first approximation.

The force A acts in the same direction, and is of constant amount at all points of the circle, and therefore it must be independent of the electrostatic E.M.F., as the integral of the latter round the circle is zero. A, then, represents the total E.M.F. of induction, which is measured by the rate of variation of the number of magnetic lines of force which pass through the circle. If the electro-magnetic field containing the circle is assumed to be uniform, A will therefore be proportional to the component of the magnetic induction perpendicular to the plane of the secondary. It will therefore vanish when the direction of the magnetic induction lies in the plane of the secondary. A will consist of an oscillation, the intensity of which is independent of the position of the air space in the circle, and the corresponding sparking distance will be called α.

The term $B'\sin\frac{2\pi s}{S}$ can have no effect in exciting the

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fundamental vibration of the secondary, since it is symmetrical on opposite sides of the air space.

The term $B \cos \frac{2\pi s}{S}$ will give a force acting in the same direction in the two quadrants opposed to the air space, and will excite the fundamental vibration. In the two quadrants adjacent to the air space it will give a force in the opposite direction, but its effect will be less than that of the former one. For the current is zero at the extremities of the circuit, and therefore the electricity cannot move so freely as near the centre. This corresponds to the fact that if a string fastened at each end has its central portion and ends acted on respectively by oppositely directed forces, its motion will be that due to the force at the central portion, which will excite the fundamental vibration if its oscillations are in unison with the latter. The intensity of the vibration will be proportional to B. Let E be the total E.M.F. in the uniform field of the secondary, ϕ the angle between its direction and the plane of the latter, and θ the angle which its projection on this plane makes with the radius drawn to the air space. Then we shall have approximately

$$F = E \cos \phi \sin \left(\frac{2\pi s}{S} - \theta \right),$$

and, therefore, $B = -E \cos \phi \sin \theta$.

B, therefore, is a function simply of the total E.M.F. due both to the electrostatic and electro-dynamic actions. It will vanish when $\phi = 90°$—that is to say, when the total E.M.F. is perpendicular to the plane of the circle, whatever be the position of the air space on the circle. B will also vanish when $\theta = 0$—that is to say, when the projection of the E.M.F. on the plane of the circle coincides with the radius through the air space. If the position of the air space on the circle is varied, the angle θ will vary, and, therefore, also the intensity of the vibration and the sparking distance. The sparking distance corresponding to the second term of the expansion for F can, therefore, be represented approximately by a formula of the form $\beta \sin \theta$.

Now the oscillations giving rise to sparks of lengths α and $\beta \sin \theta$ respectively are in the same phase. The resulting oscillations will therefore be in the same phase, and their amplitudes must be added together. The sparking distance being approximately proportional to the maximum total amplitude may therefore also be obtained by adding the sparking distances due to the two oscillations respectively. The sparking distance will therefore be given as a function of the position of the air space on the secondary circuit by the expression $\alpha + \beta \sin \theta$. Since the direction of the oscillation in the air space does not come into consideration we are concerned only with the absolute value of this expression, and not with its sign. The determination of the absolute values of the quantities α and β would involve elaborate theoretical investigations, and is, moreover, unnecessary for the explanation of the experimental results.

Experiments with the Secondary Circuit in a Vertical Plane.—When the circle forming the secondary circuit was placed with its plane vertical, anywhere in the neighbourhood of the primary, the following results were obtained:—

The sparks disappeared for two positions of the air space, separated by 180°, namely, those in which it lay in the horizontal plane through the primary; but in every other position sparks of greater or less length were observed.

From this it followed that the value of α must have been constantly zero, and that θ was zero when the air space was in the horizontal plane through the primary.

The electro-magnetic lines of force must therefore have been perpendicular to this horizontal plane, and therefore consisted of circles with their centres on the primary, while the electrostatic lines of force must have been entirely in the horizontal plane, and therefore this system of lines of force consisted of curves lying in planes passing through the primary. Both of these results are in agreement with theory.

When the air space was at its greatest distance from the plane the sparking distance attained a maximum value of from 2 to 3 millimetres. The sparks were shown to be due to the fundamental vibration, by slightly varying the secondary, so as to throw it out of unison with the primary, when the sparking distance was diminished, which would not have been the case if the sparks had been due to overtones. Moreover, the sparks disappeared when the secondary was cut at its points of intersection with the horizontal plane through the primary, though these would be nodal points for the first overtone.

When the air space was kept at its greatest possible distance from the horizontal plane through the primary, and turned about a vertical axis, the sparking distance attained two maxima at the points for which $\phi = 0$, and almost disappeared at the points for which $\phi = 90°$.

The lower half of Fig. 8 shows the different positions of minimum sparking. A A′ is the primary conductor, and the lines *m n* represent the projections of the secondary circuit on the horizontal plane. The arrows perpendicular to these give the direction of the resultant lines of force. As this did not anywhere vanish in passing from the sphere A to the sphere A′, it could not change its sign.

The diagram brings out the two following points:—

(1) The distribution of the resultant E.M.F. in the vicinity of the rectilinear vibration is very similar to that of the electrostatic E.M.F. due to the action of its two extremities. It should be specially noted that near the centre of the primary the direction is that of the electrostatic E M.F., showing that it is more powerful than the electrodynamic, as required by theory.

(2) The lines of force deviate more rapidly from the line A A′ than the electrostatic lines, though this is not so evident

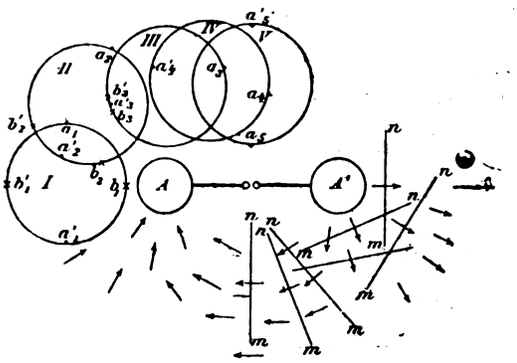

Fig. 8.

on the reduced scale of the diagram as in the author's original drawings on a much larger scale.

It is due to the components of the electrostatic E.M.F. parallel to A A′ being weakened by the E.M.F. of induction, while the perpendicular components remain unaffected.

Experiments with the Secondary Circuit in a Horizontal Plane.—The results obtained when the plane of the secondary was horizontal can best be explained by reference to the upper half of the diagram in Fig. 8.

In the position I., with the centre of the circle in the line A A′ produced, the sparks disappeared when the air space occupied either of the positions b_1 or b'_1, while two equal maxima of the sparking distance were obtained at a_1 and a'_1, the length of the spark in these positions being 2·5 millimetres. Both these results are in accordance with theory.

In the position II. the circle is cut by the electro-magnetic lines of force, and, therefore, α does not vanish. It will, however, be small, and we should expect that the expression $\alpha + \beta \sin \theta$ would have two unequal maxima $\beta + \alpha$ and $\beta - \alpha$, both for $\theta = 90°$, and having the line joining them perpendicular to the resultant E.M.F., and between these two maxima we should expect two points of no sparking near to the smaller maximum. This was confirmed by the observations.

The maximum sparking distances were 3·5 millimetres at a_2 and 2 millimetres at a'_2. Now with the air space at a_2, the sphere A being positive, the resultant E.M.F. in the opposite portion of the circle will repel positive electricity from A, and therefore tend to make it flow round the circle clockwise. Between the two spheres the electrostatic E M.F. acts from A

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towards A′, and the opposite E.M.F. of induction in the neighbourhood of the primary acts from A′ to A, parallel to the former, and acting more strongly on the nearer than on the further portion of the secondary, tends to cause a current in the same direction as that due to the former, namely, in a clockwise direction. Thus the resultant E.M.F. is the sum of the two as required by theory, and in the same way it is easily seen that when the air space is at a'_2, the resultant E.M.F. is equal to their difference.

As the position III. is gradually approached, the maximum disappears, and the single maximum sparking distance a_3 was found to be 4 millimetres in length, having opposite to it a point of disappearance a'_3. In this case clearly $\alpha = \beta$, and the sparking distance is given by the expression $\alpha(1 + \sin\theta)$. The line $a_3 a'_3$ is again perpendicular to the resultant E.M.F.

As the circle approaches further towards the centre of A A′ α will become greater than β, and the expression $\alpha + \beta \sin\theta$ will not vanish for any value of θ, but will have a maximum $\alpha + \beta$ and a minimum $\alpha - \beta$, and in the experiments it was found that the sparks never entirely disappeared, but varied between a maximum and a minimum, as indicated by theory.

In the position IV. a maximum sparking distance of 5·5 millimetres was observed at a_4 and a minimum of 1·5 millimetre at a'_4.

In the position V. there was a maximum sparking distance of 6 millimetres at a_5 and a minimum of 2·5 millimetres at a'_5. In these experiments the air space should be screened off from the primary in the latter positions as well as in the earlier ones, in which it is unavoidable, as otherwise the results would not be comparable.

In passing from the position III. to the position V. the line $a\,a'$ rapidly turned from its position of parallelism to the primary circuit into a position perpendicular to it. In the latter positions the sparking was essentially due to the inductive action, and therefore the author was justified, in the experiments described in my previous Papers, in assuming the effect in these positions to be due to induction.

Even in these positions, however, the sparking is not totally independent of electrostatic action, except when the air space is half way between the maximum and minimum positions, and, therefore, $\beta \sin\theta = 0$.

(To be continued.)

THE USE OF ELECTRIC MOTORS ON SHIPBOARD.*

BY LIEUT. J. B. MURDOCK, U.S.N.

The use of electric motors is extending very rapidly ashore, and naturally raises the question whether there is a field for them on shipboard. The transmission of energy by electricity possesses two general advantages over any other system—in being more economical when energy is to be transmitted to a distance, or when it is to be subdivided into a number of paths. The former has no application on shipboard, where distances are short, but the latter seems to meet many of the conditions for the modern navy.

A good dynamo will place 90 per cent. of the mechanical energy it receives in the form of available electrical energy in its external circuits. If, now, a good motor be placed in this circuit 90 per cent. of this electrical energy, or about 80 per cent. of the work of the engine, can be obtained as mechanical work. The loss in transmission is 20 per cent., and the cost of dynamo and motor renders such a system uneconomical in comparison with the simple one of placing a steam engine where the work is to be done. If, however, the power is required in twenty places instead of in one, the question becomes radically different, and this is the one inviting our attention.

In the new cruisers one of the first impressions received is that of complexity and confusion arising from the number of small engines scattered over the vessels. Nor is the feeling dispelled by a closer examination, for the ship is found to be a labyrinth of steam, exhaust, and circulating pipes, complex in arrangement, and requiring constant care and attention to keep in order. Joints and valves leak, steam condenses, and water freezes, totally disabling some part of the mechanism. If injuries occur, repairs are difficult and frequently impossible with the ship's resources, and an important engine may be disabled for months, or until the arrival of the vessel in port. A still more important objection to this complicated system of steam circulation in men-of-war is found in its liability to injury in action, and the danger to the crew which such injury might bring about. A single pipe cut by shot might disable a very important part of the ship's offensive apparatus, and pipes so injured are difficult to repair, and require time which could not be spared. The escape of steam in such a case would inevitably interfere with the fighting of the ship, and might cause loss of life or even a panic in the crew. If, therefore, it is necessary to use so many auxiliary motors, is steam the best vehicle for the transmission of power?

The electric motor is for equal power smaller than almost any steam engine, is more efficient, involves less waste in transmission, and has small mains, which are therefore less liable to injury, and admit of rapid repair of injuries. With the low potential used on shipboard there is, moreover, no danger to the *personnel*, and a broken main could be stopped without the delay of turning off the current. Every objection against the indiscriminate use of steam engines is removed by the use of the electric motor. A motor is, moreover, portable, and power may thus be quickly obtained in any place in the ship where the motor may be fastened down.

On grounds of utility, therefore, the motor appears to possess decided advantages. These appear to exist equally in economy. Small engines are notoriously uneconomical as compared with large ones. Small motors and dynamos are less so. By concentrating the whole auxiliary power of the ship in the dynamo room, large, economical compound condensing engines may be used in driving high-efficiency dynamos, and the power thus obtained distributed through large mains to the motors with very slight loss. The question of economy therefore rests upon the amount of subdivision, and is apparently in favour of the electric motor under just the circumstances in which distribution by steam becomes complex, and the loss due to using a number of uneconomical engines forms a large total aggregate. The question of economy of coal is one of the most important to be faced, and becomes paramount in a ship, which, without plenty of coal in her bunkers, is a mere helpless steel box, drifting at sea. Is it not advisable to seriously consider the saving and general advantages to be obtained by the high economy of large engines of the best type, and the high efficiency of well-designed dynamos and motors, in place of the notorious wastefulness, heat, dirt, and noise of small auxiliary engines?

In order to carry out such a plan it is only necessary to connect the motors to the incandescent-light mains. It will be necessary to closely analyse the demands for power, and to place in the dynamo room a sufficient number of dynamos to supply the maximum required to be used at any time. The paramount consideration should be to have a reserve in action, and it is probable that more power will be needed then, through the use of gun-carriage and other motors and search-lights, than will be saved by the diminished use of incandescent lights. The dynamo room in this case becomes a central station for light and power, and valuable information may be derived from the experience of central stations ashore. It seems to be settled now in ordinary practice that, in cases where the load varies largely, it is in the long run more economical to use several engines of medium size, throwing in one after the other as the demand increases, rather than to employ one or two large engines which must generally be operated in partial load.

The objection to such a system is, that although the danger in action is not diffused over the whole ship it is concentrated in one place, and any injury there would cripple the ship. This is merely placing the dynamos in the same category as the engines and boilers, and, like them, the dynamo room must have all protection that can be given it. It should always be below the protective deck, when there is one, and in other cases below the water line. The mains should consist of several parts in parallel, connected together by copper wire spans at intervals. Each main becomes then a net work of conductors, and although this entails greater first cost, it reduces loss in transmission to a negligible quantity and guarantees safety and durability. The distribution should be made as much as possible below the protective deck, branch mains being generally vertical. Every circuit necessary in action should be thoroughly accessible for repairs, while at the same time receiving all possible protection. The highest insulation is of course demanded.

The simplicity of such a system is in marked contrast with that of steam distribution. All incandescent lights, search lights, and motors are connected in parallel, and any one may be put in or out of action by the movement of a single switch.

Apart from all advantages of distribution, the electric motor is the most efficient, compact, noiseless and simple vehicle for the transmission of energy that is known. If well made, it requires only ordinary care and attention to be always ready for use. Its principal danger on shipboard is from salt water, but with proper care this is small.

Nothing like a complete presentation of so wide a subject can be given within the limits of a single article, but the foregoing may call attention to some of the necessities of our service, and also to some fields in which experimental work may well be carried on.

* Extract from an official report to the United States Government.

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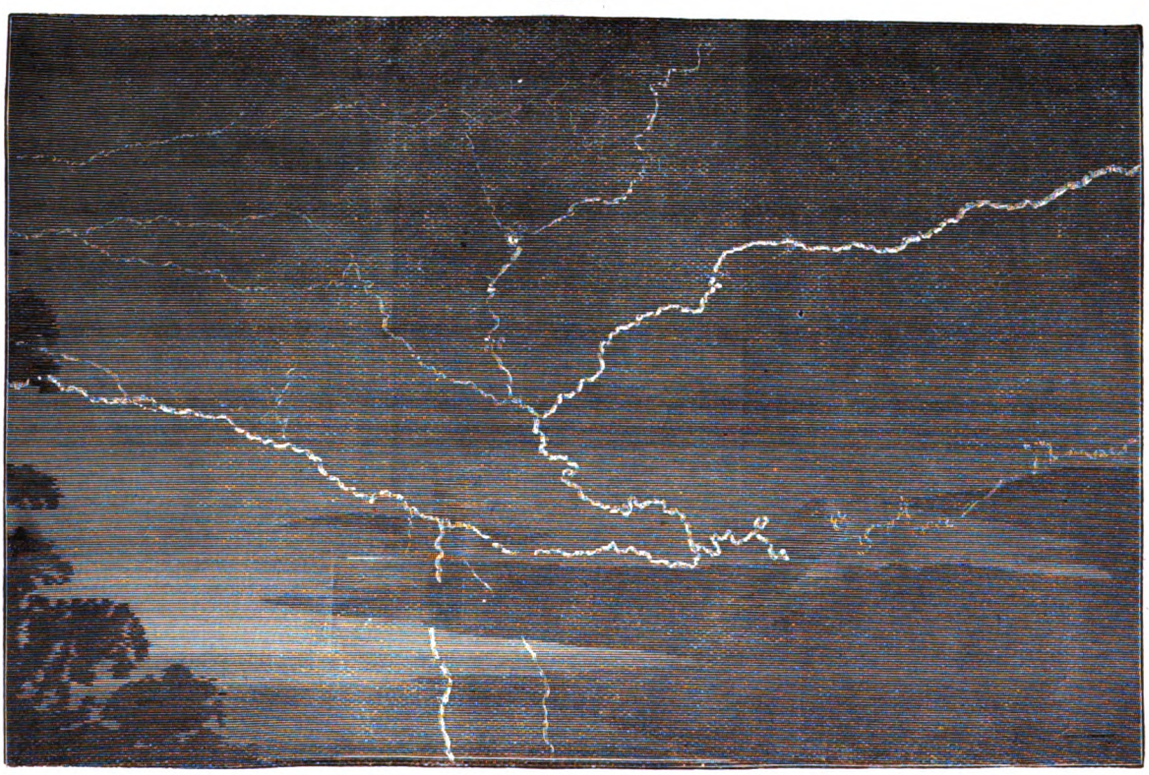
PHOTOGRAPHS OF LIGHTNING EXHIBITED AT THE MEETING OF THE BRITISH ASSOCIATION.

FIG. 1.—This figure shows the apparent duplication of flashes, probably from internal reflection from back of glass plate. Also the ribbon-like form of one of the flashes. Taken on board H.M.S. "Neptune," November 14, 1884, 6:30 p.m., between Madeira and Gibraltar.

FIG. 2.—This figure shows three flashes nearly parallel; also one *dark* flash. Taken August 17, 1887, in London.

FIG. 3.—This figure shows the meandering type of flash, also the tendency to form brighter spots in certain portions of the flash. Observe, too, that the flash is slightly ribboned at the edges only, where the definition is less good than in the centre. Taken May 26, 1886, 10:30 p.m., near Tours.



The above engravings are taken from photographs exhibited by the Hon. R. Abercromby during the discussion on Lightning Conductors at the meeting of the British Association. These photographs are amongst those obtained by the Royal Meteorological Society in response to their recent app Unfortunately, some of the finer details are inevitably lost in the process of engraving on wood.

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The Electrician.

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Owing to the increase in the number of pages of "The Electrician," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

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For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
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THE SOCIETY OF ARTS MOTOR TRIALS.

In the month of December, 1886, the Council of the Society of Arts announced that they were prepared to conduct a series of competitive trials of prime motors "suitable for electric light installations," and that they would award two Gold and four Silver Medals. The motors were to be divided into two classes, A and B, and one gold and two silver medals were to be awarded in each class. In Class A were to be included those motors "in which the working agent is also produced," the steam-engines being further classified into condensing and non-condensing types, and the gas motors into coal gas, water gas, petroleum vapour, and liquid petroleum engines. In Class B were to be included those motors "to which the working agent must be supplied," including steam engines without boilers, gas and water engines. Each class was again subdivided into two groups, one for engines developing under 10 horse-power and the other for engines developing from 10 to 20 horse-power; and it was further announced that no competition would be held unless at least ten motors were entered. The conditions laid down for the trials were in the main identical with those adopted by the Royal Agricultural Society. The experiments were originally intended to have been carried out in or about May or June, 1887. In the month of January, however, a revised set of regulations was issued by the Council with the object of including engines deriving power from the combustion of any kind of hydro-carbon, and also air engines, and the trials were at the same time postponed for twelve months until May of the present year.

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In making these proposals the Council of the Society of Arts were of course actuated by the best possible intentions, and it is impossible to overlook the fact that their willingness to undertake so serious an expenditure of time, labour, and money, on behalf of electrical engineering, entitles them to the gratitude of every member of the profession. But although we have previously taken occasion to express our appreciation of this well-meant scheme, yet at the same time—and so long ago as July of last year—we gave expression to some foreboding that its success would not be commensurate with the importance of the question or with the dignity of its sponsors. We most sincerely regret to find that our lugubrious anticipations have proved only too correct, for notwithstanding a still further postponement of the trials—which in fact are scarcely now complete—the entries have been extremely meagre in number, being confined to *one* steam engine and *three* gas engines.

The want of alacrity of the engine makers in entering upon a competition of this character is not difficult to understand. From a commercial point of view it is obvious that an average firm has more to lose than to gain by taking a part in the game, and the smaller the number of competitors the more will the triumph of the successful rival be minimised. But apart from general considerations it is evident that in this particular case there are difficulties of a special kind which render the selection of the most suitable motor for electric lighting purposes a task of more than usually difficult, if not an altogether impossible character. In our own opinion—an opinion which we endeavoured to force upon the attention of the Council whilst there was still time for reconsideration—the scheme was doomed to failure if only on account of the lack of any definite indication as to the *kind* of electric light installations for which the engines were to be supposed to be adapted. That any one engine could be pronounced the most suitable for any and every species of installation is absurd on the face of it. As a matter of fact, there is probably not a single fairly good type of engine in existence which is not somewhere or other in use at the present moment for electric lighting. We do not argue from this that every known type of engine may be advantageously employed in some phase or other of the electric lighting industry; but the consideration is one which certainly tends to emphasise the fact that the conditions under which dynamos have to be supplied with motive power are by no means of a uniform character. It is true that regularity of speed is the one distinctive feature which is demanded of every motor used for electric lighting, but this speed may be high, low, or moderate; it may be required to be absolutely constant, or to be capable of automatic variation within a certain range. Again, if the engine be large, we look to economy of working as of the first degree of importance, and we can, if necessary, correct speed variations by means of an electric governor or otherwise; but if the engine be small, it is seldom desirable to do this, and the question of economy is to some extent subordinated to absolute steadiness of running. Central station lighting, domestic lighting, factory lighting, ship lighting, constant current and constant potential distribution, distribution with or without batteries, and so on, each demand that the question of engine power shall be considered from a special standpoint, and we repeat that it is impossible to select any motor which, without qualification, can be asserted to be the best for electric lighting purposes in general. It may be said, and probably with some degree of accuracy, that the Society of Arts never intended to place their *imprimatur* upon any one motor as the best for all round purposes, and that this is proved by the classification which they have so carefully set forth. But, unfortunately, this classification, elaborate as it is, does not take any account whatever of the different requirements of the various types of installations to which we have referred; and therefore any motor which obtained the gold medal in Sections A or B goes forth to the world as the most "suitable for electric lighting installations."

It is, of course, true that any adequate extension of the scheme in the direction indicated would have immensely increased both the difficulty and the cost of the undertaking, and in fact it would probably have proved impracticable.

That the affair should terminate, however inevitable this may have been, in something very like a *fiasco*, is the more to be regretted since the Commission appointed by the Society to carry out the tests is exceptionally strong, and the equipment at their disposal is probably of unequalled excellence. The *personnel* consists of Prof. KENNEDY, F.R.S., Dr. J. HOPKINSON, F.R.S., and Mr. BEAUCHAMP TOWER. The motors upon which the trials have just been carried out are one Davey Paxman engine (of the same type as that which last year gained the prize at the Royal Agricultural Society's trials at Newcastle), one "Otto" gas engine, one "Griffin" gas engine, and an Atkinson cycle gas engine. The trial, therefore, resolves itself into a contest between these three gas engines, and regarded from this standpoint the result will still possess considerable interest and importance to electrical engineers. The points of merit considered of the greatest importance are the following:—

a. Regularity of speed as to revolutions per minute under varying loads.

b. Regularity of speed during the various parts of one revolution.

c. Power of automatically varying speed to suit arc lights.

d. Noiselessness.

e. First cost.

f. Cost of running.

g. Cost of maintenance.

Special meters were provided to measure the consumption of gas with exceptional accuracy. Each engine undergoes three tests:—(1) a continuous run of six hours at full power; (2) a run of three hours at half power; (3) a run of one half hour unloaded. The brake power and the indicated power are both obtained; also the quantity of cooling water employed and its rise in temperature. The time required to start the engine is also ascertained. The tests have been carried out under conditions which leave no room for doubt that the final results will possess the highest attainable degree of accuracy, but some time will necessarily elapse before their publication, and, as we have said, the whole thing resolves itself into a competition between three of the leading gas-engine makers.

ON THE C.-G.-S., AND PRACTICAL UNITS OF MEASUREMENT.*

BY W. H. PREECE, F.R.S.

In the C.-G.-S. system, which may now be considered to be in universal use, the quantity of heat which will raise one gramme of pure water one degree centigrade from the standard temperature, 4°, is the C.-G.-S. thermal unit, and is frequently called the *calorie*; but the term calorie is just as frequently applied to the kilogramme water degree. Its mechanical equivalent is 42,000,000 ergs.

* Paper read before the British Association meeting (Section A) at Bath, September, 1888.

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Since heat is a generic term applied to that form of work which is expended on any substance when its temperature is raised, it seems desirable that the thermal unit and the unit of work should be more closely allied.

The *watt* has been universally accepted as the unit of power; it is the unit rate of doing work. It is 10^7 ergs done per second.

Now, Sir W. Siemens at Southampton, 1883, proposed to call 10^7 ergs a *joule*. Hence, a watt or the work done by a coulomb or by an ampere flowing through one ohm for one second is a joule per second, and there would be 4·2 joules in one calorie.*

Thus, ·2381 gramme of water raised one degree, or one gramme of water raised ·2381°, would equal one joule.

We cannot, unfortunately, avoid the use of a coefficient. The arbitrary character of the degrees of temperature prevents this, but the relations between the quantities are very simple.

One joule = 10^7 ergs = ·24 calorie.

One watt = one joule per second = ·24 calorie per second.

One calorie = 4·2 joules = 42,000,000 ergs.

One British thermal unit (pound-water degree F.) = 1,058, joules = 252 calories.

Let us take a glow lamp having the following elements:—

	C.-G.-S. units.	Practical units.
E.M.F.	$= 100 \times 10^8$	100 volts.
R.	$= 200 \times 10^9$	200 ohms.
C.	$= \cdot5 \times 10^{-1}$	·5 ampere.
E.C.	$= 50 \times 10^7$	50 watts.
Candle-power		20 candles.

$$H = \frac{C^2 R}{J} = \frac{\cdot0025 \times 200 \times 10^9}{4\cdot2 \times 10^7} = 12 \text{ calories.}$$

Thus, 50 watts develop 12 calories per sec, 4·2 watts develop 1 calorie, 1 calorie per sec. develops 1·7 candle.

It is quite clear that the acceptance of the joule will facilitate many calculations, and prevent much confusion. While on this question, it is well to point out the extreme inconvenience that is rapidly increasing owing to the incessant necessity for using C.-G.-S. units in magnetic questions, through our having the ampere and the C.-G.-S. unit current different. This is the consequence of having accepted the volt as equal to 10^8 instead of 10^9 C.-G.-S. units.

The result is that the ampere is one tenth of the C.-G.-S. unit current.

The only reason ever given in favour of the accepted volt is that it is very nearly the electromotive force of a Daniell's cell. This was a good reason twenty-five years ago when telegraphy was the principal practical application of electricity; but now, when we are rapidly extending the applications of electricity in all directions, when we are using higher multiples of volts every year, the time has come when we should seriously consider the advisability of making the volt 10^9 instead of 10^8 C.-G.-S. units of *electromotive force*, and so make the ampere and the C.-G.-S. unit of current the same.

Again, it is perfectly clear that 106 centimetres of mercury at O°C. 1 square millimetre in section is only a very rough approximation to the true ohm, and that 106·3 would be a much closer approximation, and be very nearly the truth. The roughness of the approximation of the legal ohm has prevented its general acceptance, and there will be no universal acceptonce of one and the same unit of resistance until we agree on the value of the true ohm.

The legal ohm was accepted in 1883 provisionally for 10 years.

There will be a congress of electricians in Paris next year, and if we English electricians proceed there, armed with the opinion of the British Association Committee that 106·3 C.M. in their opinion more nearly represents the true ohm, and that the volt should be made equal to 10^9 C.-G.-S. units of electromotive force, it would have very great weight in the final determination.

It is most desirable also that we establish and name unit magnetic field, but whether this is to be based on the C.-G.-S. units or on the practical units must remain open for consideration and discussion.

There is one other point to which I wish to direct the attention of the committee; it is the value of the standard of pure copper.

We have hitherto accepted implicitly Matthiessen's standard. According to his experiments the specific resistance of a cubic centimetre of pure copper at 0°C. is 1,642 C.-G.-S. units; but this is known to be about 3 per cent. wrong, and it is most desirable that experiments should be made to determine the proper figure. The resources of the Cavendish laboratory, where so much good work has been done, might be devoted to this desirable work.

I recommend (1) that the practical unit of work 10^7 ergs be called the *Joule*; (2) that experiments be made to determine the specific resistance of pure copper.

THE SPECIFIC RESISTANCE OF PURE COPPER.*

BY WALTER T. GLOVER.

The introduction of the electric light, whilst effecting many improvements in electrical manufactures, is in one essential particularly aided in developing an improvement which had already commenced, and which had been principally initiated and carried on by the development and extension of submarine telegraphy. The increased length of submarine cables, drawing attention to the necessity of decreased resistance in the conductor employed, naturally brought with it as the result of most careful testing, a more perfect system of smelting, and the production of a quality of copper of greatly increased purity, as this necessity became apparent and was insisted on. Whilst the original cables submerged in 1853-4 between England and Holland had a conductor consisting of solid copper wire, with a conductivity of about 50 per cent. of pure copper, the latest form of submarine cables now possess a conductor equal to and exceeding 96 per cent. of pure copper.

The special attention given to the electrical quantities of the copper wire used for telegraphic and telephonic external work has tended in the same direction of obtaining a material of greater electrical efficiency, and lastly the electric light has still further added a strong stimulus to the smelter and to the wire manufacturer to produce a metal of the best possible conductivity. It can be well understood of what great importance a difference of two or three per cent. of conductivity of an electric light cable would make in the economical working of an installation. An increase in the resistance of an electric circuit of two or three per cent. may practically be assumed to mean a corresponding increase in the cost of the production of the motive power, and an increased item of the general expenditure for maintenance.

The lowness of the conductivity of the copper conductor must be met by the increased cost of construction by employment of a larger conductor, or by the increased cost of maintenance. These results have, however, been avoided by the great improvements in manufacture, whereby a material is now produced of a much higher specific conductivity than was formerly thought possible for ordinary commercial use.

This result has produced an apparent anomaly, for it is now not unfrequently the case that "hanks" of copper wire are manufactured which, on undergoing careful tests for conductivity at the works where they are to be used, are actually found to possess a *higher conductivity* than that assigned to absolute pure copper of the same gauge.

Numerous instances of this fact were given by Mr. Willoughby Smith in a communication addressed by him to the Society of Telegraph Engineers and Electricians some time back, in which some samples came out 4 per cent. in excess of the standard of pure copper.

If these were isolated cases it would not be immaterial to suppose that some error had occurred in the tests; but similar observations have so often been noticed that one is inevitably led to the conclusion that the standard usually accepted as that represented by pure copper must be an erroneous one, and one which should require recalibration.

* The Committee decided to call the C.-G.-S. thermal unit a "therm," to avoid the confusion arising from the use of the calorie.

* Paper read before the British Association meeti (Section A), at Bath, September, 1888.

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A reference to various text-books, tables, &c., all show that whilst a certain amount of difference exists in the various standards given, as the base of the tables, there is a general unanimity in describing the standard as obtained from determinations by Dr. Matthiesen. The experimental investigations by Dr. Matthiesen into the specific conductivity of the various metals were carried out more than 15 years ago, and it is evident that the quality or purity of the metal experimented with at that time was, as regards copper, different from the quality or the purity which can be obtained at the present time. The table produced by my firm, and which has been found everywhere a most useful help in electrical calculations and observations, is based upon one of Dr. Matthiesen's tests, but owing to the present quality of copper produced it represents more nearly commercial copper than that which is considered as absolutely pure copper. The question of the wire gauge having now been definitely settled in favour of the Board of Trade Standard Wire Gauge, I feel that the British Association for the Advancement of Science may with the greatest advantage to both the scientific and commercial worlds, advance a step further in this direction by instructing their Committee on Electrical Standards to at once commence a series of definite experiments to determine what is the specific resistance of pure copper. We shall have the greatest satisfaction, being large manufacturers of every variety of copper conductors for electrical purposes, in supplying the committee with all their requirements so far as this metal is concerned, and as the experimental investigation must of necessity be carried out at some considerable expense, and not being aware of how far the finances of the Association will enable them to place a grant at the disposal of the committee, we wish to mark our sense of the great scientific and commercial importance of this undertaking by contributing towards the determination of an authorised standard of the "specific resistance of pure copper."

On the final determination of this standard we would pre-prepare suitable tables, based on the British Standard Gauge, which should be available for all branches of the profession for reference and calculations.

COMPARISON OF GASSNER'S DRY CELLS WITH LECLANCHE'S.*

BY WM. LANT CARPENTER, B.A., B.SC.

Shortly after their recent introduction into England two of Gassner's dry cells—a round and a flat form—were brought to the Hanover-square School of Electrical Engineering, with a request that they should be carefully tested and compared, under varying conditions, with the No. 2 size Leclanché cell. The E.M.F.'s were taken by Law's condenser method, and the internal resistances were measured by Kempe's method, the shunt employed being 1 ohm. The results for the round Gassner cell were respectively 1·317 volt and 0·205 ohm, and for the flat form 1·52 volt and 0·7 ohm. No attempt was made to determine the composition of the contents of the cell, which consisted mainly of a yellow, opaque, somewhat stiff, jelly, remarkably constant under varying conditions of atmospheric temperature and humidity; hence the cells could be placed in any desired position (on their side, for example), a great convenience where space is limited.

The flat form and a No. 2 Leclanché were each circuited through 10 ohms, and the fall in potential difference observed at frequent intervals for three hours. The curve representing the rate and amount of fall of the dry cell was much more regular, and showed a total fall somewhat less than that of the Leclanché. Both cells, after six days' interval, were short-circuited through 2 ohms for 2 minutes, and their recovery from polarisation observed at frequent intervals for 65 minutes. This caused a fall of 0·21 volt in the dry cell, and of 0·552 volt in the Leclanché. The recovery curves showed that while the flat cell recovered 85 per cent. of this loss in 6½ minutes, and nearly the whole of the remainder in the succeeding 10 minutes, the Leclanché required 18 minutes to recover the same proportion of its loss, and 30 minutes to arrive at the same E.M.F. as the dry cell. The latter, however, scarcely altered appreciably afterwards, while the Leclanché continued to recover slowly for some hours.

The two dry cells and two No. 2 Leclanché cells were then short-circuited through one ohm for one minute, and frequent throws of the galvanometer were taken to determine the respective rates of recovery from polarisation. The results were very similar; both dry cells recovered the greater part of their lost E.M.F. in seven minutes, and the subsequent recovery was very slow, while the two Leclanché cells required at least double the time to recover in the same proportion.

The resistance of a ringing bell, determined by the reproduced deflection method, was ascertained to be 20 ohms. The same four cells were then circuited through 20 ohms for 168 hours each, and observations of their potential differences were made, with the annexed results.

Four cells, circuited through 20 ohms.

P.D. at terminals in volts.

Time.	Leclanché.		Gassner.	
Hrs. Min.	*a.*	*b.*	Round.	Flat.
0 10	1·06	1·16	1·21	1 06
0 15	·988	·999	1·20	1 03
0 20	·938	·933	1·19	1·015
0 30	·905	·883	1·17	·977
0 35	·900	·844	1·17	·949
1 50	·778	·679	1·10	·778
3 45	·651	·646	1·04	·712
22 5	·508	·392	·833	·518
27 40	·480	·370	·828	·508
48 10*	·430	·342	·778	·447
51 40	·419	·337	·767	·436
72 0	·414	·326	·728	·364
96 10	·386	·326	·695	·298
168 0	·320	·309	·618	·171
E.M.F.'s at starting ...	1·41	1·435	1·31	1·35
Internal resistances at starting	0·741	0·635	0·252	0·618
*Do. at 48h. 10m.	0·69	0 59	0·205	0·455

The following table shows the manner of recovery of the same four cells :—

E.M.F.'s of the same four cells when recovering from the polarisation due to being circuited through 20 ohms for 168 hours. (Time reckoned from the instant of breaking the circuits.)

Time.	Leclanché.		Gassner.	
Hrs. Min.	*a.*	*b.*	Round.	Flat.
0 30	0·502	0 524	0·646	0·237
0 40	0·524	0·556	0·662	0 243
1 50	0·662	0·750	0·723	0·309
2 40	0·728	0 827	0·729	0·348
24 50	1·13	1·13	0·956	0·690
25 58	1·13	1·14	0 968	0·701
26 40	1·14	1·15	0·973	0·706
29 5	1·15	1·16	0·984	0·717
48 10	1·19	1·20	1·01	0·778
50 40	1·20	1·21	1·04	0·789
53 40	1·20	1·22	1·06	0·795
71 50	1·24	1·30	1·10	0 828
77 50	1·25	1·31	1·11	0·840
96 25	1·29	1·35	1·15	0·867
168 10	1·35	1·40	1·21	0 934
192 10	1·37	1·40	1 23	0·956
360 0	1 39	1·42	1·27	1·05

After this, the following results were obtained :—Internal resistance of round dry cell, measured by Mance's bridge method, 0·26 ohm. Ditto of flat cell, 0·63 ohm.

* Paper read before the British Association Meeting (Section A) at Bath, September, 1888.

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The round dry cell and the No. 2 Leclanché (*a*) were then each circuited through 3 ohms.

Time.	Leclanché.				Dry Cell.			
H. M.	Current Amperes	E.M.F. Volts.	P.D. Volts.	Internal Resistance Ohms.	Current Amperes	E.M.F. Volts.	P.D. Volts.	Internal Resistance Ohms.
0 0	—	1·42	—	—	—	1.27	—	—
0 5	·203	—	·608	—	·270	—	·811	—
0 8	·169	·554	·507	·277	·257	·811	·772	·151
0 11	·148	·546	·447	·442	·255	·803	·764	·153
0 16	·146	499	·437	·429	·247	·780	·741	·157
0 19	·174	·484	·421	444	·239	·772	·717	·228
0 23	·135	468	·405	·440	·234	·764	·702	·266
0 34	·125	·437	·374	·500	·221	·710	663	·212
1 0	·101	367	·304	·615	·205	·647	·616	·152
1 25	·083	·312	·249	·750	.190	·624	·569	287
1 53	·068	·234	·203	461	·182	·586	·546	·214
2 25	·052	·187	·156	·600	·172	·554	·515	·227
3 23	044	·164	·152	·700	·159	·515	·476	·246
5 30	·039	·140	·117	·600	·130	·429	·390	·300

Recovery of the cells after being circuited as in the last table.

Time.	Leclanché.	Gassner.
Hrs. Mins.	E.M.F.	E.M.F.
0 0	0·14	0 429
17 53	1·09	1·05
17 54	1·09	1·07
20 43	1·10	1·07
22 43	1·12	1·09
90 8	1·30	1·23
114 0	1 33	1·24
117 0	1·34	1·25

Considering the whole of these results, it appears that the round form of Gassner's dry cell polarises less than a No. 2 Leclanché, and is also of considerably lower internal resistance (the average value being about 0·25 ohm); further, that although the dry cell takes somewhat longer to completely recover its E.M.F. when the circuit is opened, the rate of recovery is more rapid than that of the Leclanché for the first five or ten minutes. The flat form of dry cell appears to behave in most cases not quite so well as a No. 2 Leclanché, the internal resistance being about the same—0·6 ohm. I should add, in conclusion, that the measurements here described were made under the superintendence of Mr. E. C. Rimington.

ELECTRICITY AS APPLIED TO MINING.*

BY FRANK BRAIN, M.E.

This is a Paper, from the mining engineer's standpoint, briefly sketching the known applications of electricity to mine working up to the present time. The writer regrets there is little to add to what has already been made public. He cannot but express surprise that a power which it is apparent has now passed the range of experiment, and is developing itself economically and efficiently, should not have been made greater use of than appears to have been the case hitherto.

The recommendations of the Mines Commission, and the passing of the more stringent Coal Mines Act of 1887, both have stimulated mine managers to inquire into and recognise the advantages of electricity for blasting and lighting.

By means of a small hand magneto battery and electric fuses all the shot firing in most of the fiery collieries is now done, the explosive used being one of the many lately introduced, which, fired by an electric detonator, gives off no flame. Dynamo machines at many pits are used for lighting the surface and main roadways of the colliery, and this current has been also used for the purpose of shot firing, notably, at Ynyshir Colliery, Rhondda Valley, South Wales. All the shots are fired in this way simultaneously, with every man out of the pit, thus putting loss of life beyond possibility.

This adaptation, it should be said, however, is protected by a patent. The adoption of the electric lamp in place of the well-known safety lamp is now very strongly advocated. There are several in the field, notably the "Swan" and "Pitkin" secondary batteries, and the "Schanschieff," a primary battery.

The South Wales Institute of Engineers (who have referred the matter to a Special Committee), with other kindred societies, have lately had these and other lamps put before them, and several colliery engineers are practically testing them.

One, Mr. G. W. Wilkinson, of Risca, has in use daily several hundreds, and so satisfied is he with their results that he has ordered a further number for other of his collieries.

The lighting of the main roadways by electricity is common in many mines.

Mr. Sopwith, of the Cannock Chase Collieries, who it will be remembered read a Paper in connection with the 1886 meeting of the British Association on the subject, informs the writer his plant, which has since been extended, continues working well. He has lately introduced large accumulator cells to supply twelve volt lamps in various parts of the colliery workings, where moisture and a very bad roof had to be contended with. He found there was no difficulty with the "leads," and the result was in every way satisfactory.

The applications of electricity to transmission of power are confined to a few collieries; so far as the writer knows, in Great Britain to three only, viz, Trafalgar Colliery, Forest of Dean; St. John's Colliery, Normanton; and Allerton Main Colliery, Leeds.

At Trafalgar what was a very small pumping plant started in December, 1882, developed in May, 1887, into three sets of plant doing the greater part of the underground pumping of the colliery.

As the writer has been directly concerned in the working of this plant a brief description of the last installation may be interesting.

The pump, a double-throw 9in. plunger, with 10in. stroke, is fixed 2,200 yards from the generator and 1,650 yards from the bottom of the pit-shaft. The pipe main is 7in., and at a maximum speed of 25 strokes the pump lifts 120 gallons per minute 300 feet high. It is geared 6 to 1, the small pinion being driven by a belt from the motor (an Elwell-Parker). Current is conveyed to the motor by a conductor of 19 No. 16 wires, insulated and carried on earthenware insulators. An old 4in. iron-wire rope serves for the return current. The current is 43 amperes, and the E.M.F. 320.

The cost of engine and electric plant was £644. The weekly cost of maintenance, allowing 15 per cent. for interest and depreciation on plant, £7. 17s., or ·002 of a penny per horse-power per hour, and the economy effected about £500 per annum. The power lost and useful effect in the different stages is as follows:—

INDICATED H.P. OF STEAM ENGINE, 29·49.

Received by	Loss in	Useful effects.
H.P.		
Generator 23 00	Steam engine..22 per cent.	78 per cent.
Cables 18 44	Generator.....20 ,,	80 ,,
Motor..... 14 99	Cables .....20 ,,	80 ,,
Pump..... 11·99	Motor .....20 ,,	80 ,,
Water 10 36	Pump .....14 ,,	86 ,,

The efficiency obtained throughout is only 35 per cent., but it will be noticed the engine, which is an old one, loses 6·49 horse-power, or 22 per cent. alone. This plant has worked daily since May, 1887, without interruption, and is giving every satisfaction.

At St. John's Colliery, Normanton, 39 gallons per minute are raised 530ft., equal to 6·3 horse-power work done. This is with an old girder engine, which indicates 14·2 horse-power. The efficiency, therefore, is 44·4 per cent.

* A Paper read before the British Association meeting (Section G) at Bath, September, 1888.

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This plant commenced working in the latter part of 1887. In the early part of this year (1888) so satisfied were the owners of the colliery with its working, that they laid down what is at present the largest electrical pumping plant in England. 120 gallons per minute are raised 900ft., equal to 33 horse-power nearly. The engine has not been indicated, which is to be regretted; but there is an output of 53 horse-power from the generator, so that the efficiency, comparing the actual work done with the output of the dynamo, is about 62 per cent. The current averages 66 amperes with an electromotive force of 600 volts. Immisch motors are used here. These extensions speak for themselves.

At Allerton Main Colliery very small quantities of water are being dealt with at inaccessible points, the power being taken to the motors in secondary batteries charged at the surface and conveyed in the colliery tubs.

Mr. Blackburn, the manager of these collieries, has also in work a coal-cutting machine. The motor is carried upon the bed-plate of the machine, a rotary motion being transmitted to the shaft carrying the cutter bar through gearing. The current is conveyed to the coal face from the dynamo machine placed on surface by flexible cable.

On the Continent we have underground haulage at Zaukerode Colliery in Saxony, which has been successfully and economically working since 1882. The distance from the dynamo—a Siemens and Halske—to the working level is 300 yards, and the total length of the line is 700 yards. The current is carried by well-insulated conductors to angle irons, which run along the roof of the roadway, and from which the current is taken to the motor carried upon the locomotive. A full train is 15 tubs, each containing 10 cwt., and the locomotive weighs 30 cwt. The speed varies from five to seven miles per hour. The total cost of plant was about £800, and the cost of working about three farthings per ton.

At Paulus and Hohenzollern Colliery, in Upper Silesia, a similar plant has been working since 1884. The distance from the dynamo to the working level is 250 yards, and the length of the line 820 yards. The current is conveyed as at Zaukerode. The full train is 16 tubs, each containing 10 cwt., and the locomotive weighs 42 cwt. The cost is about one halfpenny per ton, or one-half cheaper than horse transport. A similar arrangement is also working in the salt mines of New Stassfurt and at Salzberg works. At New Stassfurt tail rope haulage has been applied.

In Australasia the writer can only trace one application, and that is at the Phœnix Gold Mines, Skipper's Creek, New Zealand. Here two Brush dynamos, driven by two Pelton water wheels, generate about 52 horse-power. A No. 8 B.W.G. copper wire, on telegraph poles, conveys the current over a mountain 800ft. high, a distance of some three miles, to a Victoria motor, which drives 20 stamp-heads (each of 8cwt.), at the rate of 70 blows per minute, and it is said to be powerful enough to drive thirty heads. The loss in transmission is stated to be about 3 horse-power only.

In America the use of electric motors is much more extended than with us. The electric light companies hire them out for varied purposes, their large central lighting stations enabling them to do this to great advantage. Horses on street tramways are being fast replaced by the electric locomotive. For example, in one city alone, Richmond, Va., with grades of 3 to 10 per cent., 200 cars driven by Sprague motors on the overhead conductor system are running daily, carrying some 80,000 passengers per week. It is stated the economy as compared with horses is 25 per cent. on gross receipts. It is but lately attention has been turned to mine work, but now that they have commenced with the push and spirit of enterprise which is a distinguishing feature with American engineers, we find them making great progress.

At Silver City, Idaho, a Sprague motor is driving a 50-stamp mill four miles away from the generator. The latter, which gives off 75 horse-power, is driven by a turbine. It is stated by the manager of this mine that he saves in the haulage of his ore alone $90 per day.

At Veteran Tunnel, Aspen, Colorado, two sets of rope haulage drums are working with 10 horse-power Sprague motors, and a third is being erected.

These draw six trams at the rate of 500 feet per minute up a three-per-cent. grade.

The Lykins Valley Coal Company, at the Short Mountain Colliery, Pa., in the autumn of 1887 started an electric locomotive, which has since continued doing good work. The motor, a 25 horse-power Schlesinger, is connected to the locomotive wheels by chain gearing, and after six months' running the teeth of the pinion show but a wear of $\frac{1}{64}$th of an inch. It receives the current through a side conductor from a 50 horse-power generator. The length of the track is 6,300 feet, and it is hauling daily, at a speed of from six to eight miles per hour, some 500 tons per day. The time taken to make an all-round trip is about 14 minutes, as compared with 50 minutes when mule power was employed. The most stupendous set of electric mining plant in existence, so far as the writer knows, is now working at Big Bend Tunnel Camp, Butte County, California. A tunnel, 16ft. by 12ft. and $2\frac{1}{3}$ miles long, is cut from the Feather River through the mountain. A permanent dam is built across the river just below the head of the tunnel, by which the river is diverted from its channel and made to flow through the tunnel, thus drying up the bed of the river. A canal two miles long is constructed from the tail end of the tunnel, by which a fall of 300ft. is obtained. Here powerful Pelton waterwheels are fixed driving the dynamos (Edison's).

The working electromotive force is 1,000 volts, the conductors are double metallic, and extend a distance of 18 miles, delivering electricity at 14 different points in the circuit where power is required for winding, pumping, &c. Some 10 to 20 Sprague motors, varying from 5 to 50 horse-power, are worked by branch conductors from these various stations. The potential at the motors varies from 500 to 700 volts. It is apparent where water-power can be thus applied that the saving, when compared with the use of fuel, is very considerable, especially so in metal or diamond mining districts, where coal is expensive. The ease with which any power can be conveyed over hill and dale and into the intricacies of the mine—these are factors of no mean importance. It will be seen by this review of the more important applications of electricity to mining at present in existence how very little progress, comparatively speaking, has been made in this respect; and yet it is proving in every instance where it has been adopted a commercial success, and its application has invariably been extended. No doubt want of familiarity deters some engineers. They look upon electricity as a new idea, a something which cannot be explained, and as not to be relied upon when compared with steam, compressed air, water under pressure, and other well-known applications of power. The drawbacks and shortcomings of these are admitted, but yet they are preferred because of their certainty of action and known properties. Many look upon electricity as yet in a transition stage, but it is not so. The efficiency of the machines is now so great, the price so moderate, and men of such high standing and repute are now engaged in their development that there need be no fear or hesitancy. Electricity has passed beyond the range of theory and experiment. It is now a power in the world, and that power will increase mightily. The writer will be amply repaid if by the perusal of this *résumé* any of his fellows are induced to take up the matter for themselves. He is satisfied that under many conditions common in mine working electricity can and will be applied successfully and economically.

ELECTRO-CALORIMETRY.*

BY WILLIAM STROUD, D.SC., B.A., AND W. W. HALDANE GEE, B.SC.

Experiments have been continued, both at Owens College and the Yorkshire College, with the electrical method of measuring the specific heats of liquids, described at the B.A. Meeting at Manchester. The apparatus now adopted is shown in the figure. The calorimeters K and S are employed. They

* Abstract of a Paper read before the British Association meeting at Bath (Section A), September, 1888.

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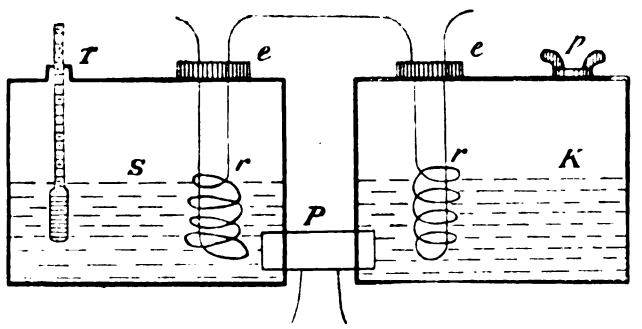
are cylindrical vessels of thin hard-rolled sheet brass. In each is a resistance coil, *r r*, of insulated platinised wire, fitted in the vessels by means of screw plugs, *e e*, of ebonite. The calorimeter S, called the standard, contains a thermometer, T, whilst K is the working vessel, provided with a screw plug, *p*, for the admission of a pipette, used in changing the quantity of liquid. Connecting S and K is a thermopile, P, made of iron and German silver wire All the fittings are by screws, with leather washers, or by India-rubber tubing, so that leakage and evaporation are entirely avoided. Instead of the compli cated methods formerly adopted for agitating the contents of the calorimeters the very simple and exceedingly effective one of shaking the vessels themselves has been employed. For this purpose the calorimeters are enclosed within a suitable box, so as to be easily rocked or shaken.



The authors discuss fully the ways of adjusting the rates of rise of temperature when electrically heated, so that these rates may be made as nearly as possible equal. This may be effected by shunting one of the coils or by adjusting the amount of liquids in the calorimeters. The latter method is found the best. For the elimination of small errors, methods analogous to those adopted in accurate weighings may be employed. Either a method of reversal or a method of substitution may be followed. The latter, by far the more preferable method of the two, is conducted as follows :—Equal quantities of water of mass *m* are at first placed in both calorimeters. After adjustment to equal temperatures the current is passed through the coils, thereby imparting to the calorimeters nearly equal quantities of heat. The difference of temperature $d\theta$ at the end of the period of heating is observed by the thermopile, and the total rise of temperature σ is also noted in the thermometers. Next the water in K is replaced by the liquid *m*, whose specific heat *d* is desired. This liquid should be approximately equal in thermal value to the water previously in K. A second electrical heating now enables the correspondiug quantities $d\theta'$, $d'\theta$, to be ascertained. It can then be shown that the formula $\sigma = \frac{m}{m_1}\left(1 + \frac{d\theta}{\theta} - \frac{d\theta'}{\theta'}\right)$ is applicable. There is no correction for cooling, for the capacities of the vessel, or for inequality in resistance of the coils. Since $d\theta/\theta + d\theta'/\theta'$ may be small, the method is not dependent for its accuracy on thermometers, and hence a much higher degree of accuracy is attainable than is possible by the older methods.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

Section II.—Electro-Magnetic Fields.

(Continued from page 629.)

130. *Intensity of Magnetisation.*—An important branch of research tending to further the improvement of electrical apparatus and machines as well as to offer one of the most interesting fields for experimental investigation is that in which the relation between magnetising force and the resulting magnetism in different metals is studied. We shall refer later to some of the work which has been accomplished in this direction, but must first concern ourselves with the necessary fundamental bases on which comparisons can be effected in the degree or extent or quantity of magnetism acquired by masses of iron or steel, differing in dimensions and shape, when subjected to the action of magnetic fields of given intensity.

The two fund mental bases of comparison may be stated as:

1. The magnetic moment acquired per unit volume of metal, and termed the "Intensity of Magnetisation" (denoted by the letter I).

2. The number of lines of force per square centimetre of sectional area, forced through the mass of the metal, and called the "Magnetic Induction" denoted by the letter B). These two quantities were written in old English letters ℑ and 𝔅 by Prof. Clerk Maxwell, and the student will find them frequently written so in writings on the subject.

We shall now consider the first of these means of comparison. The conception of the idea of "intensity of magnetisation" is essentially one in which the strength of pole or amount of "free magnetism" is thought of. That is to say, the extent of the magnetism in the mass is expressed or thought of with regard to the force of attraction or repulsion that can be exerted by its poles externally. The "action at a distance," or force exerted by a given pole strength, has been discussed already (para. 108), and it can be easily understood that we may have a number of bars of iron, of very different sizes, all of which exert the same external force, *i.e.*, have equal pole strengths, but in which the magnetism is distributed in very different proportions; or again, magnetised bars of similar size may have very different pole strengths. To effect comparisons, then, between the densities of magnetism—if one may so use the term—acquired by different bars, the pole strength is regarded as so much "free magnetism" distributed uniformly over the ends (shaded portions Fig. 110), and a comparison

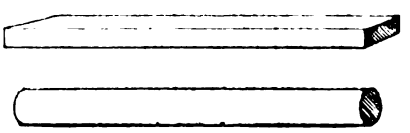


Fig. 110.

can then be made by finding for each bar what amount of free magnetism, or pole strength, exists at its ends *per square centimetre of sectional area.* This is termed the "intensity of magnetisation," or sometimes simply "magnetisation," and is obviously the same as magnetic moment per cubic centimetre. Take a bar 10 centimetres long and 2 square centimetres sectional area. If its pole strength is 1,000 C.-G.-S. units, the intensity of magnetisation is found by

$$\frac{\text{pole strength}}{\text{sectional area}} = \frac{1000}{2} = 500 \text{ C.-G.-S. units};$$

that is, for every square centimetre of end area there are 500 units of pole strength. It is evident that if we multiply both numerator and denominator of the above by the length, we have

$$\frac{\text{magnetic moment}}{\text{volume}},$$

which is, therefore, the same thing, and has the same value, and gives us the usual definition for the intensity of magnetisation, viz., the magnetic moment per unit volume (per cubic centimetre on the C.-G.-S. system). Obviously this is the more generalising definition, as it covers irregularity of sectional area. As an example of the comparison of magnets of the same size but of different pole strengths by their intensities of magnetisation we may take the two magnets already mentioned (para. 125, examples 3 and 4), which were found to have pole strengths of 554 and 527 C.G.S. units respectively. They were flat bars, measuring at the end 2·8 centimetres by 1·3 centimetre, and therefore of $2{\cdot}8 \times 1{\cdot}3 = 3{\cdot}64$ square centimetres sectional area, uniform throughout. Their intensities of magnetisation were therefore

$$\frac{554}{3{\cdot}64} = 152 \text{ C.-G.-S. units}$$

and

$$\frac{527}{3{\cdot}64} = 145 \quad \text{" "}$$

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The intensity of magnetisation reached when soft iron is subjected to powerful electro-magnetic fields may be very much higher than the above, even to values nine or ten times as high, although the above are average intensities ordinarily met with in new steel *permanent* magnets.

To further illustrate this method of comparison the following measurements taken with wrought and cast-iron bars are cited. A constant difference of potential of 42 volts was kept at the terminals of the magnetising coil (Fig. 111), which was

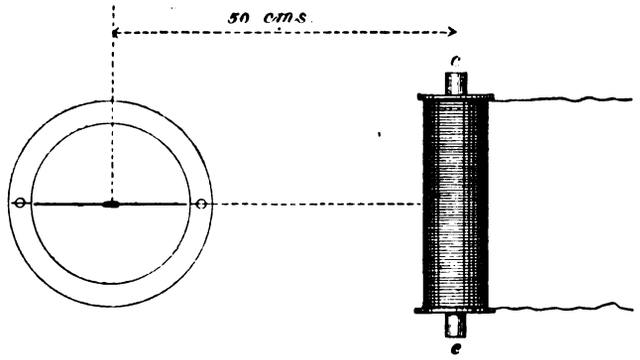

FIG. 111.

one of those previously described (para. 129, Fig. 109), the current, and therefore the magnetising force, being twice as much as that previously given for the two coils together under the same potential difference, viz.,

$$670 \times 2 = 1340 \text{ ampere-turns, approximately.}$$

We shall show in the next section on the magnetic fields of coils without cores, or solenoids, that the magnetising force expressed in C.-G.-S. units (lines of force per square centimetre) at the central cross section of a long solenoid of length l centimetres, and excited by a current C, in C.-G.-S. measure is equal to

$$\frac{4\pi C n}{l} \text{ C.-G.-S. units intensity of field,}$$

the length of the solenoid being great compared to its diameter, and forming a long narrow coil. We anticipate, however, for the purpose of showing the relation between ampere-turns and C.-G.-S. units of magnetising force. The C.-G.-S. unit is equal to 10 amperes, so that if x ampere-turns are equal to one C.-G.-S. unit we have

$$\frac{\text{ampere-turns}}{x} = \text{field in C.-G.-S. units,}$$

and therefore

$$\frac{10\,C n}{x} = \frac{4\pi C n}{l}$$

(C being in C.-G.-S. units on both sides of the equation),

whence

$$x = \frac{10\,l}{4\pi} = \frac{l}{1{\cdot}257},$$

and therefore

$$\text{field in C.-G.-S. units} = \frac{\text{ampere-turns}}{\text{length of coil (centimetres)}} \times 1{\cdot}257.$$

In the above example, therefore, which is a coil 18·5 centimetres in length, instead of 1,340 ampere-turns of magnetising force, we may put it

$$\frac{1340 \times 1{\cdot}257}{18{\cdot}5} = 91 \text{ C.-G.-S. units.}$$

The magnetising force is usually denoted by the letter H, or in Maxwell's notation by its old English form 𝔄.

It will be noticed that the electromagnet is placed, as previously described, for measuring the moment by the first method of Gauss (para. 125), the distance of its centre from that of the magnetometer needle being 50 centimetres. First of all, before putting any core in the coil, its own field with the current on was measured. This deflected the magnetometer 11 divisions, and therefore in the measurements of the moments of the cores this deflection was deducted from the readings. Three cylindrical cores similar to C C, Fig. 111, but of different dimensions, were tried, with the following results :—

Cores.	Length in cms. (l).	Diam. in cms (d).	Magnetometer deflection.	Moment in C.-G.-S. units (M).	Intensity of Magnetisation (I).
I. Wrought Iron	30·7	2·3	420	106,300	833
II. Ditto	25·9	1·9	280	67,210	881
III. Cast Iron ...	30·8	2·3	280	69,350	541

Here the dimensions of core differ, and therefore the magnetometer readings and calculated moments offer no basis of comparison as to the density of free magnetism acquired by each. This is seen notably in the last two cores, where the deflections are equal, and the moments not very widely different ; but the intensity of magnetisation, which forms the basis of comparison, shows one little more than half the other.

It may be of assistance to the student to see one of these examples worked out. Take the first :—

$$\tan \alpha = 4\,20 - {\cdot}11 = 4{\cdot}09$$

$$\text{Earth's field (H)} = {\cdot}18$$

$$r^3 = (50^2 + 15{\cdot}35^2)^{\frac{3}{2}}$$

and (*see* para. 125)

$$\text{Moment} = r^3 \text{H} \tan \alpha = 106{,}300 \text{ C.-G.-S. units,}$$

$$\text{sectional area} = \frac{\pi d^2}{4} = \frac{3{\cdot}1416 \times 2{\cdot}3^2}{4} = 4{\cdot}147 \text{ square cms.}$$

volume = area × length = 4·147 × 30·7 = 127·3 cubic centimetres, and Intensity of magnetisation

$$\text{I} = \frac{\text{moment}}{\text{volume}} = \frac{106{,}300}{127{\cdot}3} = 833 \text{ C.-G.-S. units.}$$

The low magnetisations obtained for the above-mentioned magnetising force are most probably due to the estimation of the number of turns of wire in the bobbin (para. 129) being too high. It was not wound specially for the purpose, and the exact length of wire and number of turns were not known. Further, no mechanical stress or blows were given to the iron while under the magnetising field, which would have increased the magnetisation acquired.

When the core is not of uniform sectional area, if its volume cannot readily be computed by direct measurement it may be determined for a large core by immersing it in water, and measuring the volume of water thereby displaced. Or, again, for a small core, such as a piece of iron wire, it may be found by weighing in air and then in water, the ratio of the weight in air to the loss of weight in water being the specific gravity, and, in the C.-G.-S. system the weight of 1 cubic centimetre of water at 4 degrees C. being 1 gramme, we have

$$\text{volume in cubic centimetres} = \frac{\text{weight (in air) in grammes}}{\text{specific gravity}}.$$

Substituting for specific gravity, we have

volume in cubic centimetres = loss of weight in water (in grammes).

The determination of the intensity of magnetisation is not confined to methods like the above, which have for their *modus operandi* the measurement of the external field of force of the magnetised bar, but may be calculated from the value of the magnetic induction B when that has been determined by a different method (presently to be detailed) and the magnetising force can be accurately computed.

The importance of the subject of electro-magnetism as regards our knowledge of iron and steel in various stages of magnetisation, may be conceived when it is borne in mind that most of the men whose names are most honoured amongst us, as much in some for their high scientific attainments as in others for their practical experience, insight, and intuition, have given to this field of research their careful thought and investigation, and that what we know and make use of to-day is the result of incessant experimental investigation extending over, in many cases, years of patient toil. It will be the aim of the writer to point out some of the most salient results arrived at, and to endeavour to render clear to the student the terms used in connection with this subject.

(To be continued.)

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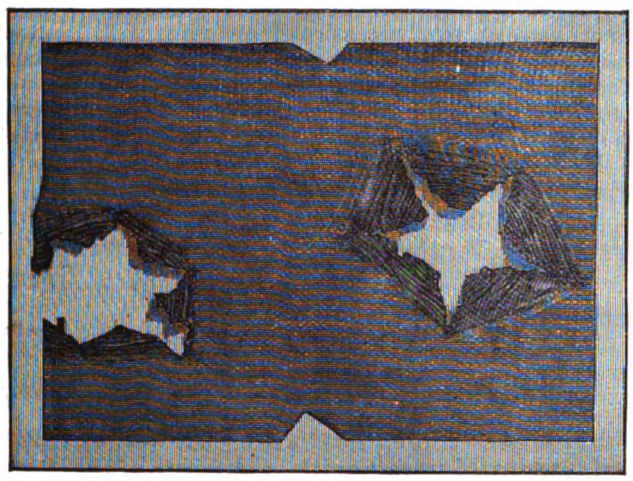
A DAMAGED LIGHTNING PROTECTOR.

The accompanying figure, taken from *La Lumière Electrique*, is a full-size representation of the sheet of paraffined paper which is placed between the line and earth plates in lightning guards of the gutta-percha sheet pattern. During the storms of July last the paper of the lightning guard at the Gréasque (Bouches-du-Rhône) office was perforated as shown. The perforations were nearly 30mm. across, one being very much like



a star-fish, while the other was not so well defined. On the plates there were blackened facsimiles of the rents, and in the centre of each black stain there was a bright spot formed by a drop of melted metal. Under normal conditions the paper is pierced only by one or two holes, such as would be made by a pin, these holes being surrounded by a black or a red aureola about 3mm. or 5mm. in diameter.

ELECTRIC TRACTION IN PARIS.

The following is a brief account of the electric tramway constructed at Paris by MM. Philippart Frères, and which runs between the Place de l'Étoile and the Porte Maillot :—

The current is furnished by a battery of 144 special twin-plate Faure-Sellon-Volckmar accumulators, having a capacity of 150 ampere-hours, with a 25-ampere discharge. Taking the mean useful voltage per cell at 1·8 volt, the total capacity of the battery is 37,000 watt-hours, or 50 horse-power-hours—that is to say, 40 horse-power-hours are practically available, permitting a 6-hour service without recharging. The accumulators are placed in the four recesses formed by the corners of the car, the 36 cells in each group being arranged in three tiers. This vertical disposition has several drawbacks : it adds to the length of the car, renders the inspection and manipulation of the cells very difficult, and dangerously raises the centre of gravity. In the new cars the cells will probably be

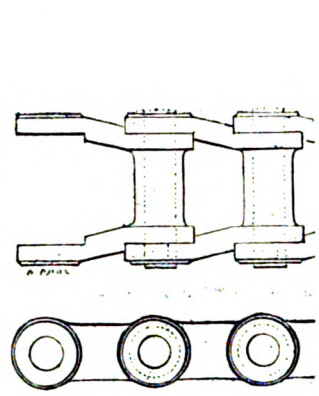


Fig. 2.

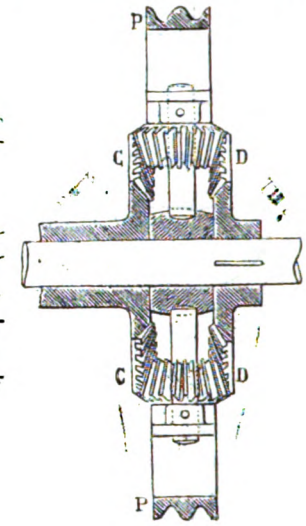
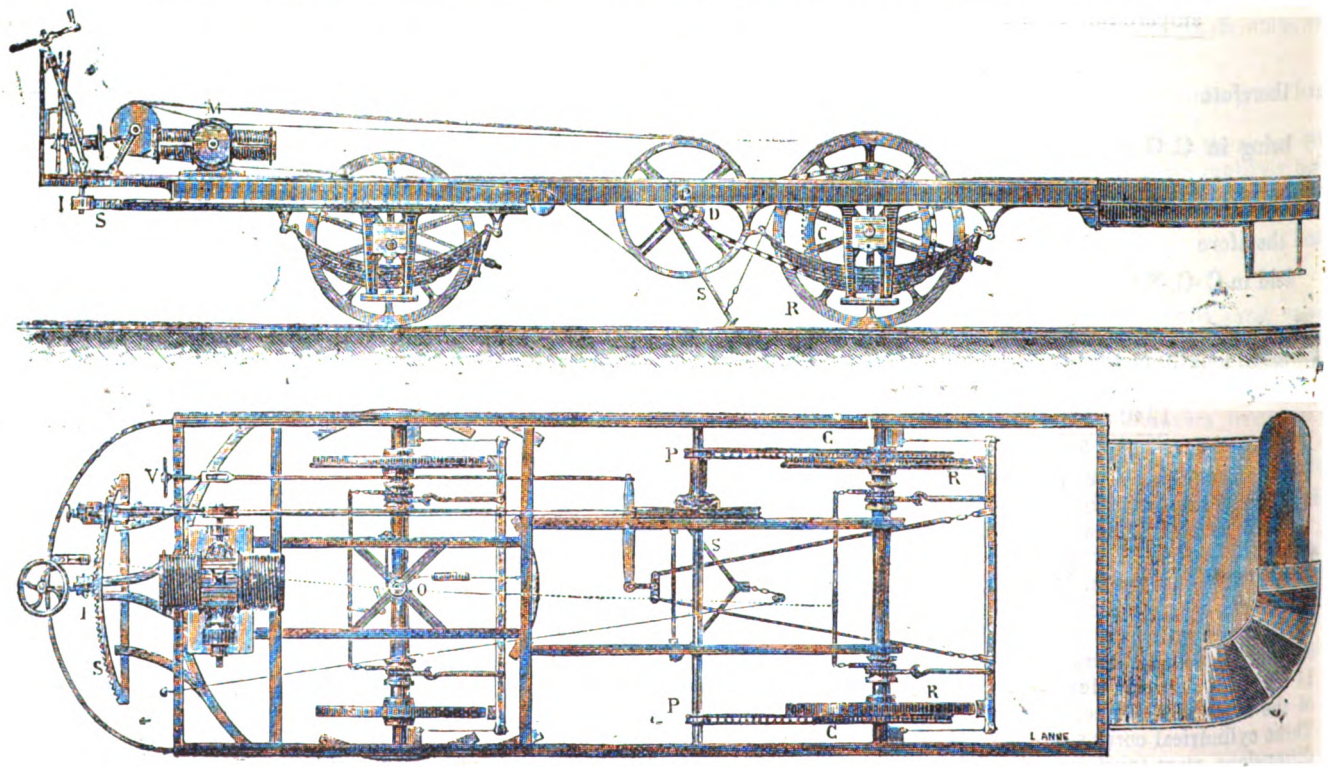


Fig. 3.

arranged in two rows under the seats. The total weight of a car with 50 passengers is about 9 tons.

Car	3·5 tons.
Accumulators	1·5 ,,
Machinery	·75 ,,
Passengers	3·5 ,,
Total	9·25 tons.

The electric motor M (Fig. 1) is a dynamo machine of the well-known Siemens type, running at from 1,000 to 1,200 revolutions per minute. This machine drives a countershaft, P, by means of a Raffard coupling. The motion of the pulley on the shaft P is transmitted to the driving wheels R by means of two Gall chains C C (shown in full in Fig. 2). The two wheels R are independent, each being driven by a special pinion, P. When running on the straight,



Electric Traction in Paris.—Fig. 1.

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the two pinions P, and the two wheels R, which they actuate, run at the same speed, but when going round curves, owing to the differential arrangement shown in Fig. 3, the two angle wheels, C and D, can revolve at different speeds. The turning of curves is also greatly facilitated by the rotation of the front wheels round a vertical axis, O, a movement which is governed by the wheel V, the pinion I and the sector S. Thanks to these devices curves of the smallest radius are easily turned.

For purposes of alteration of speed and starting, the accumulators are divided into four groups. On starting the four groups are in parallel, and there is an available E.M.F. of about 70 volts. When running at full speed all the cells are in series. The sections can also be grouped by the turning of a lever, two in series and two in parallel, as well as three in series and the fourth section in parallel with these. The car is of course lighted by electricity, six 10 candle-power incandescent lamps being run off the accumulators.

THE TELEPHONE EXCHANGE OF NEW YORK CITY.*

BY F. F. SHERWOOD.

The Metropolitan Telephone and Telegraph Company has 7,300 subscribers, operated by eleven exchanges, which are furnished with the following systems:—John, Thirty-ninth, and Harlem Exchanges, Western Electric Multiple; Pearl, New, Nassau, Murray, and Twenty-first-street Exchanges use the Chinnock system; Spring-street the improved Chinnock system, adapted by Mr. Jos. P. Davis, formerly general manager of the company; Fulton and Beaver-street Exchanges use the Law system.

John-street Exchange has 799 subscribers, and 40 trunks distributed among them. Thirty-ninth-street Exchange has 1,108 subscribers and 39 trunks, and Harlem has 374 subscribers but no trunks, terminating outside of the trunk sections. The reason that we have trunks at the two former exchanges among the subscribers is to connect the system with points not accessible or convenient to reach with trunk-calling wires.

To operate the boards during the busiest hours requires the following number of operators:—John-street, 14 operators, 57 subscribers per operator; Thirty-ninth-street, 21 operators, 52 subscribers per operator; Harlem, 6 operators, 62 subscribers per operator. But counting the trunk wires according to the business done over the average subscriber's wire, will be equal to adding 73 subscribers to John-street and 70 to Thirty-ninth-street, thus increasing the average at John to 62 and at Thirty-ninth to 56. The reason we have a greater average at John and Harlem is that they are situated in the centre of the business district, while Thirty-ninth-street, being a manufacturing district, a larger portion of the business is trunk.

We are using what we term trunk calling wires between the various exchanges, one terminating at John-street and the other at Thirty-ninth-street, for calling all trunk connections to the exchanges named.

There is an average of 3,000 connections per day called over each of these wires, and as each connection is ordered off again, the number of orders is increased to 6,000. All this work is done by two operators at each of these exchanges, and could be done by one if the whole section of the board was within her reach. We divide the trunks, one half being used for receiving and the other half for sending. Those we receive on are not multiple through the board, but end in cords, and stand open at all times except when in use. When a number is called on any given trunk, the connection is immediately made, and is ready for ringing, this being done by the office calling, as we make the office where the call originates responsible for the connection. If the number called is busy, we throw battery on the trunk, dropping the annunciator as a signal. We find this system very advantageous, as there is no delay in calling or clearing trunk connections, and the service is made prompt, as shown by ten trunk connections made and conversation started with subscribers in six and one-half minutes.

At the exchanges which have the Chinnock system, each operator at the cases answers 100 subscribers and completes all local connections, using a local calling wire and a set of local trunks which connect all the cases together. The calls for trunk connections are written on slips of paper, and passed to the operators who control the trunks to the various exchanges. Ten trunk connections were made and conversation started through this system in twelve and one-half minutes.

The Fulton and Beaver-street Exchanges have, together, 410 subscribers, and are operated by nine operators and one chief operator. All local connections are completed by the operator who receives the call over the calling wire, and trunk connections are completed by the operator at the exchange for which the subscriber calls. The Law operator simply connects the subscriber's wire with the trunk wire, and rings down the annunciator, when the operator answers and ascertains from the subscriber the number wanted. The trunk connections made through the Law system were completed and conversations started in four and one-quarter minutes, ten local connections in two and three-quarter minutes.

The number of trunk wires connecting the exchanges in New York City is 532, and average 60 connections per day, and, as this average could be increased to 70 per day, the number of subscribers could be increased 600 without increasing the trunk facilities. To other exchanges we have 187 trunks, and with those the service is quite satisfactory, and especially so with the new Brooklyn Exchange of the New York and New Jersey Telephone Company, as the service is prompt and satisfactory in every particular.

By the consolidation of the seven exchanges in the new exchange at 18, Cortlandt-street, 206 trunks which connect those exchanges will be abolished, and the number of trunks to all other exchanges may be reduced, for the total number divided among the seven exchanges will not be required when they are all accessible to an operator in the new exchange.

The new switch-board at 18, Cortlandt-street, will soon be completed, and the consolidation of the seven exchanges made. It is wired for 5,100 subscribers' and 900 trunk wires. The subscribers' operators will attend to 50 or 75 wires, according to the business done at different sections of the board. Trunk calling circuits to the other exchanges will be in operation, each receiving trunk operator attending to 50 wires. The local battery of each operator's outfit will be two cells of storage battery, one to be in use during the day, and the other at night. The one in use during the day will be charged at night from the main storage battery, and the night battery will be charged from a dynamo during the day. All wires will approach the exchange through the underground system, the underground cables terminating in the cellar. From there they will be carried to the distributing board in the exchange by 334 conductor cables.

The consolidation of the several exchanges will be beneficial in many respects. The service will be improved, the great value of "sent" trunk business will be reduced from 20,000 to 8,000 connections, and the running expenses of the exchanges will be reduced about $2,700 per month.

1,527 miles of wires are now underground, and 2,784 separate wires are altogether or in part so working, most of which give general satisfaction. The underground facilities are rapidly increasing. 18 miles of 102 conductor cable running from 18, Cortlandt-street to various points are now completed, and will be used when the exchanges are consolidated. Eight and three-quarter miles of the same cable will soon be run for trunks from 18, Cortlandt-street to the other exchanges, thereby making the trunk service from this exchange entirely underground, and doing away with the delays and expense of crossed and broken trunks, and will do away with the danger of crosses with wires carrying a heavy current, which proved so costly in connection with the burning of the Thirty-ninth-street Exchange, on which a few remarks may be of interest.

On May 23 the Thirty-ninth-street Exchange was set on fire by a cross with a wire carrying a heavy current, and one and one-half sections of the board was burned out. The work of restoring the Western Electrical Multiple Board after it has been burned and saturated with water can only be appreciated by those who have had it to do. In order to straighten out the wires it was necessary to make 1,260,000 tests, to splice 9,600 broken wires, to replace 16 cables which were destroyed from the switch-board to the cupola, and dry out the saturated portion of the board. The work of getting the lines in complete working order was delayed by the accumulation of line trouble while the troublemen were working in the exchange, but the switch-board and all the lines were in complete order two weeks from the date of the fire.

* Paper read before the Telephone Convention in New York.

UNIVERSITY COLLEGE, LONDON: THE SCIENCE SYLLABUS.

We have received a copy of the syllabus of University College, from which we extract the following information relating to the electrical work in the Faculty of Science. Throughout the session Dr. A. H. Fison lectures to a junior class on "Experimental Physics," the following being the syllabus of the lectures on "Electricity and Magnetism:"—

MAGNETISM.—Characteristic properties of magnets. Magnetic substances; properties of iron and steel. Magnetic induction. Methods of magnetisation. Law of magnetic attraction and repulsion. Comparison of magnetic moments. Terrestrial magnetism.

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ELECTRICITY.—(*a*) *Statical.* Conditions under which electrical effects are produced. Positive and negative electricity. Conduction and insulation. Law of electrical force. Induction; potential; capacity. Disruptive discharge.

(*b*) *Dynamical.* Conditions for the production of continuous electric currents. Galvanic and thermo-electric batteries. Electromotive force; strength of current; resistance. Heating and chemical effects of currents. Mutual forces between currents and magnets, and between currents and currents. Magneto-electric and volta-electric induction.

Prof. Carey Foster, F.R.S., and Dr. Fison also lecture to the Senior class on the same subjects.

The lectures in this class include the elementary mathematical theories of the chief branches of physics, and the discussion of the methods employed and results obtained in the quantitative study of physical phenomena.

The syllabus includes the following:—

MAGNETISM.—Quantitative study of magnetic phenomena.

ELECTRICITY.—Methods of measuring the most important electrical magnitudes, as Quantity, Potential Capacity, Specific Inductive Capacity; Electromotive Force, Strength of Current, Resistance; Coefficients of Induction—and discussion of their mutual relations.

In the department of Electrical Technology, lectures are delivered by Prof. J. A. Fleming, M.A., D.Sc. This course is intended as a supplement to the courses of physics and engineering, to provide for engineering students and others instruction in the subject of applied electricity, a department of technology of rapidly increasing importance. The lectures will be supplemented by visits to various practical works under the guidance of the Professor. The course will consist of about twenty-one lectures, and be arranged as follows:—

First Term.—Faraday's researches on electro-dynamic induction. The theory of electro-magnetic induction. The theory of the dynamo and of dynamo-electric machinery generally. Production of electric currents for purposes of electric lighting and locomotion. Direct and alternate current machines. Designing of dynamos for various purposes. Ship lighting. Isolated lighting. Central station lighting.

Second Term.—Distribution of electricity. Systems of underground and overhead conductors. Distribution by secondary generators. Arc and incandescent lamps. Electrical measurements. Electric photometry. Electric meters. Dynamo-electric motors. Transmission of power. Electric cars.

Third Term.—Primary and secondary batteries. Electrical distribution by accumulators. Electro-deposition of metals. Electro-fusion and metallurgy. Telephones and telegraphs. Electric bells, and recent applications of electricity.

The electro-technical laboratory is provided with a gas engine, dynamo, secondary batteries, and appliances for testing arc and incandescent lamps, and carrying out other practical electrical work. Students who have attended the lecture course, or who have obtained some preliminary acquaintance with the subject, can thus receive practical instruction in the various testing operations requisite in electrical engineering, and take part in the management of the electric lighting plant. The course comprises the testing of arc and glow lamps, measurements of various kinds, the calibration of electrical instruments, and the testing of electrical materials.

BOOKS, &c., RECEIVED.

"Bell's Asbestos Company's New Catalogue and Price List."

"Naval Reserves, Training, and Matériel." (Published by the Office of Naval Intelligence, Washington, June, 1888.)

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *September 22nd*, 1888.

Our Navy department has just issued a Red Book on Naval Reserves, training and material, which contains much matter of interest to electricians and electrical engineers. As you are doubtless aware, one of the means hit upon for spending the large surplus revenue of the country has been the rebuilding and reorganisation of the United States Navy, and it was about time that the work was taken in hand. Several new ships have recently been launched, and several others are in course of construction or are soon to be put in hand. Under these circumstances, it was eminently desirable that all the latest information from abroad as to the best forms of equipment, &c., should be obtained. This volume, which is No. 7 of the Annual General Information Series, is the result of inquiries in certain special fields, and it is a valuable contribution to the science of naval warfare. The part most interesting to electricians is comprised in Chapter V., specially prepared by Lieutenant J. B. Murdock, and dealing exclusively with the application of electricity on shipboard. The chapter discusses various ways in which electricity may be utilised in the reconstructed navy, and naturally abundant reference is made to English practice in this respect, the ships cited being the "Benbow," "Hero," "Camperdown," "Howe," and "Archer." Lieutenant Murdock calls attention to the various good points required in a ship electric lighting plant, such as compactness, simplicity, and efficiency, and under these various heads he has much to say that is interesting. He pronounces in favour of a slow-speed, compound dynamo, directly coupled to its engine. Such plants, he remarks, are almost universal in European navies, and seem better adapted by strength, simplicity, compactness, and general utility, to the conditions of naval use than anything else yet devised. He adds, however, that no American firm has as yet constructed slow-speed dynamos for the trade, although a few have been made for special purposes at a heavy expense. He furnishes a suggestive table to illustrate the difference at present existing between American and European dynamos on the basis of watt output per pound of dynamo. It is noticeable that although there are several European machines running at the rate of over 350 to 550 revolutions, there is not a single good American machine below 550. The American machine of lowest speed, the Bradley, has a speed of 550 revolutions, weighs 1,025lb., and gives the high output of 9·75 watts per pound. This is equalled in one case throughout the entire series, namely, by the Victoria H 3 machine, which, at a speed of 350 revolutions, and a weight of 3,700lb., gives 9·7 watts per pound. The Bradley is a multipolar machine. Coming to the question of engines, Lieut. Murdock bestows special commendation on the Westinghouse, as the best of the class of high-speed, double cylinder, single acting engines for all work where durability of plant is combined with lightness and economy of floor-space. Lieut. Murdock's chapter is also devoted to a consideration of the various problems connected with electric light wiring on shipboard, signalling, torpedo service, the use of storage batteries, and the use of electric motors. He is quite enthusiastic in regard to the excellent qualities of motors. In our own cruisers, he says, the first impression one receives is that of unnecessary complexity and confusion due to the large number of small engines distributed all over the vessels. The result of this use of steam is that the ship is a labyrinth of steam, exhaust and circulating pipes, which are always getting out of order, and which require constant care. Over and against the disadvantages of the use of steam he sets the many excellent qualities of the electric motor. He notes that for equal power the electric motor is smaller than almost any steam engine, is more efficient, involves less waste in transmission, has smaller mains, which are by no means liable to injury, and admits of very rapid repairs. In short, he holds the electric motor to be the most efficient, compact, noiseless, and simple vehicle for the transmission of energy that is known, and such being the case it is in its most rightful sphere on board ship. In this connection it may be mentioned that our new man-of-war "Chicago" is to have one of its 8in. guns operated by electric motor, and if this proves satisfactory, the use of motors will certainly be extended to others of the new vessels.

Some little while ago I sent you a few details as to the Craig Automatic Telegraph System which has been put on exhibition at the National Capitol. I said at the time that there would probably be some effort made to induce Congress to buy this system, as the nucleus of a Government telegraph service. Senator Blair has now taken the first step in this direction, by offering a resolution which provides for an examination of the system. He explained that if it was all that was claimed for

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it, his idea was that it should be secured for the benefit of the people. He characterised the Western Union Company as a gigantic monopoly, owning practically every useful telegraph invention, and almost every telegraph line in the country. Against such a monopoly no redress was to be had, and the only hope, outside of the purchase of the Western Union plant at an extravagant valuation, lay in the introduction of such a system as the Craig, which could supplant the other at a comparatively slight expense. I do not think that Mr. Blair's ideas are likely to make any considerable impression on his colleagues or the country at large. In fact, most Americans, even those in favour of protection, would rather see free trade resorted to, even if a reduction of the surplus follow, than agree to such a remarkable method of using the surplus to put the Government into competition with private enterprise, and against property and capital which it has covenanted to protect. The Western Union Company is not an institution which is altogether lovely and of good repute; in fact, it has a reputation, in many circles, for ways that are dark and tricks that are mean, but it is yet to be shown that either the electrical profession or the public at large would prefer a Government monopoly of the telegraph, with all its new elements of political bribery, jobbery, intrigue, and corruption. As far as we are informed in this country, the Government telegraphs in England are admirably managed, and by clean-handed and able administrators; and yet such figures as are obtainable here show that the system barely meets its working expenses, failing altogether to pay any return on the investment which the country made in its purchase.

A good deal of interest is being manifested here in the subject of electric boats, and I should not be at all surprised to see a number of such craft afloat in our waters next spring. Attention has just been called to a novel electrical boat, which has been running very successfully this summer in Pennsylvania. She is in the form of a catamaran, and is equipped with storage batteries charged from the lighting plant of the yacht of her owner. She is very steady in water, and offers little resistance in motion, so that a small charge and a small motor are sufficient to propel her some distance at the rate of four miles an hour. The only trouble that hinders the introduction of electric boats is the want of charging stations, otherwise they would be found everywhere; but now that so many hotels at our seaside and other resorts are putting in electric light plants, this difficulty will be overcome.

Electric railways are still on the boom, and there is no hint from any quarter as to the time when they will cease to be so. The Sprague Company has just been calling attention, with not unjustifiable pride, to the fact that, although it was not turning a single wheel last February, it now has about a dozen roads running, and has just closed its 26th contract. The various contracts it has must certainly reach a total of not less than one or two million dollars. The Thomson-Houston Company also report themselves very busy with a score of roads in operation, and others building in New England, the south and the west. The Julien Company has just started off the first of its ten storage cars built for Mr. Vanderbilt's Fourth Avenue road in this city. These cars are 18ft. long, and are superb in all their fittings and appointments. The large windows are of bevelled plate glass, all the panels of the doors and the sides are of elaborate carved wood, and the cushions and curtains are such as one expects to find only in a Pullman palace car. In fact, the cars are altogether suggestive of first-class railway travelling, and the main criticism offered on them by electrical engineers, I am told, is that they are unnecessarily heavy for street railway work. Still, amidst so much that is flimsy and shoddy in construction, they err in the right direction, and I have no doubt that the succeeding cars, as they are put into service, will be lighter, though not less luxurious, it being understood to be Mr. Vanderbilt's intention to have the service on this line as pleasant and comfortable as it can possibly be made. The results obtained on the Fourth Avenue road are being watched by the citizens generally with the greatest interest, and one hears very little but good wishes on every hand for the success of the enterprise.

Electrical journalism, like everything else connected with electricity in this country, continues to show signs of development. The last evidence of growth is the issuance, in Kansas City, of a new journal called *The Electro Mechanic*. This makes the second electrical publication in the West. The *Mechanic* is a monthly of 20 pages, and devotes special attention to the commercial side of electricity. The appearance of this paper impresses very forcibly on the mind the wonderful growth of Kansas City, which a few years ago was no larger than a fair-sized village, but is now in wealth, population and commerce on terms of rivalry even with Chicago. It has an extraordinarily large number of telephone subscribers, is a large receiving and distributing point for telegraphs, and has a remarkably fine electric light service. The arc lighting there has been done with the Thomson-Houston system by Mr. E. R Weeks, vice-president of the National Light Association, and one of the most thorough and efficient men in the profession. At the present time Mr. Weeks is busy over the construction of a large incandescent plant which is to supply Kansas City with some 30,000 lights, and upon which $150,000 or $200,000 will be spent at the outset. It must, by the way, be noted as somewhat significant of the strength of the arguments still made for the continuous current that the Edison system should have been adopted for very large central stations, not only in Kansas City, but in Minneapolis, one of the leading North-West cities.

The Keely motor once more fills the public eye, and empties the pockets of its shareholders. There is now a quarrel amongst some of those interested as to whether Mr. Keely shall or shall not divulge his secret. The case came up in Philadelphia last week, where a gentleman owning about half the Keely stock went into court to get a writ of attachment for Keely's arrest, on the ground that the inventor had not obeyed the order of the court made on the 7th April, to the effect that he must show the principle of his machine within thirty days. The court declined to grant a writ, and has ordered that experts shall meet at Keely's workshop and report as to what they see or can find out. The way in which this matter drags along is truly absurd. It will be remembered that one of Keely's latest dodges was to claim that he had some electrical features of importance embodied in his apparatus; but all the electricians who have had an opportunity of examining the machine characterise the whole business as a rank swindle. Most people have been of that opinion for a long time, and the course of events only strengthens the general conviction on the subject.

CORRESPONDENCE.

MAGNETISATION OF STEEL BY LEYDEN JAR DISCHARGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Can you insert the enclosed important letter from Prof. Ewing in this week's issue?

I feel sure he has hit on the solution of the difficulty. I had temporarily forgotten the fact, but now remember that the oscillations of a spark were actually observed by Feddersen to be of gradually lengthening period, and in connection with this important suggestion of Prof. Ewing's the accompanying portion of a Paper of mine in the *Philosophical Magazine* for November, 1867, may be of sufficient interest to quote:—

"*Note added October* 14, 1876.

"Since the above was in print I have seen a paper of Sir William Thomson's in the *Philosophical Magazine* for June, 1853, 'On Transient Electric Currents,' from which I gather that Weber had already applied his electrodynamometer to the investigation of transient currents—in which, moreover, I find that Thomson predicted the experiment of Dr. Feddersen, mentioned above (§ 3 and footnote, p. 355), almost exactly, and calculated the value of every oscillation in a discharge. It is also shown that all the oscillations ought to occur at equal intervals of time, whatever be the resistance ρ of the discharging circuit, provided only that it remains constant The interval is not, indeed, the simple harmonic semiperiod

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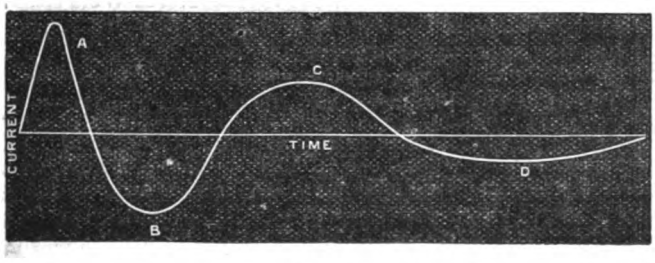
$\frac{\pi}{\sqrt{(n\kappa)}}$, but it is $\frac{A\pi}{\sqrt{(A n \kappa - \frac{1}{4}\rho^2)}}$, A being a constant which I do not yet understand, but which Thomson calls 'the electrodynamic capacity of the discharger.' I imagine, therefore, that the increasing intervals actually observed were due to the resistance of the air, across which the discharge took place, increasing as the strength and heat of the successive sparks diminished."

The constant "A" which I mention as then not understanding is now very familiar to everybody as the coefficient of self-induction L.—Yours, &c., OLIVER J. LODGE.

Victoria College, Liverpool, October 2, 1888.

"DEAR LODGE: I see in the report of the lightning rod discussion (which I was very sorry not to be able to attend) that you referred to the difficulty there is in seeing how an oscillatory current can leave permanent magnetic effects in an iron conductor or in neighbouring iron, and Lord Rayleigh spoke of experiments showing that when a Leyden jar is discharged through a helix with a steel bar inside the bar may be magnetised *in cylindrical layers* with opposite directions of magnetisation at different distances from the surface. Does not this suggest oscillations in which the period lengthens while the amplitude decays?



"Current A is so transient that its effects are extremely superficial. The inner layers are protected by induced currents in the iron (as Lord Rayleigh remarked), but it magnetises the surface layer strongly. Current B is not strong enough to reverse the effect of A on the outermost layer, but it is slow enough to magnetise a layer that lies a little nearer the axis. C, again, is too weak to reverse the effect of B, but its effects reach deeper still, and so on.—Yours, &c.,

"J. A. EWING.

"University College, Dundee, September 29, 1888."

LIGHTNING CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I demur to Prof. Oliver Lodge's second statement made in the Practical camp, viz., "Leyden jar discharges have nothing oscillatory or alternating about them, or at least the existence of such alternations is an unproved assumption."

I do not deny the existence of oscillations in a Leyden jar discharge. Under certain circumstances they must occur; but I question whether these circumstances ever can occur in a lightning flash, or that it is proved that when they do occur in a Leyden jar they are of the very great frequency assumed in the Theoretical camp. I admit also oscillations in a lightning flash, but of small frequency, such as can be distinguished by a wagging head, and not such as would be due to the presence of that which has been defined by a waggish head to be "impudence."

When Prof. Lodge wrote the following sentence, "Electric charges splash about in a struck mass of metal, as does the sea during an earthquake or when a mountain top drops into it," I wish he had added "and as does a theorist when he takes a header into a bath of cold practice."—Yours, &c.,

W. H. PREECE.

THE FINSBURY TECHNICAL COLLEGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to your note as to the probable placing of restrictions upon the entries to the evening classes in the various electrical subjects at the Finsbury Technical College, will you allow me to allay your apprehensions by informing you that nothing is further from our intentions than to impose an examination on paper as a test of admission. What we shall be driven to do if the present influx of students continues, will be to restrict admissions to the following classes of persons: (*a*) Those who are actually employed in the electrical industries; (*b*) those who have already attended some systematic course at such institutions as the Birkbeck, the City of London College, or the various Polytechnic Institutions, and now desire to go on to our more practical and more specialised work. If we do not so restrict our unmbers we fear that the laboratories will be overcrowded with mere amateurs and hunters after examination prizes. I may add that in the present session these restrictions are not likely to be applied to the laboratory class for practical electro plating and typing, in which the entries as yet are few.—Yours, &c.,

October 1st, 1888. SILVANUS P. THOMPSON.

THE ANGLO-AMERICAN TELEGRAPH COMPANY'S 1869 CABLE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I beg to inform you that the cable laid in 1869, which was broken at 135 miles from St. Pierre, in shallow water, on the 23rd ult., was successfully repaired on the 30th by the company's s.s. Minia.

A statement having appeared in many of the London papers to the effect that an entirely new cable could have been laid for the amount which has been expended in its repair and renewal, I should be much obliged if you will kindly correct this statement by publishing the following facts:—

The money expended in the repair and renewal of the Brest-St. Pierre cable laid in 1869 (during nineteen years) does not amount to *one-third* of the capital necessary to lay a new cable, even at the present low prices, and that more than *two-thirds* of the entire cable has never been disturbed since the day it was laid.—Yours, &c.,

H. WEAVER, Managing Director.

1st October, 1888.

THE MAXIM-WESTON ELECTRIC COMPANY.

CIRCULAR ISSUED BY MR. WATT.

Mr. Hugh Watt, M.P., has issued a circular to the shareholders of the Maxim-Weston Electric Company (Limited), in which he says:—

"Gentlemen: Having been identified with the Maxim-Weston Electric Company (Limited) for nearly five years, I cannot allow the misstatements made by the present Board to pass unnoticed. I would also take the opportunity of explaining my reasons for having filed a petition to wind up the Company.

"At the first meeting of the new Directors, which I attended, notwithstanding the amicable arrangement whereby I agreed not to oppose the appointment of the persons in question, provided they were acceptable to a general meeting, no sooner had I entered the room than a hostile demonstration was made by several of these persons. Mr. John Marks proposed as chairman Mr. Louis Swaby, who in turn proposed Mr. John Marks. I protested on the grounds that I had been appointed Chairman by the shareholders more than four years ago, and that my position had been recognised by the persons present so late as a few days previously at a general meeting of the shareholders. I maintained that an appointment of the shareholders could not be set aside by any committee or Board of Directors; but as they insisted upon appointing Mr. John Marks I tendered my protest and withdrew.

"I was in attendance at every Board meeting subsequently held, but owing to my being unable to induce the Board to listen to my statements or to consider the urgent financial requirements of the Company, and owing also to the violent scenes which took place at every Board meeting, I found it impossible to co-operate, much as I desired it, with my new colleagues. At five p.m. on or about August 1, after I had left for the day, Mr. Louis Swaby removed from the registered offices the minute books, the cash books, and ledgers of the Company. This was reported to me next morning, when I stated that, being unable to exhibit to shareholders, in terms of the Act, the books of the Company, I would be no party to the other books or papers remaining at my address. I consequently instructed the secretary to take to the works in a cab all the more important books, and I asked Mr. Gribble to get a van and remove to the works every book and paper belonging to the Company. The secretary was instructed by me to request Mr. Tough to place the more important

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books under lock and key, while Mr. Gribble was instructed to accompany the van and deposit the other books and papers according to the works manager's instructions. A large number of the papers taken by Mr. Gribble consisted of old 'Electric Light and Power Generator Company' wages sheets, and other papers of no value, but I cannot believe that this person, who was for nearly seven years in my employ, and is now the chief clerk to the Company, engaged by the present secretary, could have been guilty of what is insinuated in the Directors' report to have been done by my instructions. The statement with regard to payment of the staff is incorrect, as the total sum I received was only about £2 per week in excess of transfer fees.

"I repeat that throughout I told the Directors that every information in my possession, or that of the staff, was at their disposal, and I reiterated this on August 4 to Messrs. Marks, Couchman, Hildyard, and Swaby. I was, however, unable to give all the information I desired, not only as an official of the Company for five years, but as then the largest shareholder in the Company, and having a large number of friends deeply interested; for, I regret to say, as pointed out by letter to Mr. John Marks, dated August 4, the present Directors declined to listen to me, and, as stated in that letter, 'In view of the unseemly scenes which again took place yesterday, and the violent and improper language used at the Board meeting,' I sent in my formal resignation 'as Chairman of the Company, and also as a Director from to-day.'

"As I have already stated, my Chairmanship had been disputed as far back as July 19, and I had not been allowed to act as Chairman.

"A similar letter to this, complaining of the conduct of the Directors, was sent to me by Messrs. Nash, Field, and Withers, who were appointed solicitors to the Company by the new Board, without either my knowledge or consent. That firm was employed by the new Directors to ascertain the validity of their election as Directors, and right to act without a confirmatory meeting, and the occasion on which they state they were refused admittance was by an arrangement with that firm, who gave an undertaking that the new Directors would not attempt to act in such capacity until the opinion of counsel had been ascertained as to the validity or otherwise of their election.

"I deny absolutely that the books or affairs of the Company were in any confusion other than that created by the committee and afterwards the new Board, who were in the habit of sitting from about 11 a.m. till 6 p.m., rummaging over and leaving in the utmost confusion the entire books of the Company, and doing everything and saying everything but attending to the affairs of the Company.

"One of the first acts of the new Board was to dismiss nearly the entire staff at the Company's works, which had been carefully collected by me over a period of years, and was, without exception, the most efficient electrical staff in London. I am not disposed to trouble the shareholders with contradicting in detail the statements contained in the Directors' report, or in the circular addressed to them by Messrs. Boyce and Ramsay. The statements with regard to the balance-sheet of 1887 are, in fact, those, only varying in detail, given by me at the ordinary general meeting of the Company held in March last. It will be in the recollection of shareholders that after the most exhaustive explanation at a meeting of nearly three hours' duration, the report and accounts were unanimously passed. If the Directors were conversant with the Articles of Association, they would find that it is not now competent, under Clause 95, to reopen the balance-sheet in question, except as regards any error discovered within three months after passing of the accounts. Waiving the question of three months, no error has been discovered to date.

"I should wish to know how it is, in detailing the expenditure upon the Watt plant, that Messrs. Boyce and Ramsay have omitted to state that a very large amount of Watt plant has been manufactured, largely exceeding in value the expenses detailed, notwithstanding the fact that the patterns and expenses consequent on making the first machines are largely in excess of the subsequent expenditure necessary for their manufacture. The new Directors will, perhaps, be surprised to learn that when I took office the plant was then valued at about £23,000, and that upon a revaluation made at that time by a competent firm it was estimated that it would realise £3,000, and that about two-thirds of it was sold, realising only about £1,800.

"I think the Directors might have saved themselves a vast deal of trouble; but I cannot forget that they have now been in office nearly three months, and have literally and absolutely nothing to show for that period, and I therefore sympathise with them in placing before the shareholders a confusing mass of figures, so as not to appear at the meeting they have convened entirely empty-handed.

"I am informed that the Directors earnestly urged the re-valuer of the stock—the same person who originally valued it—to put everything down at the very lowest figure. If it is a question of auction value, the revaluation is as valueless as the original valuation. The principle upon which I proceeded in originally valuing the old stock was in taking over the sound machines at the lowest price at which I could purchase them, and the price at which the machines were valued at December 31st, 1887, was a little less than the price at which they could then be obtained; the exact figures at which the goods purchased by me were obtained; and a valuation similar to that at which the old plant was taken over from the original management. I maintain that the new valuation, therefore, is misleading and incorrect. I do not think the shareholders will thank the new Directors for cutting down the value of their assets from 5s. per share to 2s. 6d., merely to suit their financial exigencies in providing fresh capital. . . .

"I wish to know if the new direction, who have been nearly three months in office, have introduced business of £5 value to the Company, and whether orders that have been received have not been entirely from connections established by me?

"I wish to know whether the new Directors have mortgaged the plant of the Company for an advance of £1,000, and whether a large portion of this sum has been disbursed in fees to Mr. Louis Swaby and themselves, notwithstanding their protestations to the contrary when taking office?

"I wish to know whether they have voted themselves £100 in payment of the expenses of the committee? which, if done, is *ultra vires*.

"I wish to know if Mr. John Marks proposed and Mr. Couchman seconded the appointment of Mr. Louis Swaby as Managing Director; and whether Mr Swaby voted for himself, being opposed by Messrs. Klenck and Hildyard?

"I wish to know whether the same gentleman proposed and Mr. Swaby again supported his own appointment to proceed to America to examine the different electrical systems there, and report in the interests of the Company?

"I wish to know whether the moment the American Company knew that I had ceased to be a Director of the Company they withdrew the long credit granted to me for plant supplied and available to almost any amount?

"I wish to know whether any firm have agreed to supply the Company with goods to any value upon terms of credit?

"With regard to my account with the Company, since March last, and during all the time that the committee were, according to my judgment, doing their best to wreck the Company, I was lending the Company, from time to time, large sums of money to prevent writs being served, and to enable operations to continue. Upon the new Directors taking office I urged upon them the desirability of a subscription among the Board for the purposes of the Company; but, as I have already said, they declined to listen to me. Notwithstanding the fact that the Company was owing me a large sum of money, I was prepared to advance to the Company £1,000 provided the other Directors subscribed £500 each. I made a similar proposal to the committee in April last. . . .

"But for the appointment of the committee in March last I would have been able to obtain a payment of, say, £4,000 to £5,000 from outstanding debtors with regard to whom trifling disputes had arisen, some of which had been already settled, and others were on the point of a settlement, when a committee was appointed of comparatively unknown men.

"In conclusion, I would recommend the shareholders to leave those who have taken upon themselves the reins of office to subscribe, as I did in 1883, the capital necessary to carry on and extend the business; but as I have no hope that such will be the case, I have, in the interests of myself, as a large creditor and shareholder, filed a petition, believing that the only outlet from the present deadlock and a further squandering of the assets of the Company is by liquidation and reconstruction under the auspices of men of social, commercial, and financial position. I may add that my petition is supported by other creditors, and, provided you approve of the course which I have taken, I shall be glad if you will intimate to me in writing that you do so, which will no doubt strengthen my hands in the quickest mode available for getting rid of the present Board, and placing the Company at an early date in the position it occupied before the present Board took office."

COMPANIES' MEETINGS & REPORTS.

The Direct Spanish Telegraph Company (Limited).

The thirtieth ordinary general meeting of this Company was held on Tuesday, 2nd inst., at Winchester House, Old Broad-street, Sir James Anderson in the chair.

Mr. CH. GERHARDI (the Manager) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said: When I last had the pleasure of addressing you I held out the hope that we should reach a dividend of 5 per cent. I am to-day in a position to say that we have reached that point. It has been customary with us at these meetings to tell you what we have done since the date of this report—that is, during the three months beyond the period which the report deals with. The traffic has increased—we have carried 2,000 more messages in the three months than in the corresponding three months of 1887—yet we have not earned as much money. This arises from two causes, the first being that the practice of inditing messages in code has increased, and telegrams are thus made shorter. The other reason is that the extra European traffic which we carry over our cables has slightly decreased, in consequence of the raising of the tariff on the American cables since the 1st of September last. I do not despair of being able to keep up our dividend of 5 per cent., and I should not be surprised if we made more; but at present we are not making more. The traffic, however, is sound, and derived from commercial sources, and there is nothing political or spasmodic about it. There are a few relatively small items in the accounts which I will explain. The first is for a new cable house at Barcelona and for protection of cable amounting to £194, half of which has been charged to the present account. There is, as you know, an International Exhibition at Barcelona this year. It has not done us any good telegraphically; on the contrary, we have had to spend something in protecting our cables with buoys to keep them clear of the men-of-war which on the occasion of the opening of this Exhibition anchored near the cable. In this matter we were assisted very frankly and very kindly by the Minister of Marine of Spain, and every possible assistance was given us by the local naval authorities; therefore, our cables sustained no damage. With regard to the cable house, the temporary hut which was erected in 1874 required renewing, and as the land on which it stood was within the Exhibition grounds, we decided to erect a new and suitable cable house before the opening of the Exhibition; and, in consequence, we hope to get, and we

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have a positive promise that we shall get, the ground which the cable house and shore-end occupy free of rent, so that we are so far fortunate. The other item I may mention is one of £28 "special allowance." This was for medical and other expenses incurred by one of our superintendents who had been called up to London to explain some matters, and who was taken very seriously ill whilst here. Another amount is that of £55. 6s. 8d. for inspection of foreign stations. Our manager, Mr. Gerhardi, went to Bilbao, Madrid, Barcelona and Marseilles to see how all was going on, and to improve some working arrangements with the Spanish and French Governments. You will observe by the report and accounts that the traffic receipts for the half-year show an increase of £851 over the corresponding period of 1887, and I may add that in order to get that increased traffic we had to spend £260 more than we did in the corresponding half-year of 1887. I have really, gentlemen, very little to say. Everything is going on well, your cables are in good order, and your traffic is steadily growing. The first six months of the year to which the report refers are those during which there is the least traffic, so that we are justified in expecting that we shall get a larger increase still in the second half of the year ending on 31st December next. I shall be glad answer any question that any shareholder may have to put.

No one having put any question to the chair, the first resolution, proposed by the CHAIRMAN and seconded by Mr. ETLINGER—

"*That the report and accounts now presented be and are hereby received and adopted,*"

was carried unanimously.

The second resolution, proposed by the CHAIRMAN, and seconded by Mr. ETLINGER—

"*That the dividend at the rate of 10 per cent. per annum, less income-tax, on the Preference Shares, and a dividend at the rate of 5 per cent. per annum, free of income-tax, on the Ordinary Shares, both for the half-year ended 30th June, 1888, be and are hereby declared,*"

was also carried unanimously.

A vote of thanks to the Chairman and Directors, moved by Mr. LEWIS WELLS and seconded by Mr. DAVID LOWE, was carried *nem. con.*, and the CHAIRMAN having thanked the shareholders, the proceedings terminated.

Maxim-Weston Electric Company (Limited).

An extraordinary general meeting of the shareholders was held at the City Terminus Hotel, Cannon-street, on Wednesday, Mr. John Marks, the Chairman of the Board, presiding.

Mr. SAMUEL J. BOYCE (the Secretary) read the notice convening the meeting. The report of the Directors was taken as read.

The CHAIRMAN: The duty now devolves upon me, gentlemen, of moving the adoption of the resolution that has been read by the Secretary, and which is contained in the notice convening this meeting. But before doing that it will be, perhaps, as well for us to retrace our steps a little, and devote a few minutes to a consideration of the causes which have led us to the necessity of asking you to consent to a reduction of capital. You will recollect, gentlemen, that in March last the late Board called the annual general meeting of the shareholders, and Mr. Watt, the then Managing Director of the Company, having moved that the report and the accounts should be adopted, Mr. Swaby, the only then remaining Director with Mr. Watt, moved the rejection of the report and accounts, on the ground that they were altogether untrue. That led up to some discussion, and Mr. Watt, I think you will bear in mind, made some very grave charges against Mr. Swaby at that meeting, which it is very satisfactory to us to know have been refuted in the Law Courts since. As a sort of compromise, a committee was appointed to inquire into the affairs of the Company, and to report to the shareholders at a subsequent meeting. That committee did their work as well as they could under the circumstances and with the limited power with which they were invested. The result of their investigation was that they reported to the shareholders that the balance-sheet presented by Mr. Watt was an untrue one, and they recommended the shareholders to appoint additional Directors to act with Mr. Watt in carrying on the affairs of the Company in future. At a subsequent meeting, at which Mr. Watt presided, five gentlemen were named as new Directors, and the names were supported from the chair and carried unanimously. That was on July 19th. The new Directors at once set themselves to work, and on that very day two of our number called at the office and requested the secretary to call a Board meeting for the following day. Mr. Watt had, however, to preside at a meeting of the New Chili Company, I believe, on the following day, and it was arranged that the Board meeting should take place two days later—on the 21st July, two days after the election of the new Directors. At that Board meeting Mr. Watt was not present. The Directors asked the secretary to produce the books and documents belonging to the Company, but he replied that they were locked up in the safe, and that the key of the safe was in Mr. Watt's possession. We were unable, therefore, to transact any business whatever at that meeting, but we did the best we could under the circumstances. We instructed the secretary to have returns prepared of the *employés* at the works and the clerks in the offices, with their respective salaries. At that meeting, when we asked the secretary what he had to report, he said that a cheque for £724 had been received from the Peel Mills Company. The cash-book was not locked up in the safe, so we looked to see if the cheque was entered up. It was entered up, but there was no entry in the bank-book of the cheque having been paid into the account of the Company.

A SHAREHOLDER: When was that?

The CHAIRMAN: At the first board meeting, on July 21st.

The SHAREHOLDER: When was the cheque received?

The CHAIRMAN: Some days previously. Upon asking the reason why the cheque had not been paid in, the Secretary informed us that he had endorsed the cheque, and entered it, and that Mr. Watt had then paid it into his private account, saying that the Company were indebted to him, which they were. Mr. Watt retained the cheque, and paid into the Company's account a cheque for £74, retaining £650 against what he claimed as being due to him from the Company (shame). At the following meeting, on July 27th, Mr. Watt was present; but, notwithstanding that he had presided at the meeting at which the new Directors, whom he supported, were elected, he positively refused to let us have access to the minute book and the other documents of the Company, and which were absolutely necessary for the purpose of carrying on the business of the Company, and the ground upon which his refusal was based was that he questioned the validity of our election, and that until he had taken a legal opinion on that point he refused to give us any assistance whatever in carrying on your business. We, however, took the opinion of Mr. Emden, through our solicitors, Messrs. Nashville and Withers, and that was that we were legally appointed Directors of the Company, and had a right to carry on the business of the Company on behalf of the shareholders (cheers). The Chairman went on to refer to the steps which led up to the resignation of Mr. Hugh Watt, and said that Mr. Watt caused all the books and papers to be removed to the works, except the transfer book, which was retained "so as not to cause inconvenience to members of the Stock Exchange." This was in August, but certificates sent in for transfer as far back as March last were in the office then (shame). The then Secretary absolutely refused to carry out the instructions of the Board. He was therefore peremptorily dismissed (hear, hear). The Chairman continued: Then came the question of the clerks. Upon inquiring of the clerks whether they were the servants of the Company they said they were not—they were the servants of Messrs. Hugh Watt and Co. We asked the clerks what salaries they were receiving, and upon their telling us we turned to the books and found that the amounts were paid by this Company. The whole staff of clerks paid by the Company were clerks of Messrs. Hugh Watt and Co. They were doing the clerical work of the Maxim-Weston Company, the Yuruari Mining Company, the New Chili Mining Company, and the Port Darwin Company, and there was a shorthand clerk doing Mr. Watt's correspondence with his constituents in Glasgow (laughter). These were all being paid out of the coffers of this Company. I think the other companies I have named must get their work done very cheaply.

Mr. KLENCK: Query, is it done cheaply?

The CHAIRMAN: We do not know that. On Aug. 3rd, the day before his resignation, Mr. Watt called in a firm of engineers in the City, took them to the works and sold them some movable plant and stock for a sum of £175, and two engines alone, part of this property, had cost the Company between £300 and £400, and the very morning of the day on which he resigns he collected the money and paid it into his own private account (shame). Let us now refer to Messrs. Boyce and Ramsay's investigation of the books. You will remember that in the annual balance sheet the profit on the year's trading was put down at £1,555. As to how Mr. Watt dealt with some of these items I have the particulars before me. First, as to the Palace Hotel, Birkdale, a question was asked about the debtors at the meeting in March last, and Mr. Watt said that the whole of these debts were "good and recoverable." I am quoting his own words. The Palace Hotel, Birkdale, was indebted to the Company in the sum of £2,750 for plant supplied. That Company went into liquidation on the 30th of November, 1887—that is to say, a full month before the balance sheet was made up, and about four months previous to Mr. Watt's statement that all the debts were good and recoverable. I say on the 30th November, 1887, that Company went into liquidation; we took back our lighting plant in discharge of our debt of £2,725, and Mr. Watt told you in March last that the debts were good and recoverable, knowing that this Company, owing £2,700, was in liquidation. Messrs. Lewis and Co., of Manchester, by our books, were owing £1,265, for which they never paid a penny piece, and in June of this year the plant was returned to the Company, and we sustained a loss of something like £700. The plant, stated in our books as being supplied at a cost of £200 to the people owning the shop in Victoria street, also showed a loss. There is in the books a profit on the transaction of £104, and a few weeks after the goods had been supplied they were sent back to us and taken back into stock, and this is treated as a regular sale at a profit of £104, on which Mr. Watt takes his commission. And this is the manner in which the profit on the year's working has been made up.

Mr. NEWTON: When the goods were sent back were they taken as a purchase?

The CHAIRMAN: No, sir, they were not. The plant was put in the books as being supplied at a cost to the purchaser of £200; that was put back into stock and is still there, and has never been paid for. It has been put there merely as a kind of show, and it has been looked upon, I suppose, as a very good advertisement; but to write that up as plant supplied and to put it in the balance-sheet, I call it scandalous. That is how the profit of £1,550 has been made up. Plant to the value of £5,000 or £6,000 has been consigned to various parties abroad, to some people in the Mauritius and in various parts of the colony. That has been written in the books as if it were an actual sale. A profit amounting to upwards of £2,000 is assumed to have been made, and upon this £2,000 of course Mr. Watt has taken his commission, likewise bear in mind; and when we come to correspond with those gentlemen in the Mauritius, they inform us they have sold between £500 and £600, and they will be very pleased to return the remainder. That is to say, £5,500 was sent, £500 has been sold, and they will be very pleased to return the remaining plant to the value of £5,000. It would not then, it would not now, absolutely pay the cost of sending it over; and this is what Mr. Watt treats as a *bonâ fide* sale according to your books, and upon

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which he takes his commission as Managing Director. I could go on *ad infinitum* with similar instances, but I think I have now shown you sufficiently how Mr. Watt has made up his accounts, and how it is that he has credited you with a profit of £1,555 on your last year's trading.

A SHAREHOLDER: You have other instances?

The CHAIRMAN: I am sorry to say we have. With regard to the profit and loss account, I do not know that I can add anything to what the accountants have mentioned in their report; it merely goes to show how in this particular instance, as in others, to use a homely expression, Mr. Watt has cooked the accounts of the Company, and beyond that I cannot say anything to you. Now, gentlemen, I think I have said sufficient to show you the manner in which Mr. Watt has mismanaged the Company, and for which he was paid the large salary of £1,200 a-year and 5 per cent. commission. I think it would be a matter of surprise if this Company was in any different position under such management than it is. It would be simply short of a miracle if in the hands of such a manager the Company should go on in a successful course. So much for the past. Now for the present. Let us turn to the Directors' report. You will find the Directors say in one paragraph of the report that the Company possess valuable patents and good plant and machinery adapted to the requirements of the business, a state of things only to be obtained by years of experience and the expenditure of large capital. They also have a large and valuable stock. Well, gentlemen, we consider that after writing off the amounts recommended by the accountants, after reducing the value of the patents—after considerably reducing the value of the patents—that the present assets of the Company represent about 2s. 6d. per share; we therefore propose to start *de novo* with the reduction of the capital from 5s. to 2s. 6d., and we ask you shareholders to take up the unissued shares, amounting to 188,000, at 2s. 6d. The Board are prepared to do their share in taking up these shares, and we have applications from gentlemen who are unable to attend this meeting to the extent of some thousands of the new shares. Now, gentlemen, we know perfectly well that we labour under this disadvantage, that you can purchase these shares in the market at less than 2s. 6d.; but we feel confident, as stated in the report, that notwithstanding the unsatisfactory position of the Company, with honest and attentive management a good and profitable business may be carried on, and therefore we strongly recommend you to fall into the scheme and reduce the capital to 2s. 6d., and take up these unissued shares, because we feel confident, with a capital of £23,500, which it will give us as a working capital, the present shares, which can be bought at considerably less, will be brought up to fully 2s. 6d., and the time will very soon arrive, if you fall into our scheme, that they cannot be bought on the market at that. What are the prospects of the Company in regard to electric lighting? I dare say you, in common with myself, have read the address delivered by Mr. Preece, the celebrated electrician, at the British Association's recent meeting at Bath. Therein he says that the time has now come when there never has been such a prospect for electric lighting companies as there is at the present time; the disadvantages under which they have laboured on account of past legislation have been removed, and he says altogether he thinks the present is a most propitious opportunity for electric lighting. I am happy to say he refers, though not by name, to the Maxim-Weston. He does not name the Company; but he refers to the installation at the central Post Office Savings Bank, which he eulogises in the highest possible manner.

A SHAREHOLDER: Is it going on?

The CHAIRMAN: We believe thoroughly well.

The SHAREHOLDER: Is it on the Watt patent?

The CHAIRMAN: Oh, dear, no; it is on the Maxim-Weston scheme. Well, gentlemen, we have had before us many schemes, and we have given careful attention to the whole of them; but the scheme which we feel is best to recommend to you is that of which we have given you notice, and which will be moved to-day. The only alternative scheme that presents itself is to fall into Mr. Watt's views and to wind up. There is no help for it. If you do not take up the unissued shares there is no help for it but to wind up, and, as you are all aware, Mr. Watt has a petition on the file which comes on for hearing next Wednesday. I have no doubt whatever we shall successfully resist his motion to wind up. Should you not fall into our views and pass this resolution to-day and take up these shares, there is no help for it but to wind up, and in that case we might as well let Mr. Watt deal with the thing, and there will be very little left for the shareholders. The Chairman then proceeded to deal with the circular issued that morning by Mr. Watt, reading the various paragraphs through and commenting upon them *en passant*. He said that it was perfectly true that he (the Chairman) had proposed Mr. Swaby's election as Chairman—for this reason, that Mr. Swaby was the only old Director remaining except Mr. Watt, and it was believed to be in the interests of the Company that Mr. Swaby should be elected. Mr. Swaby declined to act as Chairman, and proposed that himself (Mr. Marks) should occupy that position, and that was carried unanimously. It was not correct to say that Mr. Watt attended every Board meeting. He did not attend the first meeting, and he was not present for more than five minutes at any subsequent Board meeting. As to the violent scenes, they were wholly on the part of Mr. Watt. The books and papers referred to where thrown amongst the machinery (shame). On August 7th, Mr. Watt was most gracious, and told the Board that he would assist the Company all he could, and would never dream of taking an action against the Company. The shareholders had seen how these promises had been carried out. As to Mr. Watt's statement that he had not been allowed to act as Chairman, that was correct, because the new Board elected their own Chairman, as they were fully entitled to do by the Articles of Association. It was quite true that the staff had been reduced, but not in the indiscriminate manner that Mr. Watt would have them believe. The whole list was gone through with the works manager, and all the men indispensable to the proper carrying on of the business had been retained. Mr. Watt (continued the Chairman) omitted to state that all the Watt plant manufactured had been included in the stock sheets. He was happy to say that the new Directors had done some business, very nearly, if not quite, equal to what had been done by Mr. Watt in the preceding six months. The new valuation had been made fairly and honestly (cheers). As to the fresh capital, he would be very sorry if the shareholders did not fall in with the views of the Board, for they believed the Company would be made successful by adopting them; but it was a matter of indifference to the Board whether their recommendations were accepted or not. As to the questions asked by Mr. Watt, the Board had made a claim against Mr. Watt for certain sums—that, in fact, he was the Company's debtor instead of its creditor. The Directors had not arrogated anything to themselves. They were appointed by the shareholders, and they were ready to vacate their seats whenever the shareholders wished it. As to the auditor, Mr. Dever, who was present, was a gentleman of the highest position, and was incapable of covering up anything which the shareholders should know. Mr. Dever wrote a report upon the 1886 accounts, which Mr. Watt did not read to the meeting. As to their refusal to register the transfer of Mr. Watt's shares, that was because Mr. Watt, as they contended, was in the Company's debt, and they had a lien on the shares of holders in default (cheers). When the new Board took office there was the magnificent balance of £3 at the bank, and the new Board had made themselves personally liable for an overdraft of £1,000 with which to carry on the business, taking a debenture from the Company for the amount; but neither the Board nor the committee had ever received a farthing for their services, except Mr. Swaby, to whom a certain amount legally and properly due had been paid (cheers). The parent Maxim-Weston Company had, through their representative here, made inquiries about the Company, and he believed they would assist it; but they would not do so while Mr. Watt was at the head of affairs. Improvements had been made in the original patents, and these would be available for this Company. It was proposed that the works manager and one of the Directors should go to America on the business of the Company, but at present no selection had been made pend-

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ing the result of Mr. Watt's petition to wind up the Company and the probability of additional capital being provided. Mr. Watt had, it was true, lent the Company money, but he had charged 10 per cent. for it; whereas the bank had lent the Board £1,000 at 5 per cent. Mr. Watt spoke of his five years' connection with the Company, but it would have been to the advantage of the shareholders if that connection had ceased some years ago (cheers). After strongly recommending the scheme proposed in the report of the Directors as the only one by which the Company could be saved from utter ruin, the Chairman concluded by moving the following resolution :—

"*That the capital of the Company be reduced from £125,000, divided into 500,000 shares of 5s. each, to £62,500, divided into 500,000 shares of 2s. 6d. each, and that such reduction be effected by cancelling capital which has been lost or is unrepresented by available assets to the extent of 2s. 6d. per share upon each of the 312,000 shares which have been issued and are now outstanding, and by reducing the nominal amount of all the shares in the Company's capital from 5s. to 2s. 6d. per share.*"

Mr. J. M. KLENCK seconded the resolution.

Mr. HIRSCH thought the shareholders ought to congratulate themselves on the fact that at last they had a Board of Directors who were trying to do the best they could for the interests of the Company. As to Mr. Watt's circular, there were many statements in that which the shareholders themselves knew to be incorrect, and he thought the Chairman had dealt with that effusion in a very able manner. The shareholders ought undoubtedly to strengthen the hands of the Board in taking proceedings against Mr. Watt for the amount due by him to the Company; and with regard to the recommendation of the Board as to the finding of further capital, it was clear that if the money was not found the Company would have to be wound up.

Mr. EMPSON asked what was the position of the Company with regard to the Watt patent, which Mr. Watt claimed for his own, although this Company had been charged with the expense of bringing it out. He also asked whether the Directors had considered the advisability of instituting proceedings against Mr. Watt.

Mr. JOHN NEWTON said it seemed to him that Mr. Watt's circular was part and parcel of the petition which was to be heard next Wednesday, and unless the shareholders strengthened the hands of the Directors at that meeting, there was the possibility that the petition would be granted. If it were properly opposed by a resolution of the shareholders it would probably be dismissed, or at least adjourned. The statements made by Mr. Watt were simply intended to damage the credit of the Company. Mr. Newton confirmed the Chairman's statement as to the violent behaviour of Mr. Watt at the Board meetings which he attended, and said he thought the other companies attended to in Mr. Watt's office might be fairly asked whether they paid anything towards the salaries of the clerks paid by this Company.

Mr. DEVER (of Messrs. Deloitte, Dever, Griffiths and Co.) said that certain facts with respect to the accounts of 1886 were referred to by him in a letter accompanying the balance-sheet. This letter, however, Mr. Watt did not read, and the shareholders were left in the dark. That meeting he (Mr. Dever) did not attend; but finding that his letter had not been read, he addressed another communication to the shareholders, concerning the 1887 accounts, and the reading of that document at the meeting in March last led up to the appointment of the committee (cheers). The item of patents had actually been increased from £32,829 to £40,737 during 1887, instead of being written down.

Mr. GRIFFITH said the first question to be decided was whether the Company was to continue, or be wound up, and he thought they should distinctly make up their minds on that point (cries of "Vote").

The resolution proposed by the Chairman was then put and carried unanimously.

Mr. HIRSCH then proposed

"*That the Directors of this Company be, and are, hereby authorised to oppose Mr. Hugh Watt's petition for winding up this Company.*"

And, secondly,

"*That the Directors of this Company be, and are, hereby authorised to take immediate legal steps against Mr. Hugh Watt for the purpose of recovering such sum or sums as are due by him, the said Mr. Hugh Watt, to the Company.*"

Mr. EMPSON seconded the proposition.

Mr. LEE did not think the resolution could be legally passed, but he was quite sure the Directors would do everything necessary to protect the interests of the shareholders.

The CHAIRMAN pointed out that the resolution, though not legally binding, would strengthen the hands of the Board in opposing Mr. Watt's petition for the compulsory winding up of the Company.

Mr. GRIFFITH, while agreeing with the proposal to resist the petition for winding up, contended that the difficulties of the Company were due mainly to their having at the start paid the American Company large sums for patents which had proved to be useless. They had consequently had to pay thousands more for doubtful improvements, and yet they were told to expect assistance from the parent Company, which, instead of helping its child, had been living on it. He thought the suggestion that legal proceedings should be taken against Mr. Watt showed more feeling than judgment. What ought to be done was to see whether the claims could not be compromised (no, no).

After some further conversation the proposition to oppose the winding-up petition was carried *nem. dis.*

The second proposition led to considerable discussion, at the conclusion of which

Mr. J. M. KLENCK, one of the newly-elected Directors, said it would be well to repeat briefly how matters stood. Mr. Watt had put a petition on the file claiming £754, but the Company had a claim against Mr. Watt for £2,113, independently of other sums which might be found to be due to the Company. Mr. Watt had also petitioned for a rectification of the register; but the Directors would certainly oppose this, as while a shareholder was in debt to a company the Directors had a lien upon the shares of the debtor. He thought, therefore, that the resolution would strengthen the hands of the Board (hear, hear). The point of the whole thing, however, was—Were the shareholders going to find the money? (cries of "Yes"). In that case the Company would be able to do a good and profitable business. There could be no doubt that the electric light was to be the light of the future now that the restrictions imposed by the Board of Trade had been removed and the light had been perfected. The Directors, therefore, with confidence asked the shareholders to entrust them with the means of putting the Company in a sound position, for they thoroughly believed that with the small amount of capital asked

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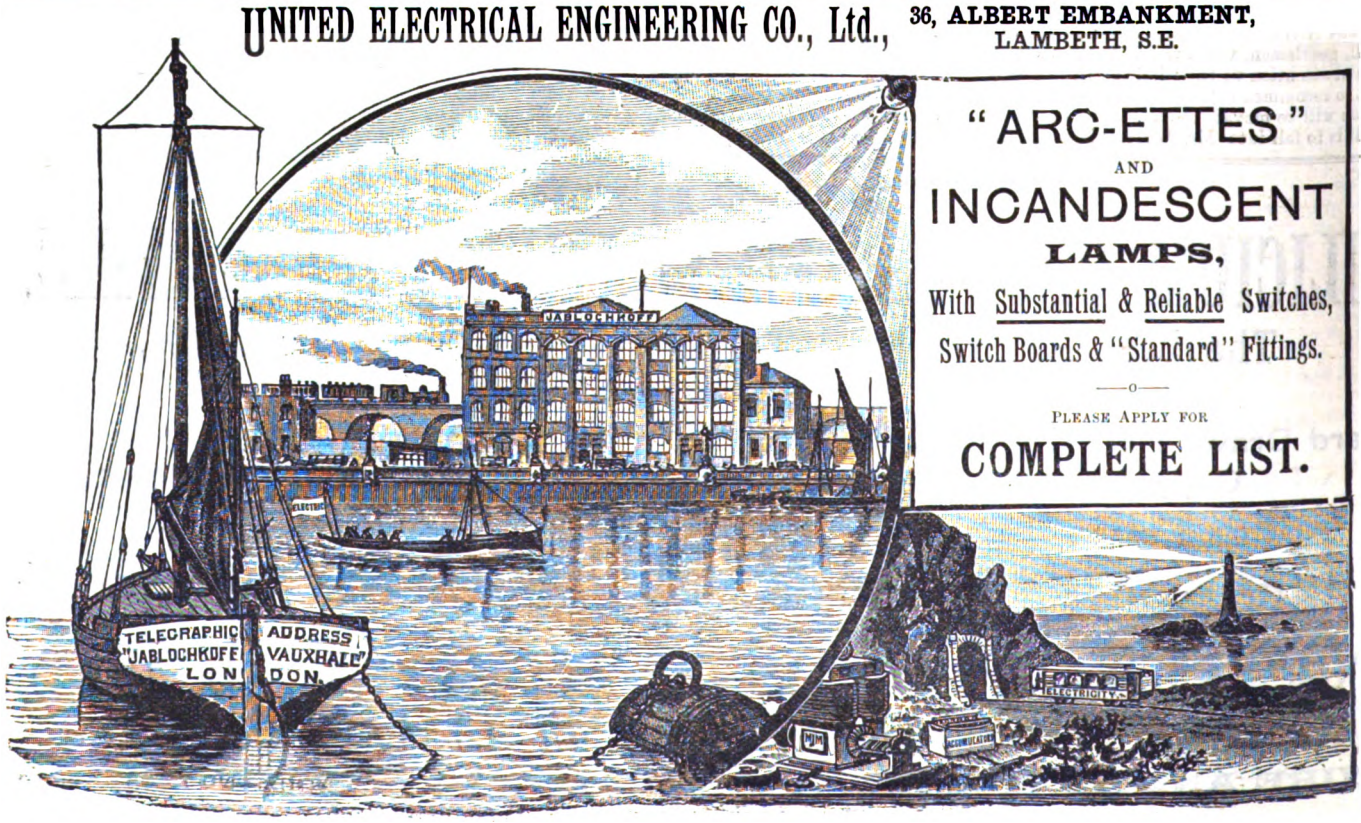

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for—under £24,000—the undertaking would be made commercially successful (cheers).

Mr. Hirsch's second proposition was then put and carried with two dissentients.

Mr. HILYARD, in reply to a question, said that, so far as the Board had been able to ascertain, Mr. Watt had spent about sixty hours at the factory during 1887; his pay had therefore been at the rate of about £20 an hour (laughter).

The meeting having lasted nearly two hours and a-half, then closed with a vote of thanks to the Chairman and Directors.

Eastern Extension Australasia and China Telegraph Company (Limited).

Report and accounts of the Directors for the half-year ended 30th June, 1888, to be submitted to the thirtieth ordinary general meeting to be held at Winchester House, 50, Old Broad-street, London, E.C., on Wednesday, 10th October, at 2 o'clock.

2. The gross receipts, including Government subsidies, have amounted during that period to £239,926. 0s. 5d., against £219,201. 4s. 8d. for the corresponding half-year of 1887.

3. The working and other expenses, including £22,112. 6s. 4d. for cost of repairs to cables and expenses of ships, absorb £69,297. 10s. 11d., against £76,241. 3s. 6d. for the corresponding period of 1887, leaving a balance of £170,628. 9s. 6d. From this is deducted £3,229. 0s. 5d. for income-tax, and £41,595 for interest on debentures and contributions to sinking funds, leaving £125,804. 9s. 1d. as the net profit for the half-year, against which the balance of cost of the Singapore-Saigon Renewal, amounting to £15,401. 5s. 0d., has been charged, leaving an available balance of £110,403. 4s. 1d.

4. One quarterly interim dividend of 1¼ per cent. amounting to £31,250 has been paid during the half-year, and another of like amount will be distributed on the 16th instant, leaving £47,903. 4s. 1d. to be carried forward.

5. Numerous small repairs have been effected by the Company's maintenance ships during the half-year under review, but no interruptions of a serious nature occurred until the 30th June, when both the Java-Australian cables were suddenly and simultaneously interrupted in deep water about 220 miles from Banjoewangie. The Company's s.s. "Recorder" was immediately dispatched from Singapore to effect repairs, and special steamers were chartered by the Company and the South Australian Government to carry telegrams between Java and Australia during the interruption. At first some difficulty was experienced by the s.s. "Recorder" owing to the prevalence of bad weather and the ends of the cables being deeply buried, but communication was successfully restored on the 13th July, and the second cable was also repaired on the 6th August, when it was found that the interruptions had been caused by volcanic action.

6. In consequence of the serious inconvenience to the telegraphing community, occasioned by the unfortunate interruptions above referred to, and in order to avert a recurrence as far as possible, your Directors immediately decided to lay an additional cable from Banjoewangie to Western Australia, to connect with the land lines of that colony, avoiding, as far as practicable, the volcanic region. This line will give the Colonies the advantage of a third cable to Java and an alternative land system *vid* Perth and Eucla to the existing overland line between Port Darwin and Adelaide. The announcement appears to have given much satisfaction in the Colonies and elsewhere.

A contract has been entered into with the Telegraph Construction and Maintenance Company for manufacturing and laying this cable, which is expected to be in working order early next year.

NEW COMPANIES REGISTERED.

MEDICAL AND SCIENTIFIC APPARATUS COMPANY (LIMITED).—This company was registered on the 25th September, with a capital of £1,000 in £1 shares, to acquire the provisional protection and subsequent patent rights of T. P. C. Crampton for improvements in chemical thermometers, applicable also to other thermometers, and to carry on business as electricians and electro depositors. The subscribers are:—

	Shares.
J. A. White, 38, Holborn-viaduct, solicitor	1
E. J. De Burriatte, 38, Holborn-viaduct, solicitor	1
F. E. Pearl, 37, St. George's-street, Peckham, clerk	1
A. J. Essinger, 11, Hatton-garden, merchant	1
F. Asruch, Portsdown-road	1
F. C. Rimmer, Manor-park, Streatham, secretary	1
J. White, 64, Myddleton-square	1

Registered without special Articles.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended September 28th, 1888, amounted to £4,788.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the month of September, 1888, amounted to £1,888, against £1,996 in the corresponding period of last year.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this line for the month of September, 1888, amounted to £49,273, and to £46,081 in the corresponding period last year.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended September 28th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,947.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this company for the month ended September 30th, 1888, amounted to £4,875.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated receipts of this company for the half month ended September 30th, 1888, were £2,034, as compared with £2,388 in the corresponding period of 1887.

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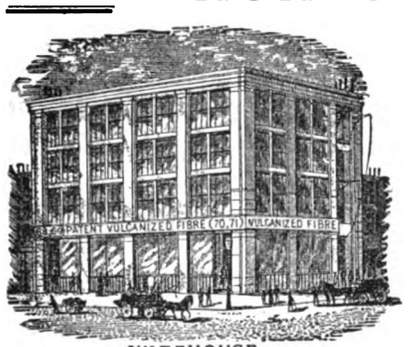

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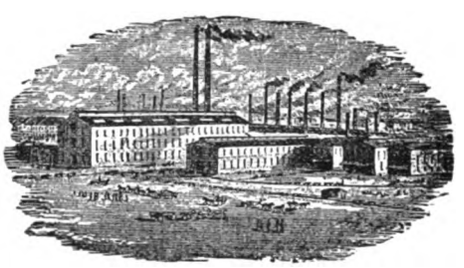
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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Oct. 3, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Oct. 3, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5,0	Anglo-American	48 49	2 16 3	Jan., Apr., July, Oct.	50⅜	47⅞
2,614,820	Stock	10/0	Do. Preferred	80½ 81½	3 7 6	,, ,,	83½	79½
2,614,820	Stock	nil.	Do. Deferred	17 17½	...	February	18½	16½
130,000	£10	3/0	Brazilian Submarine	13⅜ 13⅝	5 4 8	Mar., June, Oct., Dec	13½	13¼
16,000	10	9,0	Cuba Submarine	13¾ 14¼	5 19 4	February and August	...	...
6 000	10	10/0	Do. Preference	18 19	5 5 3	,, ,,	18½	...
12,931	5	4⅞'87	Direct Spanish (£4 paid)	4 4⅛	3 11 1	March & September	4⅛	...
6,000	5	5/0	Do. Preference	9¼ 10½	4 15 3	April and October	...	...
60,710	20	2/0	Direct United States	10½ 10⅝	3 16 2	Jan., Apr., July, Oct.	11	10⅜
380.000	10	4,6	Eastern	12¼ 12⅝	4 16 0	,, ,,	12½	12¼
70,000	10	3/0	Do. 6 per Cent. Preference	14¼ 15¼	3 19 0	,, ,,	15	...
200,000	100	5⅞	Do. 5 per Cent. Debentures, 1899	107 110	3 18 0	February & August	...	...
250,000	10	2/6	Eastern Extension	12⅝ 13⅛	4 19 1	Jan., Apr., July, Oct	13⅛	13 1/16
22,050	10	8/3	German Union Telegraph and Trust	9 9¼	7 7 4	January and March	...	...
179,177	10	3,0	Globe Telegraph and Trust	7⅛ 7⅜	4 14 11	Jan., Apr, July, Oct.	7⅛	7 1/16
178,992	10	3/0	Do. 6 per Cent Preference	14⅜ 14⅝	4 3 6	,, ,,	14⅝	14¼
150,000	10	5/0	Great Northern	14 14½	5 3 5	Jan., July, and April	14⅝	14
17,000	25	37/6	Indo-European	38 40	6 5 0	April and October	...	...
33,348	10	3/0	London Platino Brazilian	6 6½	...	May and November	...	...
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	7½	...
338,225	Stock	13½%	Submarine	135 145	10 0 0	February & August	...	...
30,000	10	6/0	West Coast of America	7⅜ 8¼	6 1 3	January and July	7⅜	...
150,000	Stock	8%	Do. Debentures	114 119	6 14 6	June and December	...	...
88.321	10	nil.	West India and Panama	1⅜ 1⅝	...	...	1 1/16	1 1/16
34,563	10	*10/0	Do. 1st Preference	12 12½	7 12 0	April and October	...	...
45,181	15	9/0	Western Brazilian	12⅝ 12⅞	...	March & September	13¼	12¼
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 15 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	£5 7s. 6d. '87	Consolidated Telephone and Maintenance	1/16 1/4	...	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	3/8 7/16	3 9 0	...	...	...
80,000	5	10/0	United	13½ 13¾	5 9 1	June and December	13 9/16	13 5/16
50,000	5	2/6	United River Plate	5⅜ 5⅝	...	April and October	5⅜	5⅛
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3¼ 3⅜	...	...	3⅜	3¼
23,692	5	nil.	Do. (fully paid)	4¼ 4⅜	...	February & August	4⅜	4¼
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅜ 2⅝	...	...	2¼	2 1/16
312,000	½	5% '86	Maxim-Weston	1/16 1/16	...	February	1 1/16	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	38½ 39½	6 1 7	March and July	39½	39¼
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16⅜ 17⅛	5 14 3	February & August	17¼	16 11/16

* On account of arrears of dividend.

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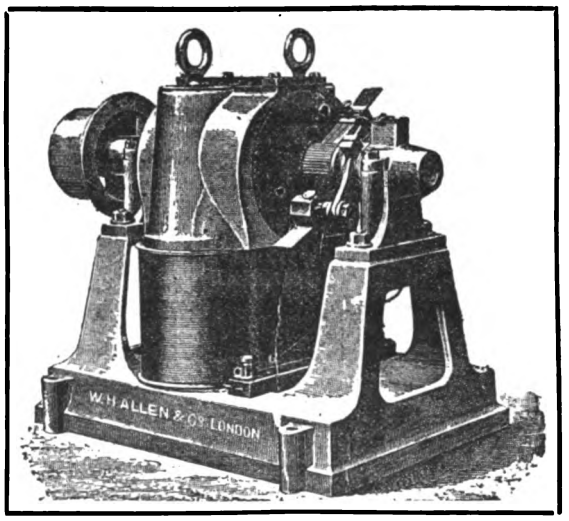

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 513.—Vol. XXI. FRIDAY, OCTOBER 12, 1888. Price 4d.

NOTES.

Nature calls attention to the fact that the question of electrolysis by alternating currents was discussed at length by Sir William Thomson in a Paper which appeared in the *Philosophical Magazine* as long ago as June, 1853. It is a noteworthy fact that at that early date, and from purely theoretical considerations, Sir William was able to predict the effects of current density, which have only now been re-discovered. At the same time we are disposed to think that Sir William would himself dissent from our contemporary's remark that the communication contained "all that it is necessary to know on the subject." We print this week a Paper by Mr. A. E. Kennelly embodying some conclusions which, from a practical point of view, it seems very desirable to know.

Much as we sympathise with the individual shareholders of the Maxim-Weston Company, and firmly as we believe in the future of electric lighting, we shall, nevertheless, be heartily glad to hear that the new board has failed to obtain the money they are asking for, and that the company has gone into voluntary liquidation. In the long run, we feel assured that this would prove to have been the wisest course. The assets of the company seem to consist chiefly of more or less obsolete stock, and of undeniably worthless patents, doubtful book debts, and visionary contracts. On the other side, there are judgment debts and other debts, and continual expenses, to say nothing of a mortgage on the property. The name of the Maxim-Weston Company is not synonymous with success in this country either from an engineering or a commercial standpoint, and with the competition of younger, better equipped, and better managed firms to be faced, we altogether fail to understand what chance can possibly remain for a concern handicapped with a past such as that of the Maxim-Weston.

In our issue of October 21, 1887, we published an article embodying the results of the experience gained by the North Metropolitan Tramway Company in the running of the Elieson electric tramcars over their lines. These results were of a sufficiently satisfactory character to lead the company to desire a further extension of the experiments; but unfortunately some difficulty arose upon the question of capital outlay, and eventually nothing further was done by the Elieson Company. Meanwhile, however, negotiations were proceeding with the Electric Traction Syndicate, and it was decided to allow that company to place six cars upon the line which runs from Canning Town to Plaistow. These arrangements have just been carried out, and the cars are now running. The contract is at the rate of fourpence-halfpenny per car mile, and is to extend for six months. The arrangements adopted do not call for any special description, as the whole of the plant belongs to well-known types, which will be perfectly familiar to our readers. The cells are 92 in number, of the E.P.S. type, specially designed for traction work. The motor and gearing are by Immisch and Co. The motor is of 6 horse-power, with a 7-in. armature, and a double set of Renold's steel chain gearing is used, the ratio being ten to one. The cells are charged from an Immisch 10-unit dynamo, driven by a Davey-Paxman 8 horse-power portable steam engine. A single charge enables the accumulators to travel a distance of 36 miles, which is equivalent to half a day's work. The cells are withdrawn sideways, and the change is very expeditiously effected. The details have been worked out by Mr. Thomas Frazer, the company's engineer, and seem to have been reduced to the greatest simplicity and ease of manipulation. We look forward with confidence to the complete success of the experiment, provided always that the rate of depreciation of the accumulators is sufficiently low.

We are glad to see that the Leamington Town Council have come to terms with the Midland Electric Light and Power Company with regard to the improvement of the lighting of the Parade in that town. The replacement of twenty-five existing 16 candle-power lamps by the same number of 50 candle-power lamps and the introduction of a few 300 candle-power incandescents, besides four arcs, ought to go a long way to place the lighting on a satisfactory basis. As regards the working of the station, there is now absolutely no room whatever for complaint. Ever since Christmas last the lighting has been carried out with perfect regularity.

The *Law Times*, commenting on the Electric Lighting Act of 1888, points out that the legal effect of the clause dealing with the compulsory sale to the local authority at the end of forty-two years may shortly be illustrated by the operation of a similar clause in the Tramways Act of 1870. We may add that the operation of the Tramways Act is of interest to electrical engineers from intrinsic, as well as merely illustrative reasons. Section 43 of the Act cited provides that the companies shall sell "upon terms of paying the then value (exclusive of any allowance for past or future profits of the undertaking, or any

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compensation for compulsory sale, or other consideration whatsoever) of the tramway, and all lands, buildings, works and materials, and plant of the promoters suitable to and used by them for the purposes of their undertaking." "These words," says the *Law Times*, "seem to be clearly expressed, and apparently what was intended was that a valuation should be fixed for the tramway and all lands, *taken as a connected whole*, without any reference to profit and losses. But the opinion of four counsel of great repute, including the present ATTORNEY-GENERAL and Sir HORACE DAVEY, which was published in *The Stock Exchange* last year, does not seem to favour this view. They considered 'that the local authority would have to pay when purchasing the undertaking the then value of the tramway and all lands, &c., as part of a going concern, and not merely the value of the tramway, lands, &c., considered independently of the undertaking of which they form part.' Now, the expression 'going concern' is usually applied to a concern relative to its profits and losses, which are expressly excluded by the terms of the statute. The concluding words also have no meaning unless it is intended that profits are to be taken into account, because the land, &c., comprise the whole undertaking except the carrying on of the business with reference to the profits and losses." Finally, however, our legal contemporary thinks it "doubtful whether the shareholders will realise more than the value of the actual property taken as a whole, and apart from the 'circumstances that they are in such a position as to be ready for immediate working.'" Upon the whole, we take it that the acquisition of the tramways by the local authorities will be distinctly conducive to the interests of electrical engineering, since it must lead to increased inquiry for electric traction, and in many cases this may ultimately lead to extensive municipal works, combining lighting with the transmission of energy.

IN a recent issue we spoke of the long-distance telephone line between New York and Chicago as being already in operation. We are courteously informed, by our esteemed contemporary the *Western Electrician* of Chicago, that the building of the line is not yet complete, although it is in active progress. As a matter of fact, we were misled by the recollection of some successful telephone experiments upon existing telegraph lines between the cities referred to.

THE report of the Education Commission now issued shows that, although differing on some points of detail, the Commissioners are agreed on the main outlines of a scheme for technical instruction, by which term is meant instruction in the scientific or artistic principles which underlie the industrial occupations of the people. Just a few details will suffice to show the nature of the proposed scheme. The subject of technical training is not to encroach upon general education. Elementary science, varying in its requirements with the locality, is to be a part of this instruction. Itinerant science teachers are recommended in the case of sparse populations as well as in towns. The examination in science in all the lower standards is to be oral. Manual instruction is not to be begun before a child is ten years old. It should be provided for in some higher educational institution, attendance upon such instruction by elementary scholars to count for attendance at the elementary school. Voluntary effort on the part of manufacturers and employers of labour is to be fostered and not discouraged; but care is to be taken not to lead the artisan population to trust to the artificial teaching of a school instead of to the practical and diversified training of the workshop.

DR. SESTIER, in his important work on "La Foudre"—a work which is a perfect mine of information as regards the history and tradition of the subject—hazards the opinion that the Temple of Solomon was provided with a thoroughly complete system of lightning conductors. We learn from JOSEPHUS that the roof of the inner Temple was studded all over with *flèches* of gold or gilded metal, and an immense quantity of brass was employed in sheathing the walls of the outer courts. The important question remains—Was an earth connection provided? The Temple, it must be remembered, was built upon a solid and almost isolated rock, and it would appear to be a matter of some difficulty to find a good earth. The learned Doctor is, however, of opinion that the mere fact that during a period of over a thousand years the building escaped all damage from lightning affords sufficient proof that a proper earth connection had been provided. However this may be, it is perhaps worthy of note that the system of protection adopted by SOLOMON—the Wisest of Mankind—was well adapted to meet the case of the oscillatory discharge; in fact, it is precisely that which is now recommended by Dr. OLIVER LODGE.

THE palace of the King of Roumania at Sinaia is lit throughout by electricity, motive power being derived from a mountain stream in the immediate neighbourhood. With reference to this installation the London correspondent of a provincial paper tells the following story:—

"I happened to be in the Palace of Sinaia when the electric light was being exhibited to the King on trial. The representative of the English firm who were setting up the installation was an exceedingly voluble person, and he was explaining to his Majesty at great length all the advantages which the electric light enjoyed over gas. It did not tarnish gilt, it did not consume or vitiate the air, it could be turned on or off at any moment; there was no occasion to use matches, and, greatest advantage of all, it minimised the chances of fire, and absolutely gave out no heat. The King listened with great attention, and was evidently much impressed, but just as the voluble gentleman was mentioning the fact about there being no heat, he placed his hand at the bottom of one of the lamps, and even the royal presence could not restrain an exclamation of pain—he had burnt his fingers with the heated metal. Seeing this, the King gingerly touched the lamp in turn, and he, too, got a slight burn. He smiled grimly, and turning to the electrician, said: 'Hum, well, I hope, Mr. ——, all the other advantages of the electric light are not so apocryphal as this.' But he decided to have it installed all the same."

Tamworth.—The mayor of this town is promoting a public subscription towards a "demonstration" of electric lighting.

The Statue to Ampere.—M. Carnot presided a few days since at the ceremony of unveiling the statue of Ampère at Lyons.

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Cable Repairs.—The Submarine Telegraph Company's cable from Lowestoft to Norderney has been successfully repaired by Mr. J. Berdeaux, of the ss. "Lady Carmichael."

Montpellier.—The new theatre at Montpellier was opened on the 1st inst. This theatre has been fitted with a very complete installation of the electric light by M. Popp.

Personal.—We learn that Mr. G. S. Hooker has resigned his position as electrician in charge of the Bath installation, and that Mr. Orlando V. Thomas has been appointed in his place.

The Telephone in the West.—In the year ending August 31, 1888, 3,615,110 telephone messages passed over the lines of the Western Counties and South Wales Telephone Company.

Frankfort.—The aërial conductor of an electric railway at Frankfort has been struck by lightning. The flash ran along the wire to the dynamo, the armature of which it completely ruined.

Bedford.—At the last meeting of the Bedford Town Council a motion was made to appoint a committee to consider the best means of lighting a portion of the town by electricity. A decision was postponed to a later meeting.

Fulham Vestry.—At a meeting of the Vestry on October 3rd the Law and Parliamentary Committee brought up a report recommending that the solicitor to the Vestry be instructed to oppose Bills to supply the parish with electricity, which was agreed to.

Paris.—Within a month a new central station for the electric light will be opened at the Palais Royal, Paris, for the shops, the galleries, the Conseil d'État, the Cour des Comptes, the Théâtre Française, and the Palais Royal. The building of the cave in which the engines are to be placed in the courtyard is almost finished.

Interruption of the Australasian Cables.—Telegraphic communication with Australia and New Zealand is suspended in consequence of the interruption of the Port Darwin cables. The rupture was caused by the cable ship, "Sherard Osborn," while engaged in the repairs of the original cable. As the ship is on the spot, it may be expected that communication will be promptly restored.

Eastbourne.—At the last meeting of the Eastbourne Town Council a letter was read from the Eastbourne Electric Lighting Company offering to renew the contract for lighting the parade at the rate of £30 per lamp per annum. This offer was accepted, and the contract was ordered to be signed. In a previous communication the company had stated that the actual cost of running the lamps amounted to at least £32. 10*s.* per annum.

Ipswich.—At a meeting of the lighting committee of the Ipswich Town Council, on Friday last, Messrs. Lawrence, Paris and Scott applied for permission to lay cables under the footway in certain of the streets of the town. The Town Clerk reported that it was in the power of the corporation to grant the request. The matter was, however, deferred, and the applicants were informally recommended to apply for a Provisional Order.

New Submarine Cables.—The Portuguese Government has granted to the West African Telegraph Company and to the Eastern and South African Telegraph Company an exclusive concession for forty years, authorising these companies to lay submarine cables along the West African coast between St. Paul de Loanda and the Cape of Good Hope, touching at the intermediate ports of Benguella and Mossamedes. The Concession provides that these cables are to be laid before the 30th September, 1889.

The Electric Light at Indore.—The latest fad of His Highness the Maharajah Holkar, says the Allahabad *Morning Post*, has been the electric light. An engine, with all the necessary apparatus, arrived from Bombay about two months ago, and a considerable portion of the lamps, &c., had been erected, when suddenly His Highness stopped the work. So the whole of the plant has been taken up and returned to Bombay, the Maharajah agreeing to pay ten thousand rupees for this little freak.

A Portable Electric Search Light.—A new pattern of portable electric search light is now being fitted to the "Hecla," torpedo depot ship. The novelty consists in a Siemens dynamo and projector, mounted on the same carriages as a Merryweather's engine and boiler of the description so long and successfully used for fire purposes. The carriage can be drawn either by man or beast, and it is easy to see how invaluable such an arrangement might be during night skirmishing in a rough country.

A Portable Electric Lamp.—Experiments are being made at the Shireoaks Colliery by Mr. O. R. Swete, of the Associated Society of Telegraphic Engineers and Electricians, with a new portable electric lamp, the joint invention of Mr. David Urquhart, Mr. D. G. Fitzgerald, and others. It is stated that the lamp is perfectly safe, and can be placed in any position without affecting the light. The total weight is 4½lb., and its cost £1. The cost of maintenance is estimated at 3d. per week, including repairs.

Paddington Vestry.—At a meeting of the Vestry on October 2nd, Mr. Mark Judge asked that the Electric Lighting Committee's report should be considered first by the joint committee then meeting, as the subject was of great importance to the parish.—The Electric Lighting Committee having considered the report of Mr. S. J. Mackie, thought it would be to the interests of the parishioners to take the necessary steps to apply for a provisional license for electric lighting this year. This was put and carried.

St. George's Vestry.—At a meeting on October 4th, the Vestry proceeded to appoint an electric light committee, in accordance with a resolution passed at the last meeting. It was agreed that the committee consist of thirteen members, and that the following gentlemen, who were members of a former committee, be elected members, viz:—Mr. John Dovey, Admiral the Hon. A. Duncombe, Sir William J. Farrer, Lord Frederick Fitzroy, Lord Hobhouse, and Admiral Sir George Wellesley. The following gentlemen were also elected:—The Hon. Alan de Tatton Egerton, M.P.; Mr. Southern, Mr. Cove, Mr. Antrobus, Mr. Williams, Mr. J. Finch, and Mr. Adkins.

Fatal Accident in Valladolid.—The Madrid paper, *El Imparcial*, of September 21, reports a fatal accident at an electric installation in Valladolid. Two *employés* of the Sociedad Electricista Castellana, Senors Miravalles and Garcia, were inspecting the accumulators used for the service of six large arc lamps, when they met their death. According to the evidence of a child who was present, one of the *employés* had warned his companion not to touch the machinery; but he, either from foolhardiness, or judging the warning unnecessary, meddled with the conductors, at the cost of his life. His friend seized him with a view to his rescue, and received injuries which shortly afterwards proved fatal.

Retirement of Colonel Holland.—Colonel James Holland, after having filled with great efficiency, and to the entire satisfaction of the shareholders, the office of chairman of the Indo-European Telegraph Company, has felt compelled, to the great

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regret of directors, officers, and servants alike, on account of advancing age, to resign his seat at the Board. Colonel Holland has been chairman of the company for twenty years, and is succeeded by Mr. J. Herbert Tritton, a leading banker, formerly president of the Chamber of Commerce, and a name too well known to need illustration. At the same time Colonel Holland resigns the chairmanship of Reuter's Telegram Company, in which he will be succeeded by Admiral the Right Hon. Sir John C. Dalrymple Hay, Bart., K.C.B.

The Progress of the Electric Light.—At the present moment, says the *Manchester Courier*, there is a fine opportunity in London for engineers with a special knowledge of electric lighting. Since the commencement of the present year the new light has grown enormously in the public favour. For some time past it has been used in many of the clubs and public buildings. Now it is being laid on generally to all private residences of any pretence both in town and country. The house decorators are preparing designs of ceilings and walls that secure a better effect from the electric light. So many are the applications from those who wish to have the electric light installed in their houses that the engineers who undertake this class of work are seriously embarrassed.

Messrs. Immisch and Co.'s Electric Launches.—We learn that Messrs. Tagg and Son, of the Island Works, East Molesey, have received orders to construct five electric launches, each 35ft. in length, for Messrs. Immisch and Co. Another launch, designed and built for the same firm by Mr. W. Sargeant, of Chiswick, has just been completed. The launch is 65½ft. long, with 10ft. beam, and is designed to carry 80 passengers, with a mean draught of 22in., 12½ tons displacement, at six miles an hour, as regulated by the Conservancy bye-law. The electrical machinery and storage being placed below the deck fore and aft leaves a clear run the whole length of the boat for passengers. In the middle is a handsomely fitted cabin with lavatories, dining table, &c. 200 E. P. S. accumulators are placed on board, and supply current for two motors of 7½ horse-power each, driving twin three-bladed propellers by Thorneycroft and Co. The hull is constructed with primary view to comfort of passengers, and is of bright mahogany and teak throughout.

University College, Liverpool.—We have received a copy of the calendar of University College, Liverpool, for the Session 1888-89. This college, together with Owen's College, Manchester, and the Yorkshire College, Leeds, form the Victoria University, by which degrees are granted in the faculties of art, science, law, and medicine. At the University College, Liverpool, the faculty of medicine at present holds the most prominent position, but in equipment and *personnel* the science faculty is probably second to none in this country. The chair of mathematics is held by Prof. F. S. Carey, M.A.; the chair of experimental physics by Prof. Oliver Lodge, LL.D., D.Sc., F.R.S.; the chair of engineering by Prof. H. S. Hele Shaw, M.I.C.E.; and that of chemistry by Prof. J. Campbell Brown, D.Sc. In electricity and magnetism, Dr. Oliver Lodge lectures regularly to elementary, intermediate, and senior classes, consisting of first, second, and third years' students respectively, and special arrangements are also made to meet the requirements of those who wish to take up electrical engineering without spending more than one year at the college.

Chelsea Vestry.—At a meeting of the Vestry on October 2nd, the Electric Lighting Committee reported having considered a letter from the Chelsea Electricity Supply Company to the Board of Trade, asking that a certain area be added to the area of supply. The committee recommended that the Board of Trade be informed that the Vestry dissents from the application of the Electricity Supply Company for the extension of Schedule A at the present time, and that the Board of Trade be further informed that the company have not exercised any of the powers of their order as to the existing Schedule A, so far as regards the execution of works therein. Also, the committee reported that they have considered the letter from Messrs. Deacon, Gibson and Medcalf, dated 20th ult., enclosing a form of license which their clients, the London Electric Supply Corporation, desire to have granted under the Electric Lighting Acts, and asking the Vestry to assent to the same. The committee on this recommended that the Vestry do dissent from the application and inform the Board of Trade to that effect. The report was adopted, on the motion of Mr. Mossop.

The Lighting of Swansea.—On the 2nd inst. there was a large attendance of the gas committee of the Swansea Town Council, which held its meeting at the Town Hall, for the purpose of considering what steps should be taken in the interests of the ratepayers consequent on the action of the Swansea Gas Company in deciding to increase the price of gas supplied to both the Corporation for public purposes and to private consumers. The present cost of lighting the borough is about £4,000 per annum. The Town Clerk had, in accordance with instructions, obtained counsel's opinion as to the powers of the gas company over the extended borough, and the answer received was favourable to the Corporation. The Town Clerk then presented a long report on the powers of the Council under the Electric Lighting Act, 1882, amended by the Act of 1888.—In the discussion which ensued, the action of the gas company was strongly animadverted upon, and ultimately it was decided that, the consent of the Town Council having been obtained, the Town Clerk should be instructed to at once apply to the Board of Trade for a Provisional Order to light the town by means of electricity.

Tynemouth.—At a recent meeting of the Watch Committee of the Tynemouth Town Council, letters on the subject of electric lighting were read from the Local Government Board, the Clerk to the Barnet Local Board, and several of the electric lighting companies. It was resolved that the matter should be left in the hands of the Watch Committee, with the addition of two members of the Council, for them to report to the Council; the borough engineer in the meantime to prepare a plan showing the public buildings in the vicinity of the market which it had been suggested should be lighted by the electric light. A special meeting of the Town Council has been convened for the purpose of considering, and if so ordered of adopting a resolution, approving of the intention of the Council, as the local authority under the Electric Lighting Act, to apply to the Board of Trade for a Provisional Order to authorise the supply of electricity for public and private purposes within their district, and also to consider the terms of the order. The question of extending the electric light in the borough is one that is now engrossing public attention, and the outcome of the special meeting of the Council is awaited with considerable interest.

The Electric Light at Dover.—At the last meeting of the Dover Town Council a letter received from Messrs. Laing, Wharton and Down, offering to light the town by electricity, came up for consideration. They asked for a reply to be given them whether the Council would be prepared to receive a tender from them for the lighting of the streets, as they would then be able to get their appliances in full working order by the time of the expiration of the gas term.—Alderman Finnis suggested that the firm should be allowed to give their quotations.—Mr. Birch moved that it be put under the table ("No, no").—The Deputy Mayor said he could not agree

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to that. The electric light was bound to come, and there was no objection to the Council ascertaining what the price would be, and comparing it with the gas contract. The Councillor would not surely decline to receive an estimate from the firm.—The Mayor said he thought all firms were willing to give estimates without charge in the hope of ultimately getting an order.—The Town Clerk was then directed to write to Messrs. Laing, Wharton and Down, and ask them to give an estimate for the lighting of the town by electricity, as suggested in their letter.

Leamington Town Council.—At the last meeting of this Council a letter was read from the Midland Electric Light and Power Company, saying that they would supply four arc lamps, on poles, with raising and lowering gear provided, fixed, and lent for the sum of £12, the arc lamps and wires to remain the property of the company. The mayor had generously offered to supply and fix the poles and the raising and lowering gear, or the cost would have been much more than it was. The company would also supply five 300 c.p. incandescent lamps, fitted on existing lamp posts, with shades and arms, the lamps, shades, arms, wires, and fittings to remain the property of the company, for the sum of £18; twenty-five existing 16 candle-power lamps, on existing lamp posts, to be replaced by fifty candle-power lamps, two in each lantern, the lamps to remain the property of the company, for £3. Towards these costs the company will contribute one-third, in order to show their desire to assist the corporation in making the lighting of the parade the success that both bodies desired. The company would further agree to supply the currents used without any extra charges beyond the present contract for one month; but the company would make a charge of 10s. per week for cost of carbons, cleaning, &c., of the arc lamps. It was decided to accept these proposals.

Electric Light in Coal Bunkers.—"Verax" writes to the *Globe* on this subject as follows:—"In the 'Naval Notes and News' in your edition of Friday last, it is stated that the coal-boxes of all ships of the 'Admiral' type are, except the 'Benbow,' which has just sailed for the Mediterranean, to be lighted with the electric light, and the very natural question is asked, why was not this thought of before? Now, when the 'Benbow' was being completed for commission at Chatham Dockyard, and the electric fittings were under consideration, it was asked by an officer who had great interest in seeing the ship completed in a very thorough manner, and whose experience had taught him the necessity of well-lighted bunkers, that her bunkers might have electric lights put in. The question was referred to the chief constructor of the yard, the work being in his department. After, I presume, due consideration, his reply came, to the effect that such fittings were unusual, and it was not shown that any particular necessity for them existed in this ship. Had they not been unusual there would have been no need of a special application; that they were necessary the recent determination to fit them proves, and it is highly probable that had they been put in when asked for the recent lamentable explosion would not have occurred in the very ship where no particular necessity was shown for their being fitted."

Bell's Asbestos.—We have received from Bell's Asbestos Company a copy of their new illustrated catalogue. From the preface we learn that the company are the freeholders of extensive mines in Canada, from which about one-third of the total quantity of asbestos used in the whole world is now derived. The superiority of the Canadian over the Italian variety of the mineral is so marked that many of the Italian manufacturers are now actually importing the raw material from Canada. The growth and activity of the asbestos industry is one of the most striking facts in the recent history of the engineering trades. It is comparatively but a few years since it was first introduced upon a wholesale scale, whilst to-day the catalogue of the Bell Asbestos Company contains a list of nearly forty different methods or trades in which it finds employment. Its non-inflammable properties, and its use for engine packings are well known. Asbestos paper, specially prepared as an insulator for electical purposes, is steadily growing in favour; whilst asbestos paint is increasingly used for dynamos and solenoids. Asbestos putty as a heat-resisting and insulating material is suited for use in arc lamps, instead of ebonite. In the form of asbestoline we hear it well spoken of as a lubricant both for dynamos and engines. We may add, in conclusion, that one of the last-discovered purposes to which it may be applied is that of a filtering material, for which it seems to answer remarkably well.

Proposed Electric Railway in the New Forest.—At the last meeting of the Lyndhurst Highway Board a letter was read from Mr. J. C. St. Aubyn Angove, solicitor, of London, giving notice, on behalf of Messrs. Haines and Pool, engineers and promoters of the scheme, that it was their intention to apply to the Board of Trade for a provisional order empowering them to construct a tramway between Lyndhurst-road Railway Station and Lyndhurst. The line would be of three-feet gauge, and the tramcars would be propelled by electricity. Mr. Angove asked the board to consider the matter at once, because arrangements had been made to proceed with the work immediately after the Board of Trade had issued the order.—In answer to questions, the Clerk said the promoters proposed to lay the rails by the side of the road, on the waste land, and they did not cross the road until they reached Dunstan's Arch, near the police station, where the crossing was a level one.—Mr. Palmer, on being appealed to, said he believed the scheme meant ruin to Lyndhurst.—Mr. Head said he should object to the cars going into Lyndhurst at all.—Mr. Haines and Mr. Angove then had an interview with the board, and Mr. Haines said they intended to go entirely on the waste, and not to be within the authority of the Crown. They only proposed to go on the highway from Beaulieu-road to Gosport-lane. With regard to the passing places, they intended to arrange with the Crown for them, so as not to get on the highway at all. They proposed to carry passengers and goods. There would be no noise, no smoke, and no smell. —Messrs. Haines and Angove having withdrawn, the board proceeded to discuss the matter, Mr. Roy remarking that the plan of the promoters was incomplete. It should be clearly understood that the tramway should not be so near the road as to frighten the horses. The promoters asked to come within 15 feet of the centre of the road, and that was simply inadmissible.—Ultimately, Mr. Roy proposed the following resolution:—"That this board has a decided objection to allowing the electric tramway in close proximity to horse traffic on the score of danger, and the board observes that the promoters purpose to construct their line within 15 feet of the centre of the road, which, in their judgment, they find to be wholly inadmissible."—This was seconded by Colonel Macleay and agreed to.—Messrs. Haines and Angove were called in and informed of the decision, when Mr. Haines said he thought the difficulty might be got over by their taking in the waste on the other side of the road if the board would give it up.—Mr. Roy said the promoters must get the consent of the Crown for the passing places before they came to them again, or otherwise it would be of no use to do so.—Mr. Angove said they did not anticipate any difficulty on the part of the Crown.

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ON THE VOLTAMETRIC MEASUREMENT OF ALTERNATING CURRENTS.

BY A. E. KENNELLY.

It has until apparently quite recently been generally supposed that an electric current reversing its direction with the frequency that characterises what is commonly called an alternating current would not decompose water visibly; or, in fact, that if any decomposition did take place at the electrodes, the recombination at each reversal was so speedy and complete that no free gas was developed. It has been shown, however, lately, in a Paper by Messrs. Manœuvrier and Chappuis,* that when the electrodes are small free decomposition does take place, mixed gas being liberated at each. Since that time Professors Ayrton and Perry have contributed to the data on the subject in an article appearing in *The Electrician* of July 13th, 1888, and in which some very interesting phenomena observed with polarised electrodes are described, while it is mentioned that the quantity of gas liberated under given conditions is a function not only of the current density per unit surface of electrode, but also of the rate of alternation.

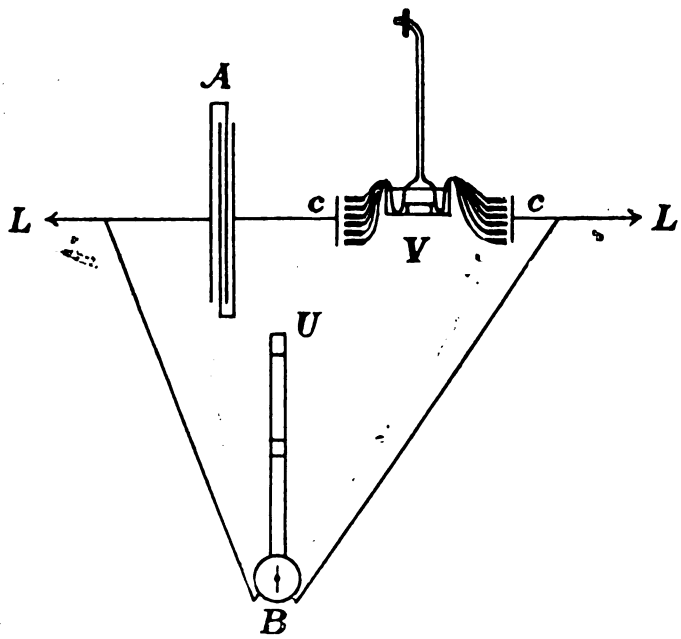

FIG. 1.

The statement of the connection that exists between these variables seems not to have yet been published. The following experiments made recently at Mr. T. A. Edison's laboratory for the purpose of investigating this matter show that under certain conditions the quantity of gas liberated is in very close accordance with that which a continuous current of equal strength would supply, and hence afford ground for the hope that it will shortly be possible to measure the strengths of alternating currents by the voltameter, as closely and as conveniently as in the case of continuous currents.

Two methods have been tried.

(1.) The condenser method, or incomplete metallic circuit.

(2.) The ordinary method with complete metallic and liquid circuit.

Several series of measurements have been made, all agreeing very fairly. The following series, taken at one time, will suffice for all.

The source of the alternating current was a Siemens alternating dynamo machine, designed for 100 volts, the electromotive force being very readily under control through the current in its field magnets, the speed of revolution being on the occasion of this experiment very steady at 1,470 per minute. At this speed its alternations being eight to the revolution are 196 per second.

The voltameter, Fig. 1, was of special construction. An ordinary glass evaporating dish, 11·5 centimetres in diameter and 6·3 high, was filled about two-thirds with a 10 per cent. (by weight) solution of pure sulphuric acid in distilled water, the density of this solution being 1·065 at 19° C. At the bottom of the dish was immersed a disc of resinous material, 5 centimetres in diameter and 1·2 centimetres high. Twelve platinum wires of different lengths, but equal diameter (0·0178 centimetres), projected vertically from the upper surface of the disc, so as to stand in a ring of 4 centimetres diameter, and equidistant from each other. These wires were ranged from 1·5 centimetres down to 0·025 centimetres in length, the corresponding wires across one diameter having as closely as possible equal lengths. Connections with rubber-covered wire, sealed in the material of the disc, made six little separate voltameters each with its own pair of insulated leads. By uniting more or less of these leads outside the instrument, the voltameter might be made to comprise any or all of the couples of electrodes, thus enabling a considerable range of electrode area to be at command, as shown by the table given below:—

Over this sextuple voltameter there rested a glass bell seven centimetres in diameter, terminating after 10 centimetres of elevation in a vertical glass tube of uniform bore 7·5 centimetres long and about 0·6 centimetres internal diameter, closed at the top by a rubber tube and fish clamp. This tube was graduated for volume by comparison with a burette, and found to have a capacity per linear centimetre, from several measurements, of 0·2684 ± 0·002c.c. In using the instrument, the tube and bell were filled with solution, and gas electrolytically generated until the latter stood at a certain mark near the top. All being ready, the measured current was then passed through the apparatus for a noted interval, at the end of which the length of tube occupied by gas was measured downwards from the fiducial mark.

In the condenser method the connections were as shown in the diagram—where A is the adjustable condenser; V the voltameter with commutators *c c* for connecting the separate couples of plates in multiple; B U a Cardew voltmeter; and LL the leads to the dynamo.

Under these conditions we know that the absolute quantity of current passing through the voltameter, assuming that the periodic variation of electromotive force follows the sine law,

$$Q = n\pi ekt \times 10^{-7} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where Q is the absolute quantity of electricity that traverses the voltameter in time t; e is the mean alternating potential = difference, as indicated by the Cardew voltmeter B; k is the absolute capacity of the condenser A; and r is the number of alternations per second.

This formula is thus independent of the resistance of the voltameter, which is quite negligible under these conditions. If V_0 be the volume of gas at zero centigrade theoretically

Nos. of couple	Diameter. cm.	Circumference. cm.	Length of each wire. cm.	Cylinder surface. sq. cm.	Section surface. sq. cm.	Total surface of each plate. sq. cms.	Sum of surface in multiple.	Greatest horizontal distance between wires forming couple.	Least horizontal distance.
1	0·0178	0·0559	1·5	$8·39 \times 10^{-2}$	$0·025 \times 10^{-2}$	$8·415 \times 10^{-2}$	$21·555 \times 10^{-2}$	—	—
2	,,	,,	1·0	$5·59 \times 10^{-2}$	,,	$5·62 \times 10^{-2}$	$13·140 \times 10^{-2}$	3·7 cm.	1 cm.
3	,,	,,	0·8	$4·47 \times 10^{-2}$	,,	$4·50 \times 10^{-2}$	$7·520 \times 10^{-2}$	—	—
4	,,	,,	0·4	$2·24 \times 10^{-2}$	,,	$2·27 \times 10^{-2}$	$3·020 \times 10^{-2}$	—	—
5	,,	,,	0·1	$0·56 \times 10^{-2}$	,,	$0·585 \times 10^{-2}$	$0·750 \times 10^{-2}$	—	—
6	,,	,,	0·025	$0·14 \times 10^{-2}$	,,	$0·165 \times 10^{-2}$	$0·165 \times 10^{-2}$	—	—

* See *The Electrician*, August 3, 1888, p. 403.

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No. of Trial.	Time of passage of current, in seconds.	Voltameter coupled in circuit.	Area of each compound electrode. sq cm.	Capacity k, inserted in A.	Cardew reading.	Corresponding mean alternating voltage. Volts.	Length of tube filled by gas. cm.	Corresponding vol. c.c.	Equivalent current, c, absolute units.	Calculated vol., V_0. c.c.	Vol. corrected to temp. 19° C. c.c.	Ratio of observed vol. / calculat'd vol.	Density of current per sq. cm. of either electrode, in amperes.
1	500	1, 2, 3, 4, 5, 6	$21{\cdot}56 \times 19^{-2}$	4	87° 45′	97·3	5·15	1·383	$12{\cdot}4 \times 10^{-2}$	20·87	22·32	0·062	1·12
2	300	4, 5, 6	$3\,02 \times 10^{-2}$	4	87°	96 8	18·7	5·02	$2{\cdot}39 \times 10^{-2}$	12·37	13 23	0 380	7·9
3	240	5, 6	$0{\cdot}75 \times 10^{-2}$	4	85° 30′	95 7	30·55	8·20	$2{\cdot}36 \times 10^{-2}$	9·78	10 46	0 784	31·5
4	120	6	$0{\cdot}165 \times 10^{-2}$	4	82°	93·1	9 3	2·50	$1{\cdot}15 \times 10^{-2}$	2·28	2·55	0 930	69·7
5	180	6	$0{\cdot}165 \times 10^{-2}$	4	84° 20′	94 8	27·7	7·44	$2{\cdot}34 \times 10^{-2}$	7·27	7·78	0 956	141 8
6	—	6	$0{\cdot}165 \times 10^{-2}$	4	83°	93 9	On making contact one of the electrode s of couple No. 6 burned.						
7	180	one of 5 and opposite of 6	$0{\cdot}585 \times 10^{-2}$ / $0{\cdot}165 \times 10^{-2}$	4	85° 15′	95·4	27·75	7·45	$2{\cdot}35 \times 10^{-2}$	7·31	7 82	0·953	av = 62.6
8	180	ditto	ditto	2	81°	92·4	11·65	3·13	$1{\cdot}14 \times 10^{-2}$	3·54	3·78	0·826	av = 30·4
9	180	ditto	ditto	5	82°	93·9	19·05	5·11	$1{\cdot}73 \times 10^{-2}$	5·35	5·72	0·893	av = 46·1
10	—	ditto	ditto	5	80°	91·9	On making contact the other electrode of No. 6 burned.						
11	120	5	$0{\cdot}585 \times 10^{-2}$	5	85°	95·3	24·5	6·57	$2{\cdot}93 \times 10^{-2}$	6·09	6·51	1·009	50·1
12	120	5	$0{\cdot}585 \times 10^{-2}$	5	85° 15′	95·4	24·5	6·57	$2{\cdot}94 \times 10^{-2}$	6·10	6·53	1·006	50·1
13	600	5	$0{\cdot}585 \times 10^{-2}$	*720 ω	80° 20′	92·1	26·25	7·04	$1{\cdot}22 \times 10^{-2}$	12·65	13·53	0·520	20·9
14	135	5	$0{\cdot}585 \times 10^{-2}$	*Lamps off-ering 230 ω	78° 00′	90·4	30·80	8·26	$3{\cdot}47 \times 10^{-2}$	8·09	8·65	0·955	59·3
15	135	5	$0{\cdot}585 \times 10^{-2}$		78° 00′	90·4	30·65	8·22	$3{\cdot}47 \times 10^{-2}$	8·09	8·65	0·950	59·3

* Resistance inserted in place of A.

decomposed by a continuous current, c, in absolute measure equivalent to the passage of this quantity, Q, we have

$$c = n\pi ek \times 10^{-7} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and

$$V_0 = 5{\cdot}43\, nekt \times 10^{-7} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Besides the Cardew voltmeter steady potential indication, a quadrant electrometer, not shown in the diagram, with its needle connected to one pair of quadrants, was employed to measure the potential difference at the voltameter terminals, and thus indicate its mean resistance.

The above table gives the results of ten measurements. The volume of the gas is corrected for temperature, but no correction is introduced for the barometric pressure or the tension sustained by the gas in the tube.

The condenser used was adjustable from 0·001 up to 5 microfarads, and is probably accurate to at least 0·5 per cent.

The last two columns show that—

When the density of current per square centimetre of either electrode was	The percentage of gas actually generated of that calculated as due was
1·12 ampere	6·2 per cent.
7·9	38 ,,
30·04 (average)	82·6 ,,
31·35	78·4 ,,
46·1 (average)	89·3 ,,
50 1	100·8 ,,
62·6 (average)	95·3 ,,
69·7	93·0 ,,
141·8	95·6 ,,

The trials Nos. 13, 14, and 15 were taken without condenser, and with non-inductive resistances in its place. In trial No. 13 this resistance was a length of fine platinum wire (hot). In trial Nos. 14 and 15 the resistance was a 96 volt 10 candle-power Edison lamp, offering 230 ohms resistance at equivalent illumination. In calculating the current strengths for these three observations, the resistance of the voltameter itself was required. It was measured in two ways—1st, by means of the quadrant electrometer, and the potential differences it indicated on the known resistance, and on the voltameter; 2nd, by rapidly substituting a non-inductive resistance alternately with the voltameter in the lamp circuit, and adjusting this resistance until the illumination was equal in both cases. These two methods concurred in showing the resistance of the voltameter to be 30 ohms, and the maximum resistance it offered through the whole series was 35 ohms.

The table shows that

When the current density per square centimetre of either electrode was—	The per cent. of calculated gas actually liberated was—
20·9	52
59·3	95·3

These results, corroborated by several previous series, go to show that for a rate of alternation of 200 per second, and currents of between 0·1 and 0·35 amperes, the quantity of gas generated by an alternating current in a voltameter is approximately equal to that generated by an equal continuous current when the mean current density at the surface of the electrode is above 50 amperes per square centimetre of each; that below that density the quantity of gas developed rapidly diminishes, and that below one ampere per square centimetre soon disappears.

Also that the resistance of a voltameter with very small plates, traversed by an alternating current, is much less than that it would offer to an equal continuous current. Were this not the case, the resistance of a voltameter for alternating current measurements might for many purposes prove prohibitively great.

HERTZ'S RESEARCHES ON ELECTRICAL OSCILLATIONS.

BY G. W. DE TUNZELMANN, B.SC.

(*Continued from page 698.*)

Other Positions of the Secondary Circuit.—Dr. Hertz made numerous observations with the secondary circuit in other positions, but in no case were any phenomena observed which were not completely in accordance with theory. As an example of these consider the following experiment:—

The secondary was first placed in the horizontal plane in the position V. (Fig. 8*), and the air space was in the position a_5 relatively to the primary. The circle was then turned about a horizontal axis through its centre and parallel to the primary, so as to raise the air space above the horizontal plane. During this rotation θ remained equal to 90°, and the value of β remained nearly constant, but α varied approximately in the same ratio as cos Ψ, Ψ being the angle between the plane of the circle and the horizontal, for α is proportional to the number of magnetic lines of force passing through the circle. Let α_0 be the value of α in the initial position, then in the other positions its value would be $\alpha_0 \cos \Psi$, and therefore the sparking distance should be given by the expression $\alpha_0 \cos \Psi + \beta$, in which α_0 was known to be greater than β. This was confirmed by observation, for it was found that as the air space increased its height above the horizontal plane the sparking distance diminished from 6 millimetres down to 2 millimetres, its value when the air space was at its greatest distance above the horizontal plane. During the rotation through the next quadrant the sparking distance diminished almost to zero, and then increased to the smaller maximum of 2·5 millimetres, which it attained when the circle had turned though 180°, and was therefore again horizontal. Similar results were obtained in the opposite order, as the circle was rotated from 180° to 360°. When the circle was kept with the air space at its maximum

* See *The Electrician*, October 5th, 1888, page 697.

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height above the horizontal plane, and then raised or lowered bodily without rotation, the sparking distance was found to diminish in the former case and to increase in the latter, results completely in accordance with theory.

Forces at Greater Distances.—Experiments with the secondary at greater distances from the primary are of great importance, as the distribution of E.M.F. in the field of an open circuit is very different according to different theories of electrodynamic action, and the results may, therefore, serve to eliminate some of them as untenable. In making these experiments, however, an unexpected difficulty was encountered, as it was found that at distances of from 1 to 1·5 metres from the primary the maximum and minimum, except in certain positions, became indistinctly defined; but when the distance was increased to upwards of two metres, though the sparks were then very small, the maximum and minimum were found to be very sharply marked when the sparks were observed in the dark. The positions of maximum and minimum were found to occur with the circle in planes at right angles to each other. At considerable distances the sparking diminished very slowly as the distance was increased. Dr. Hertz was not able to determine an upper limit to the distance at which sensible effects took place, but in a room 14 metres by 12, sparks were distinctly observed when the primary was placed in one corner of the room, wherever the secondary was placed. When, however, the primary was slightly displaced, no effects could be observed, even when the secondary was brought considerably nearer. The interposition of solid screens between the two circuits greatly diminished the effect.

Dr. Hertz mapped out the distribution of force throughout the room by means of chalk lines on the floor, putting stars at the points where the direction of the E.M.F. became indeterminate. A portion of the diagram obtained in this manner is

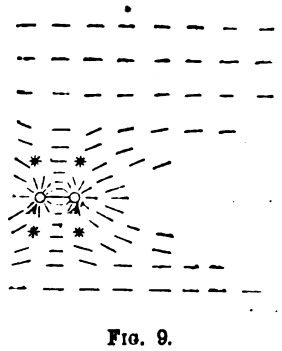

Fig. 9.

shown on a reduced scale in Fig. 9, with respect to which the following points are noteworthy:—

1. At distances beyond three metres the E.M.F. is everywhere parallel to the primary oscillation. Within this region, therefore, the electrostatic E.M.F. is negligible in comparison with the E.M.F. of induction. Now, all the theories of the mutual action of current elements agree in giving an E.M.F. of induction inversely proportional to the distance, while the electrostatic E.M.F., being due to the differential action of the two extremities of the primary, is approximately inversely proportional to the cube of the distance. Some of these theories, however, are not in accordance with the experimental result that the effect diminishes much more rapidly in the direction of the primary oscillation than in a direction at right angles to it, induced sparks being observed at a distance exceeding 12 metres in the latter direction, while they disappeared at a distance of about four metres in the former direction.

2. That, as already proved, for distances less than one metre the distribution of E.M.F. is practically that of the electrostatic E.M.F.

3. There are two straight lines, at all points of which the direction of the E.M.F. is determinate, namely, the line in which the primary oscillation takes place, and the perpendicular to the primary through its middle point. Along the latter the E.M.F. does not vanish at any point, the sparking diminishes gradually as the distance is increased. This, again, is inconsistent with some of the theories of mutual action of current elements, according to which it should vanish at a certain definite distance. A very important result of the investigation is the demonstration of the existence of regions within which the direction of the E.M.F. becomes indeterminate. These regions form two rings encircling the primary circuit. Since the E.M.F. within them acts very nearly equally in every direction, it must assume different directions in succession, for, of course, it cannot act in different directions simultaneously.

The observations, therefore, lead to the conclusion that within these regions the magnitude of the E.M.F. remains very nearly constant, while its direction varies through all the points of the compass at each oscillation. Dr. Hertz states that he has been unable to explain this result, as also the existence of overtones, by means of the simplified theory in which the higher terms of the expansion of F are neglected, and he considers that no theory of simple action at a distance is capable of explaining it. If, however, the electrostatic E.M.F. and the E.M.F. of induction are propagated through space with unequal velocities, it admits of very simple explanation. For within these annular regions the two E.M.F.'s are at right angles and of the same order of magnitude; they will therefore, in consequence of the distance traversed, differ in phase, and the direction of the resultant will turn through all the points of the compass at each oscillation.

This phenomenon appears to him to be the first indication which has been observed of a finite rate of propagation through space of electrical actions, for if there is a difference in the rate of propagation of the electrostatic and electrodynamic E.M.F., one at least of them must be finite.

At the end of the Paper in which the preceding experiments are described Dr. Hertz describes some observations which he has made on the conditions at the primary sparking point which affect the production of sparks in the secondary circuit. He finds that illuminating the primary spark diminishes its power of exciting rapid oscillations, the sparks in the secondary being observed to cease when a piece of magnesium wire was burnt, or an arc lamp lighted, near the primary sparking point. The observed effect on the primary sparks is that they are no longer accompanied by a sharp crackling sound as before. The effect of a second discharge is especially noteworthy, and it was found that the secondary sparks could be made to disappear by bringing an insulated conductor close to the opposed surfaces of the spheres forming the terminals at the primary air space, even when no visible sparking took place between the latter and the insulated conductor. The secondary sparking could also be stopped by placing a fine point close to the primary air space, or by touching one of the opposed surfaces of the terminals with a piece of sealing-wax, glass, or mica. Dr. Hertz states that further experiments have led him to conclude that, even in these cases, the effect is due to light too feeble to be perceived by the eye, arising from a side discharge. He points out that these effects afford another example of the effects of light on electric discharges, which have been observed by E. Wiedemann, H. Ebert, and W. Hallwachs.

(To be continued.)

ALUMINIUM AND ALUMINIUM ALLOYS.*

The Swiss Metallurgical Society in Lauffen-Neuhausen, Canton Schaffhausen, has succeeded in producing aluminium alloys in large quantities by means of Hérault's method. In this method the electric current is employed for fusing refractory earths containing aluminium. The negative electrode is composed of the metal, copper, iron, or tin, with which it is desired to alloy the aluminium; the positive electrode is composed of a group of carbons dipping into the molten argillaceous earth. The current is generated at these works by means of a vertical 300 horse-power Jonval turbine (Fig. 1) driving two dynamos of 6,000 amperes and 20 volts each, which are excited by a smaller Erreger

* Abstracted from the *Schweizerische Bauzeitung*, 4th August, 1888.

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dynamo. The turbine has been specially built for this purpose by Messrs. Escher, Wyss and Co., of Zurich.

The dynamos were specially constructed for this large current. The construction of these giant machines—Figs. 2, 3 and 4—was undertaken by Mr. C. E. Brown, at the Oerlikon Engine Works, and this system of construction, in which the armature wire is wound through holes in the shaft of the armature, was found specially

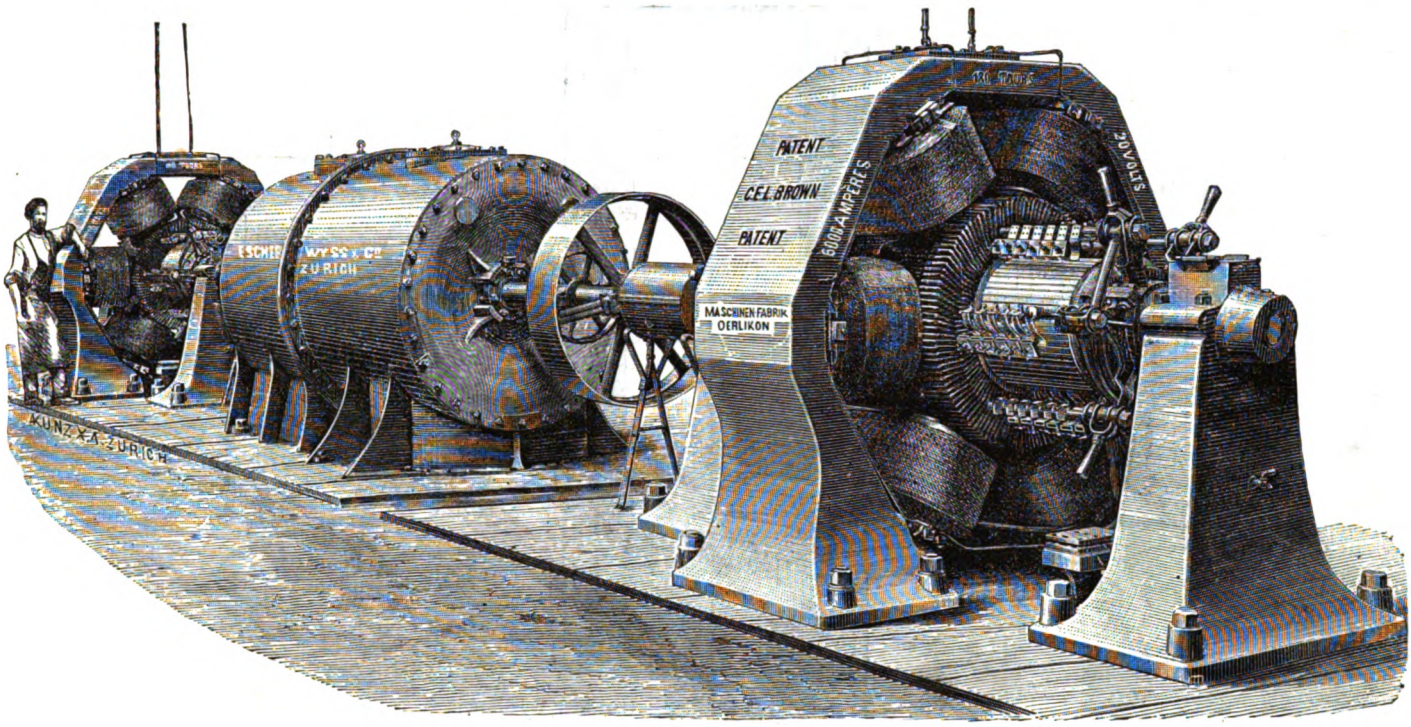

FIG. 1.—Turbine and Dynamos. Perspective View.

suitable. The machine has six field magnets, and consists of a single casting of 10,000 kilog. in weight. The field magnets are separately excited. The armature has two separate windings, each of which has six parallel divisions. Each machine has two large collectors, and no less than seventy-two brushes. Copper cables of the thickness of a man's arm conduct the electric current from the

The positive pole is formed by a group of carbons B, made up of plates *b*, while the negative pole consists of molten metal at the bottom of the carbon crucible A; the floor of this crucible has an escape closed by the carbon rod C. In Figs. 5 and 6 the general arrangement of the apparatus is represented. On the floor is a box *a* of iron or other metal, insulated at the bottom and open at top; this is fitted with a lining of carbon plates, which are then cemented together with either tar, sugar, or syrup, which surrounds and secures the basin A. In the box *a* are a number of copper pins a^1, which conduct the negative current. The positive electrode plates, *b*, are placed separately one over the other. These carbon plates may be so arranged as to have spaces between them which can be filled in with a good conductor like copper or soft carbon.

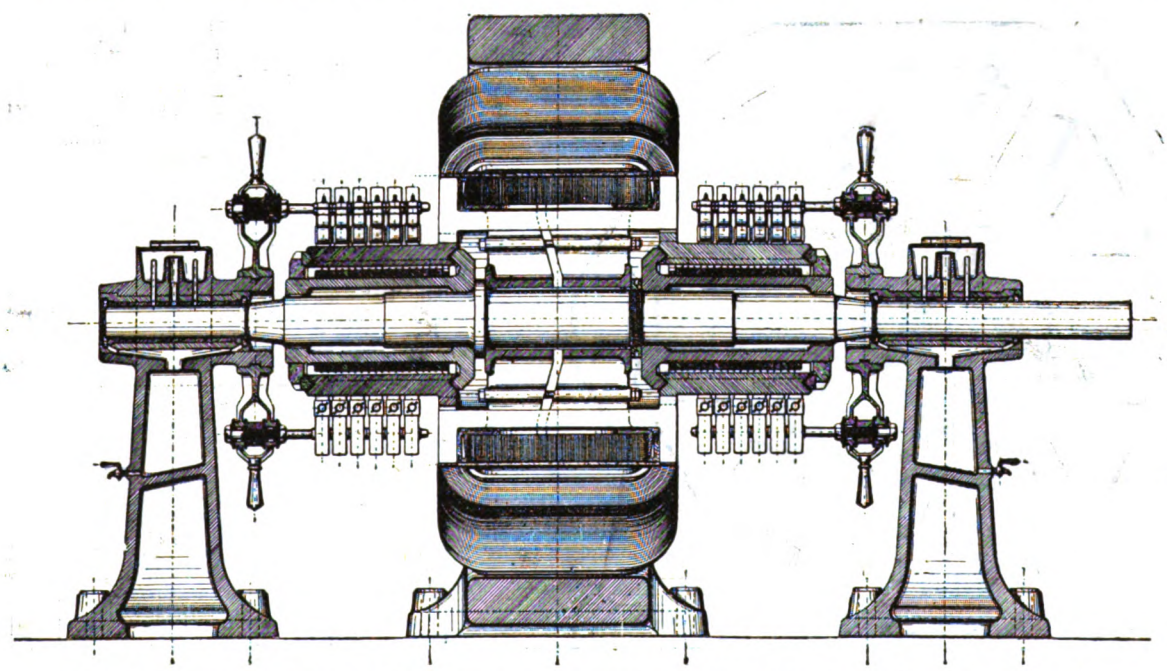

FIG. 2.—120-Kilo-Watt Oerlikon Dynamo. 6,000 amperes, 16 to 20 Volts. Longitudinal Section.

machines to the oven. The general plan of the works is shown in Fig. 7. The current from both dynamos is passed to the positive electrode in the furnace. The smelting takes place in a carbon crucible A. This is surrounded by a metallic covering connected with the negative cable.

The upper ends of the carbon plates, *b*, are connected by the cap, *g*, the loop, *e*, of which serves as a link to a chain, by means of which the carbon bundle is brought into position, and can be raised or lowered as desired.

With the exception of the space *i* necessary for the play and the

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vertical motion of the carbon bundle, the opening of the basin B is covered by graphite plates, k, in which are left a few holes, n, for the introduction of materials. Corresponding to the openings, n, grooves, m, are necessarily made in the side walls of the basin. These channels, $m\,n$, also serve as an escape for the gases generated in the basin. The movable plates, o, provided with handles, o^2, serve as coverings to the openings, n, during certain phases of the smelting process. The space, k^1, between the graphite plate, k, and the rim of the box, a, is fitted with charcoal powder.

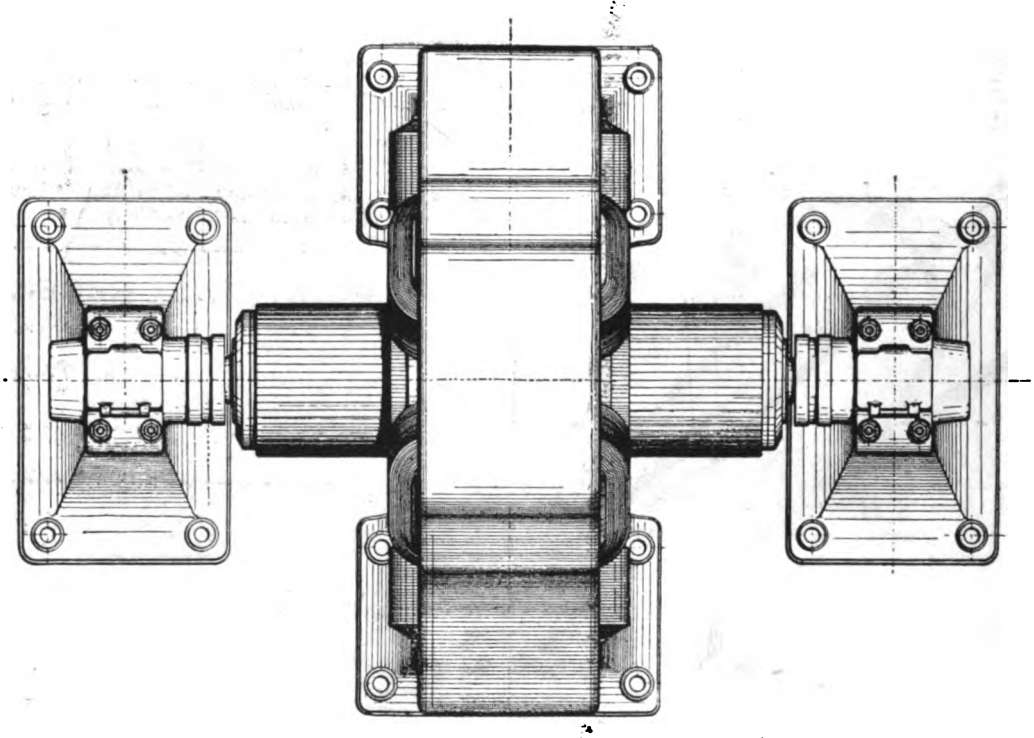

FIG. 3.—Plan of 120-Kilo-Watt Oerlikon Dynamo.

earth, Al^2O^3, is put into the basin and the bundle B is lifted a little higher. Now the current will pass through the argillaceous earth, which melts and decomposes. The oxygen attacks the carbon $b\,b\,b$ and breaks it up, so that carbonic oxide gas escapes from the basin; the aluminium dissociates from its oxygen combination and flies to the copper, so that direct aluminium bronzes are formed. The basin is now fed according to the progress of the smelting with copper and argillaceous earth.

The carbon bundle must, as stated before, be raised or lowered according to the resistance. But this can be automatically regulated by means of the chain supporting the bundle B, which can be put into communication with a reversible electric motor—regulated by the ammeter—which acts as an electrical regulator. To let off the collected fluid aluminium bronzes, the ingot mould l is placed under

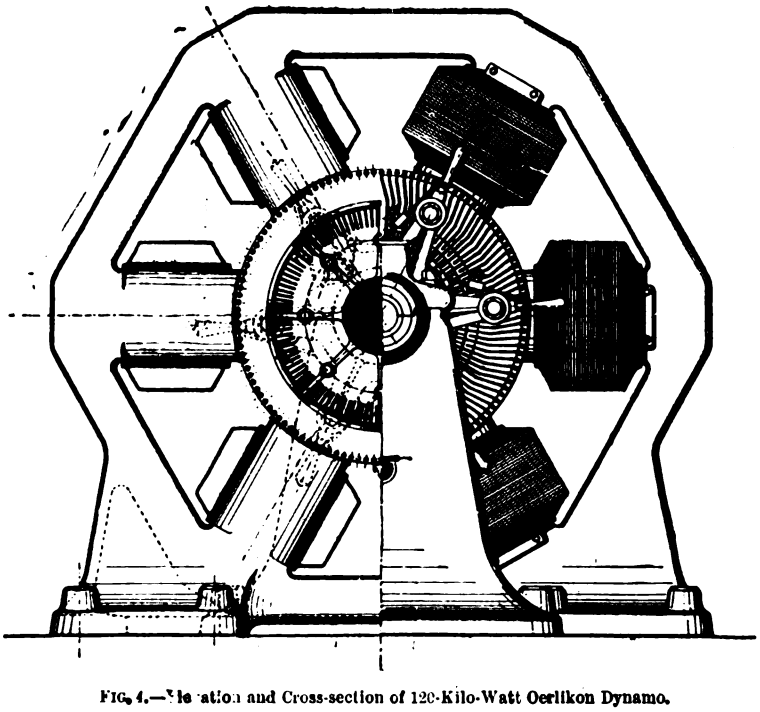

FIG. 4.—Elevation and Cross-section of 120-Kilo-Watt Oerlikon Dynamo.

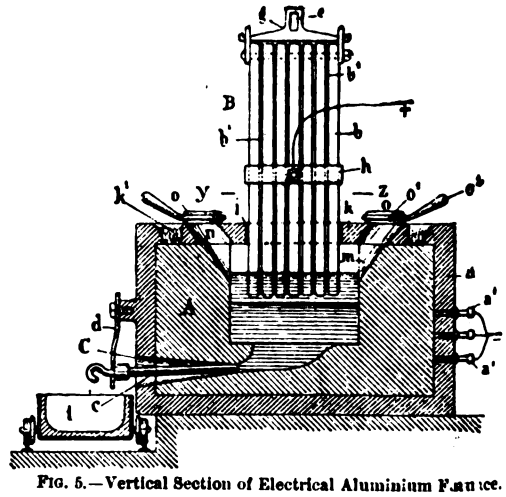

FIG. 5.—Vertical Section of Electrical Aluminium Furnace.

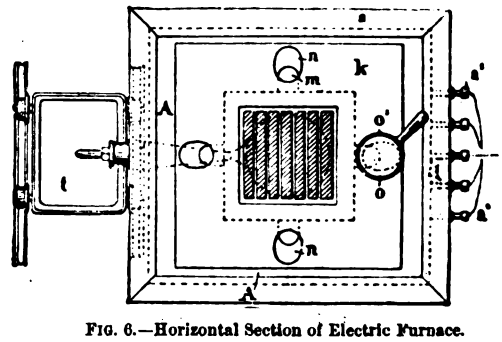

FIG. 6.—Horizontal Section of Electric Furnace.

The process is commenced by placing copper broken up in small pieces into the bottom of the crucible A; the carbon bundle B is hereupon brought nearly into contact with the copper; the current goes through the copper and melts it. As soon as the bath of fluid copper, which serves as the negative pole, is ready, argillaceous

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the tap-hole *c* C, and the channel *c* opened by removal of the carbon bolt. The best current has been found to be one of about 12,000 to 13,000 amperes, and of about 12 to 15 volts.

Metal.	Tensile strength. Kg per mm.².	Extension. Per cent.
Aluminium Bronze A	34·6	25·4
,, B	38·4	27 4
,, C	36·4	34·3
,, D	48·	37·5
,, E	51·6	29 2
,, F	56·	23·
,, G	62·1	18 5
,, H	64·	7·
Aluminium brass	48 1	20·7
Steel for artillery tubes	55·	14·
*Bar iron	38·	22·
*Delta metal	38·	20·
*Industrial bronze	23·	8·0
*Phosphor bronze	29·	17·
*Manganese bronze	29·	17·
*Durana metal	36·	22·

*Verified by Professor Tetmajer.

This process admits of the production of all forms of aluminium alloys, excepting such metals as evaporate at the melting point of aluminium. Directly mixed combinations can also be effected, as, for instance, a combination of copper with silicium and aluminium, by the use of silicate of alumina instead of argillaceous earth.

With the installations of the Swiss Metallurgical Society it is possible to produce daily 300 kilogs. of aluminium, or 3,000 kilogs. of 10 per cent. aluminium bronze. Production is continuous, as the furnace can be worked for months day and night, and can be either entirely or partially emptied by means of the tap-hole. Below are some results of experiments made by Professor Tetmajer, at the Polytechnic of Zurich, with aluminium obtained from the furnace.

The brass used in the experiments is an aluminium bronze; and brasses were cast, and had not undergone any further manufacturing process beyond being turned. These aluminium copper alloys need not, however, be cast, since they can be easily hammered, rolled, or drawn.

Aluminium brass and ferro-aluminium are two very remarkable aluminium compounds. The former is distinguished for its hardness and tensile strength; the latter, if added in small quantities to steel, insures this a clear and limpid casting. The production of ferro-aluminium is similar to that of the bronzes, inasmuch as the iron takes the place of the copper.

On July 30th the inauguration of this installation took place in the presence of the shareholders and directors. It worked very satisfactorily. Although designed for 12,000 amperes, the dynamos could yield 25,000 amperes without any interruption.

BOOKS, &c., RECEIVED.

"Calendar of University College, Liverpool, for the Session 1888-1889." (Liverpool.)

"The New County of London." By HARRY WILKINS, Vestry Clerk of St. James', Westminster.

"La Télégraphie Actuelle en France et l'Étranger." By L. MONTILLOT. (Paris: J. B. Baillière et Fils.)

"Catalogue des Livres de Fonds et d'Assortiment." (Paris: Gauthier-Villars et Fils.)

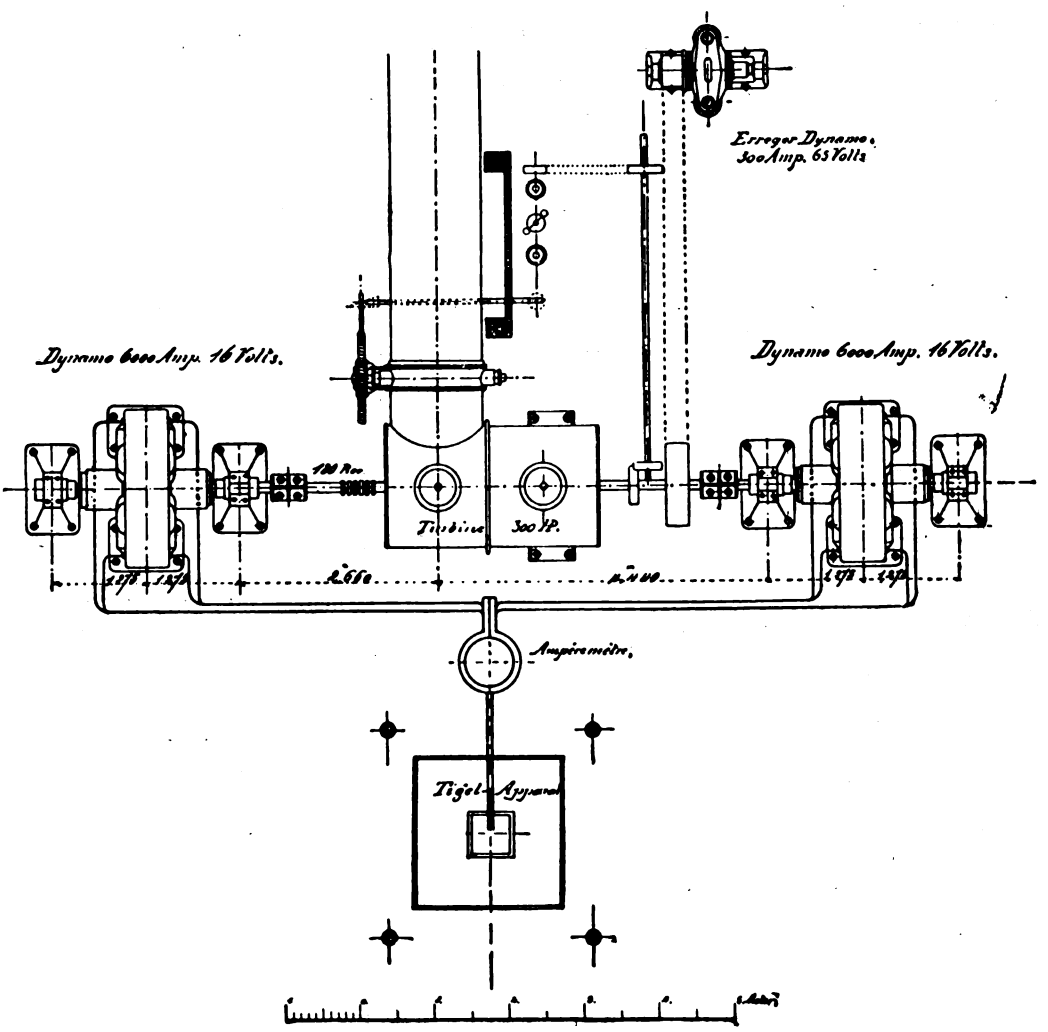

FIG. 7.—Plan of the Works of the Swiss Metallurgical Society.

LEGAL INTELLIGENCE.—THE MAXIM-WESTON ELECTRIC COMPANY, LIMITED.—On Wednesday last, upon the application of Mr. Marten, Q.C., Sir James Hannen, sitting as Vacation Judge, postponed the petition of H. Watt for a winding-up order till the first petition day in the next sittings. At the same time the motion to restrain the company from neglecting or refusing to register transfers of shares was postponed till the second motion day in the next sittings.

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PRACTICE versus THEORY.

It is one of the commonplaces of modern physical science to say that pure theory has advanced *pari passu* with the growth of the practical applications of scientific knowledge, and that their indebtedness is mutual. There was a time when this fact was not recognised, and a still earlier period when it was not even true. The cultivation of knowledge for its own sake has in most departments of science preceded its application to the useful arts. It is also true that a quite unnecessary feeling of superiority was once manifested by the devotees of pure science towards those whose labours were more directly devoted to the immediate service of mankind—including themselves, of course. Now, however, it must be confessed that the tables have been turned. It is the practical man who talks with good-natured pity of the "mere theorist," and it is the theorist who comes with hat in hand to the man of practice and begs to know if he is disposed to consider favourably this or that suggestion. Of course, amongst the leading exponents of either branch of the craft this demeanour, if it exist at all, must be taken to be more or less assumed for the occasion. The practical man has seen too many of the triumphs of theoretical prediction to feel quite comfortable, even when he affects to despise its latest prognos-

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tications. The theorist, on the other hand, possesses a well-founded conviction that the result of a mathematical investigation, so long as it is based on correct and sufficient data, affords the nearest approach to absolute certainty which is permitted to us in this mundane sphere. He knows, however, that the data must be obtained by experimental methods, and that both the experiments and the deduction may be liable to misinterpretation. The theorist is, therefore, too well aware of the advantages of long continued experiment on a scale of magnitude unapproachable in the laboratory to feel quite satisfied until theory and practice have been finally reconciled. In view, then, of the somewhat sharp dissension which at this moment exists on the subject of lightning flashes, and particularly in view of the somewhat irreconcileable attitude which the "practical" side appears for the moment to have assumed, we may be pardoned if we venture to offer a few considerations on the general question of the relationship between Theory and Practice.

In the first place, it may be remarked that no useful purpose is served by any treatment of the question which sets or attempts to set these two in sharp antagonism. Both Theory and Practice advance by and appeal continuously to Experiment. But to some extent it may with truth be said that the former is content to end where the latter begins. Theory appeals to Experiment for confirmation of the conclusions which exact reasoning—usually, that is, mathematical reasoning—has deduced from the data previously in its possession. Thus the work of the theorist ends with Experiment. But it is with Experiment (guided more or less by theory) that Practice begins, and it is not until reiterated Experiment has developed into Experience that Practice becomes firmly established. But here we must carefully distinguish between the experiment of the practical man and that of the theorist, for in general these are quite distinct in kind. The latter may be described as Pure, and the former as Mixed, experiment. Without intending anything invidious, we may say that the distinction is like that between a chemist performing an analysis and a cook concocting a soup. In Pure experiment we seek to reduce a single phenomenon to its most elementary form, and to eliminate every extraneous condition. It is true that this ideal type is seldom or never fully realised, and it is here that the aid of mathematics is invaluable in enabling us to estimate the direction and the extent of the various perturbations. The experiments of the practical man, on the other hand, are not at all of this character. He aims at producing some particular concrete result, and, provided the working conditions are ascertainable and "practicable," he cares little how complex they may be from the theoretical standpoint. As a general rule, his experiments entirely defy complete theoretical analysis. If he meets with a perturbing element his chief anxiety is not so much to discover its ultimate cause, but merely to know enough about it to enable him to ensure its suppression. The attention of the theorist, on the contrary, is immediately arrested by any such unexpected effect, and, so far from endeavouring to get rid of it, he will probably make it the subject of special investigation. When he has succeeded in bringing the phenomenon to a certain stage of development he comes, perhaps, in conflict with the practical man, who tells him that in the whole course of his experience he has never met with anything of the kind, overlooking the fact that his endeavour has been to mask or eliminate the conditions of its existence.

Another source of discord, and another reason, perhaps, for the evident scorn with which the theorist is sometimes regarded, arises from the fact that the problems which are so readily and so successfully attacked by the practical man, with a view only to the practical result, are nearly always much too hard for the theorist to grapple with in their entirety—we mean, of course, with an eye to what, from *his* point of view, would be regarded as their complete elucidation. The theory of the transmission of signals upon a telegraph wire is a much simpler matter to Mr. PREECE than it is to Mr. OLIVER HEAVISIDE. Mr. PREECE, no doubt, is quite sufficiently acquainted with the facts of the case to enable him to secure a remarkably efficient telegraph service, but it may yet prove that Mr. OLIVER HEAVISIDE'S far more complex theory approximates nearer to the ultimate truth. We hear sometimes of the "sweet simplicity of Nature;" but to the man of science the sweet simplicity seems to be chiefly exemplified in the brains of those who employ the phrase—if in any other than a poetic sense. For all that can be asserted to the contrary, it may rather be that the complexity of Nature is infinitely profound. As some one has finely said, "Every enlargement of the area of light within which we stand but increases the periphery of the surrounding darkness."

With regard to the particular controversy which is now raging, it may be remarked that the difficulties of the question are much increased by the fact that the data must necessarily be derived from observation as well as experiment. Now it is only since theory has indicated the probability of certain conclusions being justifiable that attention has been directed to the particular kind of observation which is required to furnish evidence for or against these conclusions. This fact should at least lead to a suspension of judgment until the needed observations have been made. And meanwhile, seeing that the opinions arrived at on theoretical grounds are by no means devoid of experimental evidence, we think it unwise, to say the least, for anyone to assume an air of superior knowledge, and to assert positively that practical experience has already proved the theory to be untrue.

REVIEWS.

The Steam Engine Indicator and Indicator Diagrams. By W. WORBY BEAUMONT, M.Inst.C.E., M.Inst.M.E., &c. (*The Electrician* Printing and Publishing Company, London: 1888.)

This is a thoroughly practical work embodying much useful information on the various indicators now in use, and containing a very good collection of diagrams. Though divided into 14 parts or chapters, the book really consists of two sections, the first dealing with the history, construction, and use of the indicator, and the second being devoted to the study of the various diagrams to be obtained from the many types of engines now in use, both steam and gas, and the lessons to be learnt from them, with a short account of the theoretical steam curves. We will deal with the book in these two divisions; the first covers Parts I. and II., and after a brief account of the value of the indicator, proceeds to describe the instrument, beginning naturally with the historical Watt and ending with the modern Crosby. The simultaneous progression of the indicator with the engine is clearly brought out; with the early slow speeds and pressures, the long-range spring, and a board moved backwards and forwards for the paper answered quite well, but with increased speeds and pressures both these devices failed, the first step being to substitute the paper drum with its enclosed spring for the board, and the next to do away with the old long-range spring, the violent oscillations of which absolutely destroyed all the value of the cards. Richards' indicator, with its parallel motion for enlarging the spring motion and other valuable improvements, held the field and did grand service

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till once more the march of progress carried the engine beyond its powers. As speeds and pressures again increased the indicator behaved almost as badly as of old in the way of oscillations, and again inventors set to work to produce instruments fit for their purpose, such as Darke's and Crosby's. The great object, as the author points out, is to reduce the range of the spring, and to decrease the weight of the moving parts so as to do away with oscillations and the effect of inertia. From practical experience we can pay testimony to the excellence of the Crosby for high speeds; it is really a most beautiful instrument, every detail of which has been most carefully thought out, from the socket joint where the spring sits on the piston (allowing the piston and spring free play and reducing greatly the chance of jamb) to the reduction of length of one of the two clips on the paper drum. One point in this indicator of great importance is dwelt on to some length in the text, namely, the increase of tension of the spiral spring in the drum as the latter revolves, thus securing a uniform tension in the card. In dealing with the method of attachment of indicator to cylinder we gladly note that much stress is laid on the necessity of short wide connections, and also on the importance of obtaining a correct motion for the paper drum, an apparently trifling error in the driving of which may often hopelessly distort a card. We regret that a little more information is not given as to the probable causes of errors in indicators, and the best means of overcoming them. Thus, it is quite certain that the springs, though nominally graduated hot, when tested often fail to give results in agreement with their scale, the error being sometimes as much as 2 or 3 per cent., and, further, they do not give the same results going up and coming down; no engineer should think of using springs, at any rate if he wishes to obtain real results, without testing them for himself. Other errors, such as those due to excessive pressure of the pencil on the paper, can be guarded against by care on the part of the operator. We would refer those interested in this important subject to the Paper, and discussion on it, "On the Theory of the Indicator and the Errors in Indicator Diagrams," Vol. LXXXIII. of the *Proceedings* of the Institution of Civil Engineers. The second division we have above referred to, consisting of Parts III. to XIV., deals with cards obtained from various engines, discussing their form, comparing them with the theoretical cards, and pointing out how errors in valve-setting, &c., and the amount of condensation and re-evaporation of steam in the cylinders, may be learnt from them. On page 57, in dealing with the card taken from an old atmospheric engine, there is a slight error; the horse-power should be 15·31, not 15·83, as given, so that there is a distinct gain of power even at the reduced speed. We do not quite follow the reasoning in regard to this card on page 60, which seems somewhat involved. We would here point out that there is some slight confusion caused by the way the expression "high pressure" is used; thus, it seems rather awkward to speak of an engine using 30 or 40lb. steam as "high pressure." Surely, it should, if used at all, be confined to engines using 100 to 200lb. steam, but it would be better to keep the expression as a means of distinguishing a non-condensing from a condensing engine, and use it only for engines of the first of these two classes.

In our opinion the construction given on page 79 for finding the true point of cut-off is a little easier for use in drawing the hyperbolic curve than the one actually given on page 76, as it involves drawing rather fewer lines. While thanking the author heartily for his insistance again and again on the necessity of taking the clearance spaces into account, we would remark that if any real results are to be obtained the correct clearance must be used (it can generally be pretty accurately measured off the drawings), and not a mere guess made at it. It is a slip, we suppose, when on pages 114 and 119 the author speaks of the construction giving a means of ascertaining the amount of clearance, since before the construction can be carried out the clearance must be known. What it does do, however, is to fairly well approximate to the amount of initial condensation (it can never give this accurately, since there is probably always some of this condensed steam not re evaporated even in the very best of engines), and taken along with actual feed measurements it may yield very valuable results.

The useful formula given on page 81 for calculating the mean pressure, viz., $p = \frac{P(I+H)}{R}$, is quite readily adapted to the case when clearance is taken into account, by substituting for I in the formula, $\frac{V_1}{V_0}$, where V_1 is the volume of steam at cut off neglecting clearance, V_0 this volume plus the clearance, and for H and R using the real expansion, including clearance volume, thus, in the example given $\frac{V_1}{V_0} = \frac{2}{3}$, and, therefore, $p = 75\left[\frac{\frac{2}{3}+1\cdot098}{3}\right] = 25 \times 1\cdot765 = 49\cdot125$. Similar tables to those given for the adiabatic curve are also given for the constant-weight curve in Northcott's "Steam Engine," and will be found extremely useful by students. In discussing the advantages in reducing the range of temperature in the cylinder, and thereby the initial condensation of steam by using compound systems, the tandem compound hardly receives its due. The author seems to have overlooked the fact that in a single cylinder engine the lowest temperature is really that of the condenser, for the cylinder is in direct connection with it during exhaust, while in the tandem, even if steam is not cut off till quite late in the stroke in the low-pressure cylinder, the high pressure lowest temperature is considerably greater (probably 70 or 80 degrees) than that of the condenser. Part XIII. is devoted to gas engines and their cards, and is a highly interesting chapter, while Part XIV. briefly describes methods of measuring cards by ordinates and by planimeter. The great value of the planimeter is its use as a check on the ordinate method when a great number of cards have to be worked out, which can be done by picking out a few cards and going over them with the planimeter. In conclusion, we have to express a warm welcome for a most useful, practical, and thoroughly readable book, which will prove a valuable addition to the library of those engaged directly or indirectly with prime motors.

T. H. B.

Telegrafia Militar: Applicaciones de la Cana Bambu a la Telegrafia Semi-Permanente. Por el Capitan D. RAFAEL PERALTA. (Madrid: 1888.)

This pamphlet, consisting of about eighty pages, is written solely with the object of advocating the use of bamboo canes for telegraph posts, not only for temporary military lines, but also, in the author's words, for "semi-permanent telegraphy."

The author does not pretend that the use of bamboo for military lines is a new idea, and acknowledges that such posts actually form part of the telegraph equipment of several European armies; but he entirely disagrees with the generally accepted mode of employing them, and quotes from a variety of reports (principally English) referring to the Abyssinian, Ashantee, and Afghan campaigns, and experiments made in different countries; the result of his investigations being—first, that the length of the bamboo poles hitherto used has never exceeded from 6 to 7 metres—being generally about 4 metres; second, that only in Abyssinia has bamboo been used without insulators, and that the line worked satisfactorily; third, that the weak point is the preservation of the poles.

In the second chapter, the writer affirms from actual experience in the Philippines that the bamboo sometimes attains a height of 35 metres, but it usually does not exceed from 20 to 25, and in the latter case the outside diameter at the base would be about 20 centimetres, while in the third-class canes this measurement would be reduced to 7 centimetres. In consequence of the immense destruction of bamboo at the time of the earthquakes in 1880 the canes now found in the market rarely exceed 13 metres in length, the price being about £7 per hundred. The author is without data as to the strength or breaking strain of the bamboo, but he considers they possess very great resistance and elasticity. That the bamboo cane has an extremely low conductivity is proved, he says, 1st, by the fact that it is never struck by lightning, notwithstanding its height, thus forming a very favourable contrast with the palm, which in this respect has a bad reputation

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2nd, the structure of the cane, which is full of air cells; 3rd, its fibrous nature, being composed of numberless cells and channels; 4th, that a short time after being cut no sap or moisture is to be found in it; 5th, its excellently-polished surface forming a natural insulator; 6th, the unanimous opinion of telegraph-engineers, who state that both in wet and dry weather it insulates better than any wood. The writer then proceeds to criticise the manner in which the bamboo has hitherto been used, and expounds his own ideas on the subject. Better results may, he thinks, be obtained by using canes 13 metres long—2 metres below ground and 11 metres above—the distance from post to post being 300 metres. The copper wire adopted by the German War Office does not find favour with the author; although its diameter is two millimetres, its breaking strain is only 150 kilogs, and he decides for the type used in Holland, viz., steel wire of 2·5mm., whose breaking strain is 414 kilogs, weight 40 kilogs per kilometre, and resistance 8·5 ohms. Insulators proper he considers unnecessary, and, after discussing various plans, the choice finally falls on a piece of bamboo a few inches long, which is to be passed over the top of the pole, and is detained a little way down by the increased diameter of the post. This novel insulator is encircled by an iron ring turned up at the joint to form a hook or loop, though which the line passes. The insulator is slotted, to prevent, as the author says, a continuity of water during heavy rains.

The end of the post to be buried is recommended to be cut at 10 centimetres below a knot, and this hollow filled with tar or a like substance. The hole for the reception of the post may be opened to 80 centimetres with a bar, and after this, the pole, which is provided at the end with an iron screw, may be worked down to the required 2 metres.

No damage whatever to the line is apprehended from the wind when blowing at right angles to it. Although on account of the great elasticity of the bamboo the oscillations of the posts would be considerable, yet they would coincide, but injury is admittedly possible when the wind blows along the wire, and it is insisted upon that the conductor should run very freely through the iron loop on the insulator.

Two points in this marvellously ingenious scheme require further elucidation. How does the author propose to bind his wire (say, at every second or third post) to prevent, in case of breakage, his line from running down from end to end, since he insists that the wire is to run freely through all insulators? And further, should such a calamity occur, where does he purpose seeking the fire escape necessary for replacing his wire on the top of a bamboo cane 11 metres in height?

"Betrieb der Galvanoplastik mit Dynamo-Elektrischen Maschinen zu Zwecken der graphischen Kunste" (Electro-deposition with Dynamos in its Application to Engraving). By O. Volkmer. 246 pp. (Hartleben, Leipsic, 1888.)

This little work forms the hundred-and-sixtieth volume of Hartleben's chemico-technical library. The first fifty-eight pages of the text are devoted to a short sketch of the dynamos and steam and gas engines used in electro-plating works in Germany and Austria, with some brief explanations of the general principles of continuous-current dynamos. Pages 173 to 217 are occupied with short descriptive accounts of the various chemicals used in electroplating. These portions of the book appear to be designed to give intelligent workmen employed in this industry some general idea of the principles on which it is founded, a purpose for which the exposition is very well adapted, and calculated to lead the more aspiring ones to further inquiries into the science of their work.

The rest of the volume, beginning with the second chapter, is of considerable interest to electricians. This chapter, in addition to some general remarks on electrolysis, contains much valuable information on the composition and management of the depositing solutions, and the conditions which must be fulfilled in order to get deposits of the best quality. The description of the results of a series of experiments by Baron von Hübl, a captain in the Austrian artillery, on the relation between the physical properties of electrolytic copper and the density of the depositing current, are of exceptional interest. The third chapter contains an account of some important works in Vienna, where electro-plating for engraving purposes is carried out on a considerable scale—viz., the Institute of Military Geography, of which Baron Hübl is the technical referee, and the Imperial printing works. The fourth chapter deals in some detail with the various processes of electro-typography, and the information contained in it, which is the result of the author's extensive practical experience, is of the highest value to all who are interested in this branch of electrical industry; and principally on account of this chapter we would specially recommend the book to the attention of all such as are able to read German. It will perhaps not be out of place in this connection to point out to students intending to devote themselves to any branch of electrical industry, the great importance of acquiring a knowledge of this language, which will open up many otherwise unavailable sources of information.

Applied Mechanics Questions. By the Professor of Engineering in the Glasgow and West of Scotland Technical College. (Morgan and Co., Glasgow. 1888.)

This collection of questions (with answers to some) is divided into three distinct sections—Elementary, Advanced, and Honours, and each of these sections is again subdivided and arranged in a natural order under sub-headings, so that a student may have as little trouble as possible in selecting suitable examples. These questions should form a great and much-needed help to engineering students studying for the Science and Art and City Guilds of London examinations. They are neatly printed, and published at 8d. by Messrs. John W. Morgan and Co., 129, Sauchiehall-street, Glasgow. No teacher or student of applied mechanics should be without a copy.

The New County of London, showing the practical working of the Local Government Act, 1888, as applied to the Act. By Harry Wilkins. (London: G. Shield, 30, Sloane-square, Chelsea, 1888.)

In a pamphlet of 24 pages, Mr. Wilkins, Vestry Clerk of St. James, Westminster, gives a popular summary of the main provisions of the Local Government Act, as applied to the metropolis. After a reference to the area of the new county, he describes the constitution of the electorate, and then proceeds to mention the constitution of the council, the qualifications and disqualifications of councillors and aldermen, the powers and duties of the council, the financial arrangements of the Act, the police, and the judicial officers of the new county, concluding his remarks by criticising the principles of the Act, so far as relates to the creation of London into a county, and winding up by suggesting certain simple and effective reforms in the system of local government in the smaller areas.

The pamphlet may prove of considerable use to those of our friends whose duties bring them into conjunction—conflict we were going to write—with the public authorities of the metropolitan area.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

Section II.—Electro-Magnetic Fields.

(Continued from page 707.)

131. *Apparatus for Measuring the Relation between Magnetising Force and Intensity of Magnetisation.*—We shall now consider some of the practical details of a simple test to measure the changes in the intensity of magnetisation acquired by an iron or steel rod, when the current in the coil which surrounds the rod is gradually increased. The practical example given below of a test of this kind will serve as a guide, although the effects may be observed equally well with iron wires of much smaller diameter and currents of less strength than those employed below. The apparatus is connected up as in

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Fig. 112, where the magnetometer M and distance table are shown in plan, the current meter G and adjustable resistance R in elevation, and the battery, in this case a secondary battery of 21 cells, is shown conventionally. The galvanometer is placed at five or six feet away from the magnetising coil C, and is connected to the rest of the circuit by well insulated and twisted leading wires (para. 67), in order that its needle may not be affected by any magnetic field but that set up by its own coil. A brass tube of about ½ centimetre bore and a little over a foot long was provided with cheeks at the ends, fixed so that the distance between them was exactly 1ft. The tube was then wrapped round evenly with No. 16 double cotton-covered copper wire, and the ends firmly secured by twine. This gave a magnetising coil (C in the figure) 1ft. long and of 135 turns, which was then placed on the table at 20 centimetres distance from the magnetometer needle in the position shown, and held there firmly by a wooden clamp.

The resistance R is made with German silver wire spirals connected in series and fastened to a wooden frame. German silver is chosen because less length of wire of a given thickness is required than if copper or iron were used, owing to the higher specific resistance (para. 29) of German silver, which is some 12 or 13 times that of copper. Less space is therefore taken up by the coils. The bights between each spiral are soldered to wires running to contact stops on the switch S.

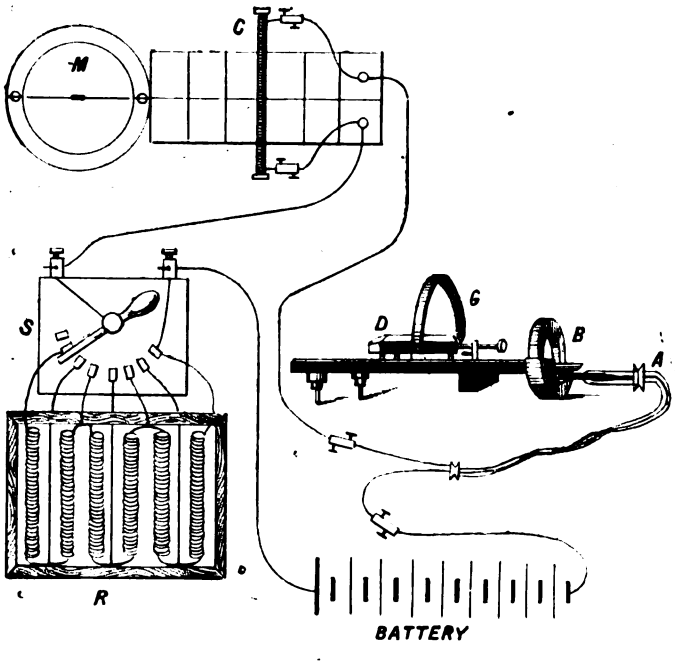

FIG. 112.

When the switch lever rests on the extreme left hand contact the circuit is disconnected, when on the second stop (as in figure) the circuit is closed, and a current will flow from the cells through all the resistance coils, the magnetising coil, and galvanometer. The current may then be increased step by step by moving the lever to the right. It is advisable to make the spirals of very low resistance on the low-resistance side (right side) of the switch, say of a quarter and half ohm, owing to the fact that when the rest of the circuit is of low resistance, very slight changes in the adjustable resistance produce great variations in the current strength. The spirals near this end of the switch should also be of thicker wire, say No. 14 or 16 B.W.G., as they have to carry the heaviest currents, while the rest may be of No. 18, and wound in spirals of 1, 2, and 5 ohms. The best arrangement, where great variation in resistance is required, is to have two separate switches; for example, suppose the total variation in resistance required was about 20 ohms. If one switch (A) of seven contacts were connected to six coils, in the manner shown in the figure, three coils being of five ohms each, and three of a quarter ohm each, and another switch (B) of five contacts connected to four coils, each of one ohm, the total resistance would be 19¾, and it could be reduced by one ohm at a time down to four ohms, and below four by a quarter ohm at a time by working the two switches. Supposing all the resistance in to start, B would be reduced four ohms by one ohm at a time first, and then its switch put back so as to add the four ohms again; then A would be moved one stop, reducing five ohms, and then again B one ohm at a time, and so on. In a test of this kind, where we are measuring the magnetisation of iron by gradual increments of current, care must be taken that if the resistance is reduced too much by mistake in one step, the reading on the magnetometer must be taken with *this* resistance in; it is no use to increase it up to what was intended at first, as the increased magnetisation of the iron due to the larger current would not be lost entirely on decreasing the current. The actual resistance in ohms is not required to be known in this test, so that the lower variations in resistance may be obtained very well by two similar metallic plates of, say, a foot square, immersed in slightly acidulated water, whose distance apart can be varied to a maximum distance of about two feet.

We must now turn our attention to the galvanometer. At the outset it will be noticed that in a test of this kind we are varying the strength of the current within fairly wide limits. In the test presently to be detailed, taken with the above apparatus the current was a little over half an ampere to start with, and was gradually increased to nearly 40 amperes. Now, with wide variation in current the galvanometer must have different degrees of sensitiveness in order to allow of reading the deflections with the least chance of error. Suppose a large current through the instrument gives a conveniently large deflection, then if the instrument remained in the same state of sensitiveness, as the current was reduced, the deflections would get smaller and smaller till the very smallness of the deflection would prevent accurate readings being taken, the movement of the needle being very slight for given changes in the current either at very low or high deflections from zero. Now, if the sensitiveness of the instrument is increased n times the deflections will be n times as large, and therefore the feebler currents can be read with ease and accuracy. The converse holds in the case before us. We are increasing the current strengths, and therefore must *decrease* the sensitiveness of the galvanometer as we proceed. We may do this in four ways, viz.:—

1. Shunting the galvanometer at intervals with shunts of gradually decreasing resistance.

2. Increasing the magnetic controlling field by bringing the controlling magnet nearer the needle.

3. By using a galvanometer wound with four or five separate coils, commencing with the fine wire coil of many turns, and changing at intervals on to the thicker wire coils of decreasing number of turns.

4. By gradually moving the needle and scale further from the coil.

As we wish to measure the currents accurately, and are working from a half to 40 amperes, the first method would be impracticable. When the current increased towards its larger values the shunts on the galvanometer would require to be so low in resistance that they would be difficult of accurate measurement, to say nothing of providing them of thick wire or stout copper ribbon, so that their resistance should not alter by heat; and to calculate the total current from the deflection of a shunted galvanometer, we must, of course, know accurately the resistance of the shunt (para. 95). As regards the second method of shifting the controlling magnet, the readings might first be taken without the magnet, and when beyond the limit of accurate reading, say 50 degrees, the magnet would be placed at a vertical height over the needle, such that the deflection of 50 was halved (or if a tangent galvanometer, a position found for the magnet, such that the deflection was the angle whose tangent was equal to half the tangent of 50 degrees). The magnet would be kept in this position until 50 degrees deflection was reached again, and then lowered to a position in which the deflection of 50 was halved, and so on. For each re-adjustment, we should know

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that the same strength of current gave half the deflection, and therefore we should multiply the deflections (or their tangents) by 2, 4, 8, 16, 32, &c., for each consecutive change. The galvanometer would have to be wound, however, with wire thick enough to carry the strongest current without dangerous heating, and therefore could not hold many turns.

The third method requires a specially-wound galvanometer. If such an instrument is available it is very convenient to use, since the constants (para. 100) may all be determined beforehand, once for all. The resistance of the coils is not taken into account, the variation in sensitiveness, as regards current, being effected *only* by the different number of turns. The reason why the coils of fewer turns are made of thick wire is that they may carry the large currents sent through them without heating sufficiently to cause injury to the insulation.

The last method can best be explained by describing Sir William Thomson's graded galvanometer, the sensitiveness of which can be varied in this way, and, in fact, was the instrument used for the test we are now considering. We shall come in the chapter following the present to a detailed consideration of galvanometers, but, although it may be considered as deviating widely from the usual custom, to digress from the main subject in hand in this manner, it is hoped that the reader will not find it altogether without interest to have instruments explained at the time they are used.

(*To be continued.*)

MINERS' ELECTRIC SAFETY LAMPS.*

BY NICHOLAS WATTS, ASSOC. MEM. INST. C.E.

It is not necessary, the writer thinks, to devote time to inquiry into the reasons which have caused so much attention to be given to the subject of this Paper by those interested in coal mining. It will suffice to say that the modifications made from time to time by numerous inventors, by providing additional gauzes and shields, and in other ways, to adapt lamps constructed on the principle of the Davy, Clanny, Stephenson, and other like lamps, to the increased velocity (20 to 35ft. per second) of the ventilating currents now obtaining in our collieries, have resulted only in rendering such lamps less unsafe than they were, but have failed to make them free from danger, and have in some cases introduced considerable complication and other objectionable features. There being, therefore, apparently not much prospect that a thoroughly satisfactory and safe lamp of the aforesaid types would be forthcoming, it was most natural that the incandescence electric lamp should be seized upon as a probable solution of the difficulty. It appears, on the face of it, most suitable for the purpose, inasmuch as the light depends for its existence on the absence of air, a condition the direct reverse of that necessary to the maintenance of the flame in oil lamps. The white-hot carbon filament is wholly enclosed in an air-tight glass bulb, from which all the air is withdrawn before the bulb is sealed. No currents of air or explosive mixture can reach it.

Attention having once been directed to the production of electric lamps for miners' use, the field speedily became well tenanted with inventors.

The writer does not propose to refer in detail to the successive developments, but rather to present to the meeting the position as it now is by passing in review some of the best lamps obtainable.

It became clear early in the history of the matter that illumination of collieries by fixed lamps connected to mains was not practicable so far as the working places were concerned. The difficulty of preventing injury to or severance of the wires, combined with other objections, left no doubt on that head. For like or analogous reasons, portable lamps, connected by leads to mains, were not satisfactory. Consequently, all energies were concentrated upon the production of an independent lamp containing its own source of light, and which could be carried about by the miner as freely as a Davy or other like lamp.

How to produce such a lamp, to compare favourably with a miner's ordinary oil lamp in price, weight, illuminating power, capability of standing rough treatment and hard knocks, and in other respects, became the problem. A good lamp of the Clanny and like types is bought for about 8s., it weighs about 4lb., and gives a light of from 0·4 to 0·5 of a standard candle.

To Mr. Swan belongs the credit of being the first to produce an electric safety lamp with an incandescence lamp as the novel feature thereof. This he did in 1881.

*The Swan Lamp** (exhibited).—Secondary battery. The elements, lead and lead-oxide, are cylindrical and are arranged concentrically in each cell. They are contained in a block of gutta percha with four cell compartments enclosed in a wooden case. The exciting liquid is dilute sulphuric acid. The cells are recharged by placing the lamp on a stand connected to a dynamo. The lamp proper is attached to the side of the case and is protected by a "bull's-eye" of thick glass. A light of from 1 to 1½ candle-power is given for a period of ten hours. The weight is 7lb. and the price 27s.

Several hundreds of these lamps are now in use at Risca and elsewhere, and the writer is informed by Mr. Wilkinson, manager at Risca, that they give satisfaction.

The Walker Lamp.†—Primary battery. Bichromate-carbon-zinc battery, the carbon being itself the containing vessel. On one side is a strong lens faced by a parabolic reflector, the two being held by a strong brass cylinder attached to the outer case, which is also of brass or copper. The lamp is made in two sizes, of which the smaller weighs 5lb. The battery is composed of two carbon-zinc cells. The liquid used is a mixture of bichromate of potash, nitric acid and plain sulphuric acid. The electromotive force is 4 volts, and the current 0·3 of an ampere.

The price is, for single lamps 30s., for dozens 27s., and for grosses 25s. The light afforded by the small lamp is sufficient to enable ordinary newspaper print to be read at a distance of 6ft. from the lamp for 10 hours. The battery of the larger lamp, which weighs 7lb., has three carbon-zinc cells. The electromotive force is 6 volts, and the current 0·5 of an ampere. Price 48s., 35s. and 32s. respectively. The cost of renewing the chemicals used, the incandescence lamp and incidental repairs, is stated to be not more than ¾d. per day for the small and 1d. per day for the large lamp. The cost of the liquid has been frequently tested, and has come out at ½d. per day of 12 hours' run. The operation of renewing, which is effected in a few minutes, consists in running off the liquid and washing out the cells, running in fresh liquid and replacing the cover, by which last act the connections between the battery and the lamp are made.

The Pitkin Lamp‡ (exhibited).—Secondary battery of four cells (seen last year in use underground at Tyldesley Colliery by some members of the British Association). The weight of this lamp is 8lb., and the price £2. 2s. Illuminating power, 4 to 5 candles; a reflector is employed to concentrate the light. The battery is composed of 4 cells, each having 8 plates or fingers, the elements being peroxide of lead and spongy lead. The battery takes 8 hours to charge. Mr. Pitkin estimates the life of the battery at about two years. Electromotive force, 8 volts; current, 0·4 of an ampere. The Pitkin lamp is furnished with a switch, and a resistance to regulate the expenditure of the electromotive force, which, if allowed to act without check, would, when the battery was started, destroy the filament. Mr. W. W. Hood, Llwynpia, tried 50 Pitkin lamps, and found that the switch was a difficulty. The men, unless very careful, put on the switch too full, and broke the filament.

The Schanschieff Lamp§ (exhibited).—Primary battery. The exciting liquid employed is a solution of basic sulphate of mer-

* Paper read before the British Association Meeting at Bath, September, 1888.

* *The Electrician*, Sept. 10, 1886, p. 359.
† *The Electrician*, Jan. 27, 1888, p. 282.
‡ *The Electrician*, Nov. 4, 1887, p. 542.
§ *The Electrician*, Dec. 16, 1887, p. 130.

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cury in the acid sulphate, one part of the salt being entirely dissolved in three parts of water (according to Schanschieff's patent). The battery can be charged in fifteen seconds. The elements are zinc and carbon; the latter not being of a porous nature. As a single liquid only is employed, no porous cells—producing resistance and causing waste of energy—are required. The weight, with a battery of four cells, is 4½lbs. Each cell takes 5 fluid ounces of the mercurial solution. The light ranges from 1½ to 2 candle-power. The consumption of zinc is $\frac{1}{12}$lb. per shift, or ½lb. for 48 hours (6 shifts of 8 hours). The liquid is supplied at 5s. a gallon, and is said to be worth, when spent, 4s. 3d., in consequence of the solid residue and free mercury precipitated by the action of the cells. The working cost of the 4-cell lamps for 6 shifts of 8 hours, is 5d., or $\frac{5}{8}$s. for one shift. In some forms of the lamp the solution occupies a little less than half the height of each cell, and the elements occupy the other half or opposite end of the cells. Thus the lamp is capable of being put out of action by inverting it. The liquid is changed every eight hours. The price is 30s.

The New Portable Electric Lamp and Power Syndicate Company's Lamp (exhibited).—The battery is secondary, and consists of two cells, the elements being lithanode (peroxide of lead) and spongy lead. The weight of the lamp is 4½lbs. The light given is 1¼ candle over a period of 10 to 12 hours. With a reflector the candle-power is about doubled. The battery takes four hours to charge, the cost of recharging being threepence per week. The price is one guinea. The lamp is fitted with an automatic arrangement in connection with the incandescent lamp, whereby, if the outer casing of toughened glass be broken, the current is cut off, and explosion of fire-damp guarded against.

The question, which is the most suitable battery for miners' lamps, though keenly debated, has not yet been finally settled. The secondary battery is, doubtless, more durable, but where dynamos are not already employed the primary battery will find favour.

The position of the light on the top or at the side of the case has given rise to much discussion, but the balance of opinion is that the side is the most suitable place.

FIVE APPLICATIONS OF FOURIER'S LAW OF DIFFUSION, ILLUSTRATED BY A DIAGRAM OF CURVES WITH ABSOLUTE NUMERICAL VALUES.*

BY SIR WM. THOMSON.

1. Motion of a viscous fluid.
2. Closed electric currents within a homogeneous conductor.†
3. Heat.
4. Substances in solution.
5. Electric potential in the conductor of a submarinecable.‡

1. Fourier's now well-known analysis of what he calls the "linear motion of heat" is applicable to every case of diffusion in which the substance concerned is in the same condition at all points of any one plane parallel to a given plane. The differential equation of diffusion,* for the case of constant diffusivity κ, is—

$$\frac{dv}{dt} = \kappa \frac{d^2 v}{dx^2},$$

where v denotes the "quality" at time t and at distance x from a fixed plane of reference. This equation stated in words is as follows:—Rate of augmentation of the "quality" per unit of time is equal to the diffusivity multiplied into the rate of augmentation per unit of space of the "quality."

The meaning of the word "quality" here depends on the subject of the diffusion, which may be any one of the five cases referred to in the title above.

2. If the subject is motion of a viscous fluid, the "quality" is any one of three components of the velocity, relative to rectangular rectilineal co-ordinates. But in order that Fourier's diffusional law may be applicable we must either have the motion very slow, according to the special definition of slowness in Article XCVII. of my collected Papers or the motion must be such that the velocity is the same for all points in the same stream-line, and would continue to be steadily so if viscosity were annulled at any instant. This condition is satisfied in laminar flow, and more generally in every case in which the stream-lines are parallel straight lines. It is also satisfied in the still more general case of stream-lines, coaxal circles with velocity the same at all points at the same distance from the axis. Our present illustration, however, is confined to the case of laminar flow, to which Fourier's diffusional laws for what he calls "linear motion" (as explained above in Sec. 1) is obviously applicable without any limitation to the greatness of the velocity in any part of the fluid considered (though with conceivably a reservation in respect to the question of stability).† In this case the "quality" is simply fluid velocity.

3. If the subject is electric current in a non-magnetic metal, with stream lines parallel straight lines, the "quality" is simply current-density—that is to say, strength of current per unit of area perpendicular to the current. The perfect mathematical‡ analogy between the electric motion thus defined, and the corresponding motion of a viscous fluid defined in Sec. 2 was accentuated by Mr. Oliver Heaviside in *The Electrician*, July 12, 1884; and in the following words in the *Philosophical Magazine* for 1886, second half-year, p. 135:—"Water in a round pipe is started from rest and set into a state of steady motion by the sudden and continued application of a steady longitudinal dragging or shearing force applied to its boundary. This analogue is useful because everyone is familiar with the setting of water in motion by friction on its boundary, transmitted inward by viscosity." Mr. Heaviside well calls this analogue "useful." It is, indeed, a very valuable analogy, not merely in respect to philosophical consideration of electricity, ether, and ponderable matter, but as facilitating many important estimates, particularly some relating to telephonic conductors and conductors for electric lighting on the "alternate-current" system. In a short article to be included in Vol. III. of my collected Papers, which I hope will soon be published, I intend to describe a generalisation, with, as will be seen, a consequently essential modification of this analogy, by which it is extended to include the mutual induction between conductors separated by air or other insulators, and currents in solids of different conductivity fixed together in contact.

4. If the subject is heat, as in Fourier's original development of the theory of diffusion, the "quality" is temperature.

5. If the subject is diffusion of matter, the "quality" is density of the matter diffused, or deviation of density from some mean or standard density considered. It is to Fick, thirty-three years ago Demonstrator of Anatomy, and now Professor of Physiology in the University of Zurich, that we

* Paper read before the British Association meeting (Section A) at Bath, September, 1888.

† This subject is essentially the "electro-magnetic induction" of Henry and Faraday. It is essentially different from the "diffusion of electricity" through a solid investigated by Ohm in his celebrated Paper, "Die Galvanische Kette mathematisch bearbeitet," Berlin, 1827; translated in Taylor's *Scientific Memoirs*, Vol. II., Part VIII., "The Galvanic Circuit investigated Mathematically," by Dr. G. S. Ohm. In Ohm's work electro-magnetic induction is not taken into account, nor does any idea of an electric analogue to inertia appear. The electromotive force considered is simply that due to the difference of electrostatic potential in different parts of the circuit, unsatisfactorily, and even not accurately, explained by what, speaking in his pre-Greenian time, he called "the electroscopic force of the body," and defined or explained as "the force with which the electroscope is repelled or attracted by the body;" the electroscope being a "second movable body of invariable electric condition."

‡ This subject belongs to the Ohmian electric diffusion pure and simple, worked out by aid of Green's theory of the capacity of a Leyden jar (*see* "Mathematical and Physical Papers," Vol. II., Art. LXXIII.).

§ *See* "Mathematical and Physical Papers," Vol. II., Art. LXXII.

† *See* "Stability of Fluid Motion," § 28, *Philosophical Magazine*, August, 1887.

‡ It is essentially a mathematical analogy only; in the same sense as the relation between the "uniform motion of heat" and the mathematical theory of electricity, which I gave in the *Cambridge Mathematical Journal* 46 years ago, and which now constitutes the first article of my "Electrostatics and Magnetism," is a merely mathematical analogy.

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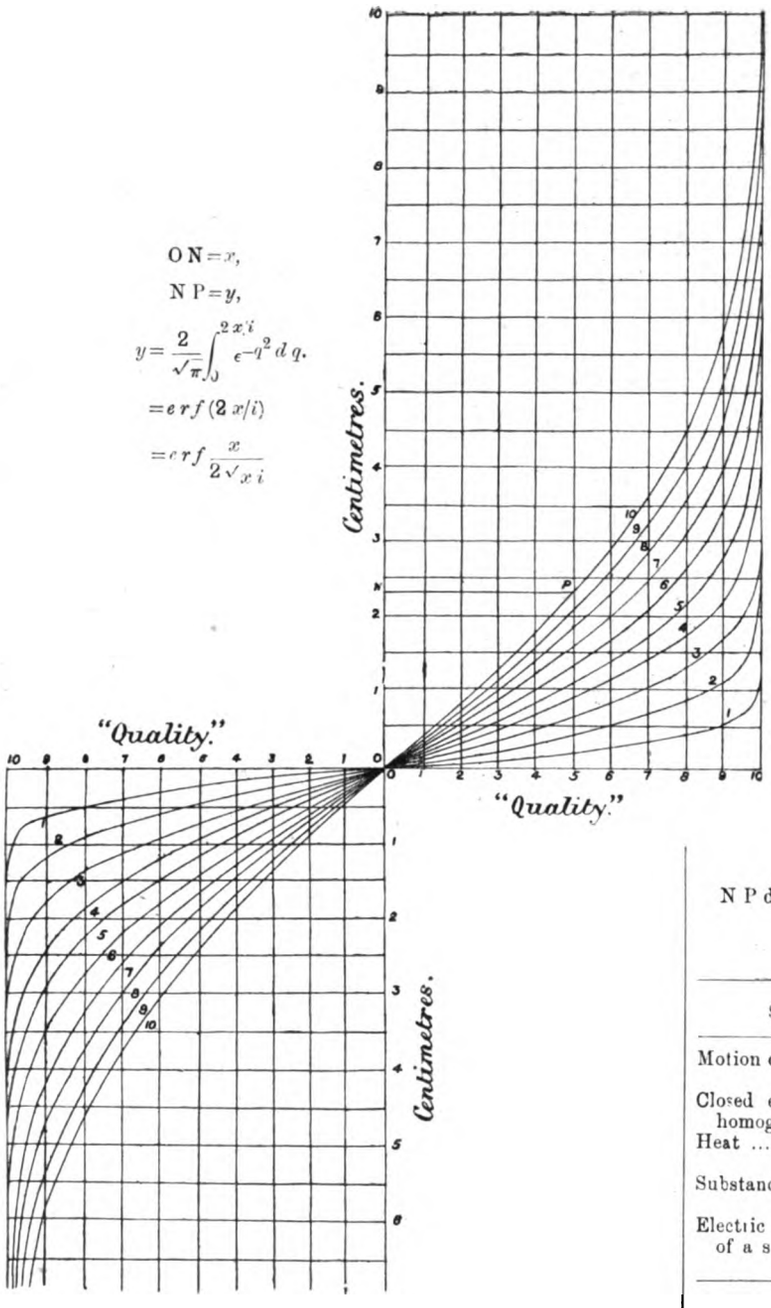
owe this application of Fourier's diffusional theory, so vitally important in physiological chemistry and physics, and so valuable in natural philosophy generally. When the substance through which the diffusion takes place is fluid, a very complicated but practically important subject is presented if the fluid be stirred. The exceedingly rapid progress of the diffusion produced by vigorous up-and-down stirring, causing to be done in half a minute the diffusional work which would require years or centuries if the fluid were quiescent, is easily explained; and the explanation is illustrated by the diagram of curves, Sec. 7 below, with the time-values given for sugar and common salt. Look at curve No. 1, and think of the corresponding curve with vertical ordinates diminished in the ratio of 1 to 40. The corresponding diffusion would take place for sugar in 11 seconds, and for salt in 3½ seconds. The case so represented would quite correspond to a streaky distribution of brine and water or of syrup and water, in which portions of greatest and least salinity or saccharinity are within half a millimetre of one another. This is just the condition which we see, in virtue of the difference of optic refractivity produced by difference of salinity or of saccharinity, when we stir a tumbler of water with a quantity of undissolved sugar or salt on its bottom. If water be poured very gently on a quantity of sugar or salt in the bottom of a tumbler with violent stirring up guarded against by a spoon, the now almost extinct Scottish species called "toddy ladle" being the best form, or, better still, a little wooden disc which will float up with the water; and if the tumbler be left to itself undisturbed for two or three weeks, the condition at the end of 17×10^5 seconds (20 days) for the case of sugar, or $5{\cdot}4 \times 10^5$ seconds (6 days) for salt, will be that represented by No. 10 curve in the diagram.

DIAGRAM SHOWING PROGRESS OF LAMINAR DIFFUSION.



6. If the subject be electricity in a submarine cable, the "quality" is electric potential at any point of the insulated conductor. It is only if the cable were a straight line that x would be (as defined above) distance from a fixed plane; but the cable need not be laid along a straight line; and the proper definition of x for the application of Fourier's formula to a submarine cable is the distance along the cable from any point of reference (one end of the cable, for example) to any point of the cable. For this case the diffusivity is equal to the conductivity of its conductor, reckoned in electrostatic units, divided by the electrostatic capacity of the conductor per unit length insulated as it is in gutta-percha, with its outer surface wet with sea water, which, in the circumstances, is to be regarded as a perfect conductor. For demonstration of this proposition, *see* Vol. II., Art. LXXIII. (1855) of my collected Papers.

7. Explanation of Diagram Showing Progress of Laminar Diffusion.

In each curve—

$$\frac{1}{10} \text{N P} = \frac{2}{\sqrt{\pi}} \int_0^{2x/i} dq \, . \, \epsilon^{-q^2},$$

where x denotes the number of centimetres in O N, and i the "curve number." The curves are drawn directly from the values of the integral given in Table III. appended to De Morgan's article "On the Theory of Probabilities," "Encyclopædia Metropolitana," Vol. II., pp. 483-84.

N P denotes the "*quality*" (defined below) { at distance = O N from initial surface or interface, and at time equal in seconds to ["curve-number"]² divided by sixteen times the diffusivity in square centimetres per second.

Subject of Diffusion.	"Quality" represented by $\frac{1}{10}$ N P.
Motion of a viscous fluid	Ratio of the velocity at N to the constant velocity at O.
Closed electric currents within a homogeneous conductor	Current-density.
Heat	Ratio of temperature minus mean temperature to mean temperature.
Substance in solution.....	Ratio of density minus mean density to mean density.
Electric potential in the conductor of a submarine cable	Ratio of potential at N to constant potential at end O.

Examples.

"Curve-number."	Time in seconds.	Case of Diffusion.
1	27056	Zinc sulphate through water.
1	25720	Copper sulphate through water.
1	17000	Sugar through wood.
1	5400	Common salt through water.
5	1180	Heat through wood.
5	118	Laminar motion of water at 10°C.
5	30	Laminar motion of air.
5	7·1	Heat through iron.
5	1·31	Heat through copper.
		Electric current in a homogeneous non-magnetic conductor:
10	·0488	Copper,
10	·0040	Lead,
10	·0038	German silver,
10	·0023	Platinoid.
1,000,000,000	2·15	Electric potential in the Direct U.S. Atlantic Cable.

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THE LIPPMANN MAGNETOMETER.

M. Lippmann's discovery of the action of a magnetic field on a column of mercury through which a current is passing has been recently utilised by M. George Miot, of Paris, in the construction of an "inductometer," or instrument for determining the strength of the magnetic field (perhaps "magnetometer" is the better word for this class of instrument). The effect of the magnetic field, it will be remembered, is to cause the mercury to rise to a height depending upon the strength of the current, or of the magnetic field when the current is constant. The inductometer is shown in the accompanying engraving, Fig. 1; and Figs. 2 and 3 show respectively sections on the lines 1 2 and 3 4.

The apparatus consists essentially of a tube, A B C, the lower portion of which is flattened in such a way that it can be placed in a short magnetic field, such as found in dynamo-electric machines. To the base B is soldered a capillary tube, D, which is surmounted by a bulb, E, above which rises a graduated tube, F. The two other bulbs, G G', are placed upon the extremities of the U-shaped tube, and are provided with branch tubes, $g\,g'$, into which the mercury is poured until its level reaches to about the middle of the three bulbs. Then on top of the mercury are poured several drops of glycerine into the bulbs G G', and a few drops of water or alcohol into the tube F.

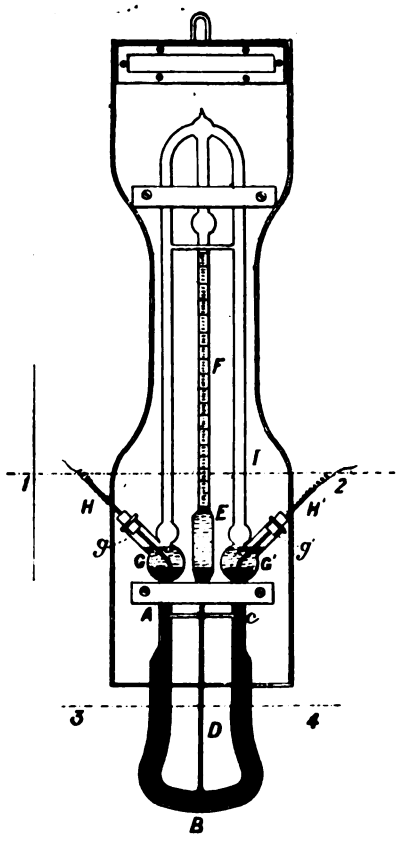

Fig. 1

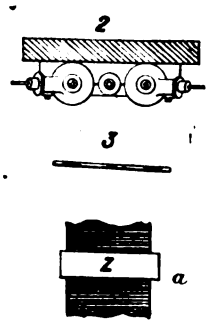

Fig. 4.

In order to preserve the mercury and other liquid from contact with the air, the U-shaped tube is prolonged above the two bulbs to unite again with the central tube at the top of the apparatus, as shown in Fig. 1. In this way the liquids are enclosed in an atmosphere of their own, having no communication with the external air.

In order to measure the intensity of the magnetic field by this apparatus, metal rods, H H', are introduced through the tubular branches $g\,g'$ into the bulbs G G', so that their ends are immersed in the mercury. The rods H H' are then connected with the poles of a generator, and the part B of the tube is placed in the magnetic field to be examined, and with the tubes B and D at right angles to the line of magnetic force. The mercury will immediately rise in the bulb E and force up the liquid therein, which may be coloured, into the tube F. The diameter of the latter being much smaller than that of the bulb, the movements of the liquid therein are correspondingly amplified.

Referring to Fig. 4, if it is desired to measure at the point a the intensity of the field of a magnet-pole Z, it suffices to place at a the part of the apparatus representing the intersection of the horizontal tube B with the middle tube D, to pass through the tube B a known current of, say, from 1 to 10 amperes, and to read the change of level produced in the column of coloured liquid in the tube F. If d represents this height read on the scale F, and C be the current traversing the apparatus at a, then the magnetic force H at that point will be represented by $\frac{d}{KC}$, K being the constant of the instrument.

The rise of the mercury is due to the reaction between the electric current traversing the tube B and the magnetic field. For the examination of a vertical field it suffices to curve the lower part of the tube at right angles.

THE WATERHOUSE METHOD OF DYNAMO REGULATION FOR CONSTANT CURRENTS.

The Waterhouse Electric and Manufacturing Company of New York makes use of a somewhat interesting method of regulation for their high-tension arc lighting machines. The following description has appeared in several of the American journals:—

Fig. 1 is a diagram of the Waterhouse type of dynamo, with a closed circuit armature, A. On the commutator C are three brushes; a and b are the main circuit brushes, and c the auxiliary brush. From the positive brush a the current passes on the conductor around the field-magnets F to the resistance R. The current from the auxiliary brush c passes directly to resistance R, leaving the field-magnets out of circuit. The currents from both circuits (field and local) join at R, and pass to the lamps, the current on the lamp line being the sum of the two. The amount of current

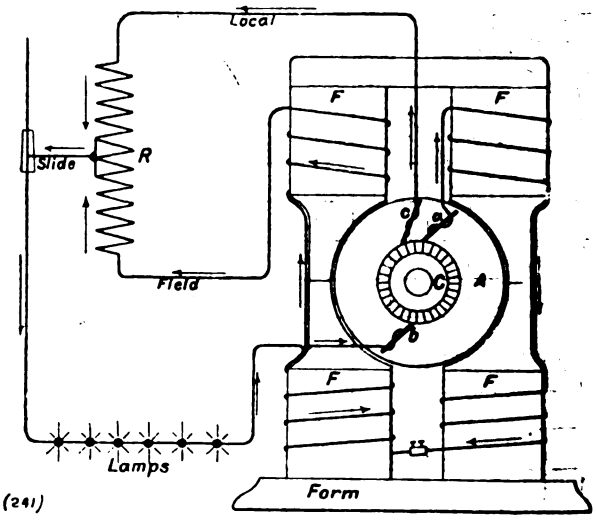

Fig. 1.

in the field and local circuits is in proportion to the resistance R in each. The brushes have a fixed position.

There is in every dynamo a point of maximum commutation on the armature, which changes with the resistance on the lamp line, moving with the rotation (towards brush c) when the resistance decreases, and back when it increases. This affects the current in the local and field circuits as follows:—When lights are turned out the line resistance is decreased, and the maximum point moves forward and forces more current out of brush c and less out of brush a. This reduces the current in the field-magnets and the E.M.F., and consequently the power required to operate the dynamo; but the current on the lamp line remains constant because the local circuit is increased proportionally to the decrease of the field-circuit. The remaining lamps therefore retain their full brilliancy, while the current cannot increase and destroy the apparatus. Thus the very tendency of the machine is to perfect regulation without

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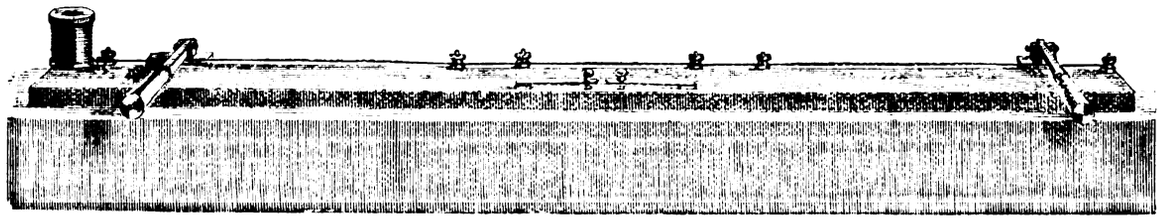
the aid of mechanism; but when to this is added the simple regulator, which makes the regulation instantaneous by assisting the current to pass out at brush c and opposing its passage around the field-magnets by way of brush a when lights are cut out, and forcing it out at brush a around the field-magnets by opposing its passing out at brush c when lights are cut in, the efficiency of the method can be appreciated.

The regulator is illustrated diagramatically by the slide, which is controlled by a solenoid. Any tendency of the current to increase raises the contact, and the result is a decrease of resistance in the local circuit, and an increase of the resistance in the field-circuit. More current will therefore flow through the local circuit and less through the field-circuit. The generating capacity of the dynamo is instantly reduced, and any tendency to produce a current above the standard is overcome. Should the tendency of the current be to decrease, say by a reduction of the speed of the armature, the slide lowers, increasing the resistance in the local, and reducing it in the field-circuit. More current will then flow around the field-magnets, and less out on the local circuit. The generating capacity of the dynamo will therefore increase to maintain the current at standard. It should be stated that the use of resistance for balancing the field and local circuits is a small amount compared to that used by the lamps, and is not interposed, as can be seen, for the purpose of compensating for lamps turned off.

CONVENIENT WIRE-TESTING APPARATUS.

A convenient instrument has lately been designed in Messrs. Woodhouse and Rawson's test room by Mr. C. Ashmore Baker, principally for testing the conductivity of wire. Two pairs of shears of peculiar construction are mounted on a mahogany base board, their cutting edges being exactly one metre apart. The wire to be tested is connected at one end with one terminal of a standard coil of suitable resistance placed at one end of the board outside the shears, and then stretched between the two pairs of shears, which also do duty as galvanometer contacts; the other end is held rigidly by a clamp at the opposite end of the board to that carrying the coil. A fairly constant current is next sent through the standard coil and wire in series, and by means of a reflecting galvanometer the differences of potential are measured first between the ends of the coil and then between the points on the wire at which the shears make contacts; from these the resistance of the wire per metre is obtained. The wire is then cut at both points simultaneously, and the metre thus cut off accurately weighed. From the quantities, weight, length and resistance, the conductivity may be easily calculated by means of a simplified formula which takes specific gravity into account.



Woodhouse and Rawson's Wire-Testing Apparatus.

The apparatus effects a great saving of time when a number of samples of wire are to be tested, and by cutting the wire off as it is fixed when the resistance is tested any error in the measurement of length due to elasticity is eliminated. With average care and a properly set up galvanometer the accuracy of the test is all that could be desired. The standard coil, keys, &c., are mounted on the same board with the shears, and there are no complicated connections to be made in setting up.

THE ACTION OF LIGHT UPON THE STATIC CHARGE.*

BY M. E. BICHAT.

Several investigators have recently shown that the passage of electricity across a gas is aided in a most singular manner when the electrified body is lighted up by the most refrangible rays of the spectrum. In a previous communication by M. Blondlot and myself, we showed that when a sheet of water is substituted for the metallic plate in M. Stoletow's experiment, no deflection is observed on the galvanometer. This fact seemed to show that the charge is not carried by conduction, and the following experiments confirm this view. A metallic cylinder, coated on the inside with lampblack, is negatively electrified and connected to an electrometer. The rate of loss of charge is not altered when, by means of a lateral opening, the inside of the cylinder is lit up by ultra-violet rays, while on the other hand, the dissipation is greatly accelerated when the ray of electric light falls on the outside of the cylinder. Now, if the luminous ray was a sort of conductor, it would equally affect the discharge, whether it fell on the exterior or on the interior of the cylinder. The electric tourniquet,* placed in a non-insulated conducting cylinder, began to turn in diffused light for a negative potential of 63 C.-G.-S. units. When illuminated by an arc light, the positive carbon of which contained an aluminium core, it began to revolve for a potential of 22 C.-G.-S. units. If a sheet of glass was interposed, all the effects of the light disappeared. It seems, therefore, that convection plays the essential part in these phenomena.

Whilst investigating the action of ultra-violet rays under various conditions, I have observed certain phenomena which seem to me worthy of notice. If a conductor connected to an electrometer is lit up by ultra-violet rays, the electrometer immediately shows a positive potential of seven to eight volts—that is to say, the air surrounding the conductor becomes negatively charged. This is M. Righi's experiment in another form. Copper has been observed to be negatively electrified under these circumstances, but the electrification was always very weak. The highest potentials obtained were with plants placed on insulating stands, the charge being, as a rule, negative. The electrometer was often deflected through more than 200 scale divisions, which correspond to a potential of over 20 volts. In this case the air surrounding the plant was positively electrified. Once only, with a geranium, was positive electrification of the plant itself observed.

THE MERSANNE ARC LAMP.†

The Mersanne lamp is distinguished from most other arc lamps by the manner in which the carbons are arranged, as well as by the way in which the feeding is effected. The carbons are horizontal instead of vertical, and are actuated by a series of grooved rollers. This arrangement allows very long rods to be used, without introducing undue resistance into the circuit. There are two fine wire electro-magnets, which are placed in series with one another, and in parallel with the main circuit; one governs the clockwork apparatus, and the other strikes the arc. In order to properly understand the mechanism of the Mersanne lamp it is necessary to examine every detail carefully.

In Fig. 1 A is a clockwork drum actuating the longitudinal shaft $a\ a$, which transmits the motion to the vertical shafts $b\ b$ (Fig. 2), $a\ a$ being divided into two unequal lengths, united by a Cardan coupling, and carefully insulated from one another. The transverse shaft d (Fig. 2) actuates the wheel e, which actuates in turn the grooved rollers $g\ g$; these rollers move the carbon rod, which is pressed tightly against them by the rollers $h\ h$, the pressure of which is regulated by the screw i. The electro-magnet B (Fig. 1) has an armature, n, which is acted on by the spring o; n alternately clutches and liberates the ratchet wheel e, the teeth of which are just visible in the figure. Whenever the arc lengthens, causing the current in the shunt to increase, the electro-magnet B overcomes the spring o, and attracts the armature n; this disengages the ratchet wheel e, and allows the clockwork drum A to move the carbons together by means of the series of shafts and cog-wheels. When the arc attains its proper length, the current in the shunt diminishes, and the weakening of the electro-magnet B allows the armature n to engage the wheel e, and stop the movement of the carbons. The pull of the armature spring is regulated by the screw v. The rod q, which is fixed to one

* *Comptes Rendus*, 1st October, 1888.]

* See *Comptes Rendus*, t. CIV., p. 1,286.

† From *Éclairage à l'Électricité*, by Hippolyte Fontaine.

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of the carbon holders, carries at the top the armature Q of the electro-magnets c c, by which the arc is struck; Q is retained by a spring strong enough to hold the armature against the attraction of any but the maximum current traversing the shunt. The attraction of Q causes q to give the carbon holder a slight jerk, and strike the arc.

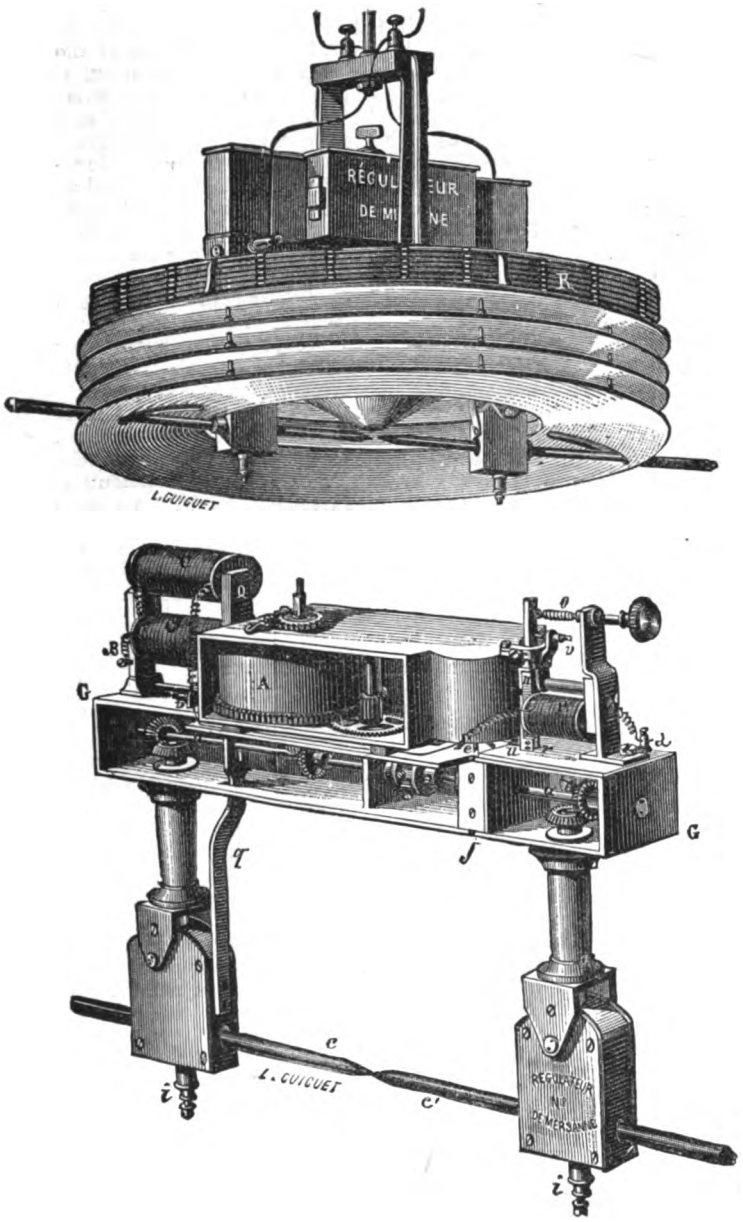

FIG. 1

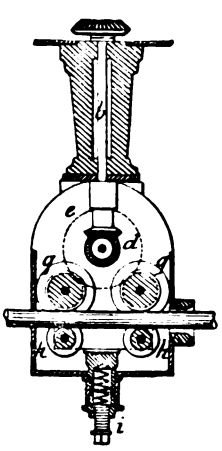

FIG. 2.

It is necessary in the Mersanne lamp to wind up the clockwork whenever the carbons are renewed. The lamp works very regularly, and is much used; amongst other places it is to be seen on the Place du Carrousel at Paris.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *September 29th*, 1888.

An interesting case was decided last week in this city, which may have considerable bearing on the installation of electric light stations within city limits. It seems that a station which had been running for some time without any objection on the part of the owners of neighbouring property was obliged to increase its capacity; and being cramped for room, instead of employing belt gearing, connected the engine to the pulley shaft by means of a large gear wheel. The introduction of the latter caused such a jar that complaint was made, and suit brought for the cessation of the nuisance. In view of the fact that the Electric Light Company has already begun the construction of a new station at another point which is to replace the present one, the judge decided that for the present the company should not be molested, but upon the prolonged continuance of the nuisance, the existence of which he considered established, the same would be followed by the issuance of an injunction.

American electrical papers describe the Waterhouse constant-current dynamo, which, as your readers may know, is provided with a third brush, as a means of regulation. According to the explanation given by the inventor, the current from the auxiliary brush passes direct to a resistance, leaving the field magnets out of the circuits. The current from both circuits, field and local, join at the resistance, and pass to the lamps, the current on the lamp line being the sum of the two. The amount of current of the field and local circuits is thus claimed to be in the proportion of the resistance in each. It is further explained that in this dynamo there is a point of maximum commutation on the armature, which changes with the resistance on the lamp line, moving in the direction of rotation when the resistance decreases, and back again when it increases. This affects the currents in the local and field circuits, so that when the lights are turned out the line resistance is increased, and the maximum point moves forward and forces more current out of the auxiliary brush and less out of the main brush beside it. This decreases the current in the field magnets, and consequently the E.M.F., and hence, also, the power required to operate the dynamo. At the same time, however, the current on the lamp line remains constant, because the local circuit is increased proportionately to the decrease of the field circuit. It is, of course, somewhat difficult to explain this without a diagram, but this method of regulation is certainly an interesting one, and is said to give good results.

The work of chopping down poles in this city goes merrily on, under the supervision of the Board of Electrical Control. It may seem ludicrous to your readers to be told that entire pole lines carrying dozens of wires have, on investigation, been found to be "dead," not a single wire being used for any purpose whatever. Considering the frequency with which companies are started here, and are later on absorbed or combined, this condition of affairs will readily be understood. The Board of Electrical Control, however, is making short work of these, and already several hundreds of poles and many miles of wire have been taken down and carted off to the Corporation yard. A curious circumstance in connection with this is that in many cases no owner can be found for these poles and lines; or, at least, those owning them disclaim ownership. The reason for this will be apparent when it is considered that it requires considerable money to take down the pole lines, and as the owners have no further use for the same, they prefer that the city incur this expense rather than themselves. At a recent meeting of the Board, quite a scene took place between Commissioners Hess and Gibbens. The question was as to the granting of privilege for one company to erect pole lines and wires. Commissioner Hess insisted that the company asking for the privilege had already been granted as much as it was entitled to. Commissioner Gibbens retorted that another company, which seemed to be in favour with Commissioner Hess, had also been granted large privileges.

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The whole matter was finally tabled, but permits for erected poles are becoming very scarce.

In a long article on the subway, the *New York Herald*, in a recent issue, gives the history of the company which has been authorized to construct the conduits in this city, and elaborates a long story of the manner in which these conduits are under control of the Metropolitan Telephone Company, by the affiliation of the latter with the Conduit Construction Company. There is, however, little in the story that was not well known before, and I think there is no fear that with an honest Board of Commissioners any undue preference will be given to any one company desiring to run wires in this city.

One of the most progressive and enterprising electric motor concerns in this country is the Baxter Electric and Manufacturing Motor Company. Starting two years ago with a small shop, they have increased their business to such an extent as to make the construction of a large factory an absolute necessity. This building has been in course of construction for some time, and was opened last week with due ceremonies, including a reception, and ball and concert. The building, situated in Baltimore, has a length of 300 feet, and is 60 feet wide and two stories high. The Baxter Company have recently constructed a 100,000-watt generator, designed for distributing power from central stations, and we learn that they now contemplate the construction of another of twice the capacity.

Electric railway work in this country continues unabated. Within a week the West End Railway of Boston has contracted with the Thomson-Houston Company for the equipment of a line running out to one of the suburbs which will require 30 cars. The Sprague Company will also put in operation 20 cars at Scranton, Pa., where fuel, in the shape of "culm," or anthracite waste, can be obtained at the rate of 10 cents a ton. Another railway company of the same city is now equipping with the Van Depoele-Thomson-Houston system, so that that town will be able to afford a good means of comparing the two systems. The Sprague Company have also entered into a contract to equip an electric railway in Minneapolis, Minn. The length of the line is 3½ miles, and power will be furnished from the Edison central station, whose plant is now in course of construction. Work on the Sprague road in Boston is also being rapidly pushed on, and there will be a special equipment of three working cars to keep the track clear of snow and ice in winter.

THE BRUSSELS EXHIBITION.

(FROM OUR OWN CORRESPONDENT.)

BRUSSELS, *October* 6, 1888.

A new pattern continuous-current transformer and a new multipolar dynamo, both of which are the invention of M. Hoho, chief engineer to the Société Electrique de Bruxelles, have just arrived at the exhibition, and will take part in the trials coming off next month. The continuous-current transformer is very similar to the one exhibited last year at the Newcastle Exhibition, its main feature being an armature with two separate windings. The field magnets are shunt-wound, and to avoid the employment of a high-tension current to excite the field, the shunt is taken off the secondary circuit. Under these circumstances, however, the generation of the magnetic field would demand an interval of time, during which the primary current would be excessive. M. Hoho has therefore wound a few turns in series with the primary circuit, and thereby obtained an initial excitation. This transformer seems likely to be very applicable to long-distance transmission and especially so to the transmission of power for charging accumulators and working motors.

M. Hoho's multipolar dynamo is a four-pole machine, with pole-pieces embracing the armature very completely. From a mechanical standpoint the machine is remarkable for its strength and solidity, arising from the compactness of the field. The machine exhibited is compound-wound, and has an output of 8,000 watts (100 volts and 80 amperes) at 1,400 revolutions a minute, its total weight, including everything, being 405 kilogrammes, which is about equal to 10 watts per pound.

SOUTH OF ENGLAND TELEPHONE COMPANY.—At yesterday's meeting the directors of this Company elected Mr. Charles Billett, of Copthall-buildings, E.C., to a seat at the Board, in place of Mr. T. F. Campbell, deceased.

CORRESPONDENCE.

BALLISTIC GALVANOMETER MEASUREMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like to mention that the method of measuring strength of magnetic field or magnetic induction with a ballistic galvanometer, by means of comparison with a standard condenser and known E.M.F., as described in Mr. Kennelly's Paper in your last issue, has been given by me in the course of my lectures at the School of Electrical Engineering, Hanover-square, as being in most cases more convenient than the employment of an earth induction. Thus, if B be the induction in any iron core of cross section A, and n the number of turns in the coil round it which is connected to the ballistic galvonometer, the quantity in coulombs passing through the ballistic galvonometer when the exciting current is reversed will be

$$\frac{2\,A\,B\,n}{10^8\,R} = a\,D;$$

where R is the resistance of the ballistic galvanometer and coil in ohms, a a constant, and D the throw produced. If now a condenser of K microfarads is charged from an E.M.F. of E volts and discharged through the galvanometer, producing a throw d

$$\frac{E\,K}{10^6} = a\,d.$$

Hence

$$B = \frac{100\,E\,K\,R}{2\,A\,n} \cdot \frac{D}{d} = \frac{50\,E\,K\,R\,D.}{A\,n\,d}$$

Yours, &c.,
E. C. RIMINGTON.

Lynton House, The Park, Norwood, S.E.,
October 7th, 1888.

THE SPECIFIC RESISTANCE OF PURE COPPER.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I wish to give my hearty concurrence with the proposition which Mr. W. H. Preece laid before Section A at the recent meeting of the British Association with reference to the necessity for the redetermination of the specific resistance of pure copper.

The time has certainly arrived for us to alter the old constant of ·1516 ohm as representing the resistance of a pure copper wire 100 inches and 100 grains at 60° F.

Owing to the great care and skill shown by the manufacturers, copper wire can now be obtained of a conductivity which was unattainable in Dr. Matthiessen's days, but the above change is rendered still more desirable owing to the introduction of the new process for obtaining pure copper wire *direct* from the deposited metal by the electro-burnishing method.—Yours, &c.,
CHAS. J. SIMMONS.

London, W.C., October 8, 1888.

GUTTA PERCHA AS AN INSULATOR FOR ELECTRIC LIGHT LEADS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A sick bed carries its patient as effectually from his course as does a raging storm many a ship; at least that is my experience. I am gradually endeavouring to make up my leeway by reading of what has been done during my enforced absence, and, in so doing, have just come across a document, which to me is certainly curious reading, and am much surprised to see some of the names that are attached thereto. It appears that the Society of Telegraph-Engineers and of Electricians formed a committee from among its members to draw up rules and regulations for the guidance of those interested in electric lighting. In April of this year the committee presented their report, and the society published and freely distributed the same. Of course, what they say about insulation, joints, different potentials, &c., should be the A B C of an electrical engineer's education; but I wish princi-

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pally to call attention to clauses Nos. 1 and 4. In the former clause they say, "Conductors.—They must have a sectional area and conductivity so proportioned to the work they have to do that if double the current proposed is sent through them the temperature of such conductors shall not exceed 150° F." And in the latter, "Whatever insulating material is employed it should not soften until a temperature of 170° F. has been reached, and in all cases the material must be damp proof." Now I quite fail to see why, with such a large margin for safety as the enforced use of a conductor capable of carrying double the required current, they should fix the softening point of the insulator at 170° F., which entirely excludes the use of gutta percha. I write with no biassed pen, as, personally, it is immaterial to me what insulator is used; but, from my forty years' experience of gutta percha, I say a great injustice has been done to an old and well-tried servant, and I have no hesitation in saying that for *well*-planned installations for electric lighting, gutta percha as an insulator for the leads will be found to fulfil all the necessary requirements. In my inaugural address as president of the Society, in January, 1883, I said: "The conductivity of conductors diminishes in well-known ratios with an increase of temperature; consequently it is essential that conductors, especially those used for electric lighting, should be of sufficient capacity so as not to be affected by the current. If the current passing along a conductor increases the temperature of the same it is plain that the resistance of such a conductor is too great, and therefore its temperature and resistance will continue to increase until very prejudicial effects are reached. Perhaps the results of actual experiment will make this more clear. The experiments were made with a dynamo, the resistance of the armature of which was 0·6 of an ohm, and an arc lamp, the resistance of which was 0·38 of an ohm. In each case the circuit was metallic, and the total length of the conductor fifty yards, insulated to a thickness of ·065 of an inch. At one part of the circuit the conductor leading to the lamp, and that leading from it, were placed so as to touch each other, the consequence of which was as follows: When the resistance of the conductor was ·28 of an ohm, and the strength of the current 27 amperes, the dielectric became soft, and allowed the conductor to form contact in twenty-five minutes; with a conductor of ·21 ohm resistance and a current of 30 amperes the same results follow after forty minutes; but with a conductor of ·07 ohm resistance and a current of 33 amperes no heating effects were perceptible during the two hours the lamp was kept burning." Nothing since then has occurred to cause me to alter my opinion; in fact, I am more than ever convinced that the conductor must be so proportioned to the maximum current it has to carry as not to increase its temperature.—Yours, &c.,

WILLOUGHBY SMITH.

COPPER: AUDI ALTERAM PARTEM.

A very careful criticism of the position of the copper syndicate has been issued by Messrs. Everitt, a firm engaged in the copper trade, and as the conclusions arrived at are somewhat different from those generally held, our readers will probably like to see the following extract:—

The advantages of the rigging of the market have not been confined to the syndicate alone, as the shareholders in many large engineering concerns can testify. It is a singular feature in the present departure that the complaining has chiefly emanated from those who probably have never purchased a ton of copper. We do not suppose that the higher rates of the present moment will hamper the copper trade any more than did the extraordinary prices in iron and steel at the commencement of the last decade cripple that industry. An increased usefulness for copper is what we anticipate. Not the least of its triumphs was that which only eighteen months ago attended upon a comparison by the Government between copper and iron wire for telegraphic purposes. The verdict for copper was conclusive, and proved its indispensability—a lighter wire, with proportionately greater strength, and a marvellous increase in the average velocity of transmission. With a favourable Budget to rest upon, it is impossible to forecast the value and the magnitude of the revolution which a capable administrator like the present Postmaster-General would initiate. The modern tendency to quick and cheap telegraphic communication is here justified. A further question suggests itself as to what the syndicate can do, having due regard to the full maintenance of the use of copper in sustaining prices in the future. What prospect is there that, for some time at least, opponents will be able to discover a corrective to the present upward tendency? It was thought such remedy was at hand when the coalition between the English smelters and the syndicate came to naught. It has since appeared that the smelters have but placed themselves between the syndicate and the deep sea. They are responsive to the inarticulate but real influence of the syndicate; and prices now move in sheer obedience to the dictates of the operators. The reason is at hand. The former available supplies of material for smelting have been securely locked by the ubiquitous key of M. Secrétan and his coadjutors; for the production of the largest mines in the old and the new world is under their control. To calculate upon a fiasco by virtue of the increased volume of Chili bars is to court disappointment; so to hope for a breakdown of present rates from any increase in refined or select copper is equally futile. So long as the wealth of the syndicate can carry the one, and its power can govern the other, they will remain passive in the progress of the struggle. The world is now waking up to the fact that the present combination is only in its infancy, and that to the relief of the strain upon the syndicate may be brought, when necessary, the federation of the mining interests which the syndicate has done so much to improve. Should, however, new forces work the defeat of the now victorious corner-men at last, the influence of the present movement will live after many days. Whenever the hour of liberation arrives, and the market again breathes its quondam freedom, it will doubtless leave hostages behind. Not the least important will be that touching the prices of the future. It is certain that the result will be the establishment of a condition which shall give to the producer and the manufacturer a fair return for their capital, to the operative a livelihood for his skill and labour, and to the consumer merchandise of a value proportionate to his money. But for ourselves at this moment, and without regard to the future, against all the drawbacks to the situation we place the living fact that the trade has, by the syndicate's daring in the application of its resources, been lifted out of a depression which, had it continued, would have proved calamitous.

ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LIMITED).

The following circular has been issued to the shareholders of this Corporation:—

"In compliance with the request of several shareholders, and in view of many important events during the last few months, the Directors, while not anticipating the approaching annual report, consider that a brief statement as to the present position of the Corporation as regards prominent questions may be of interest.

"By the Electric Lighting Amendment Act, which received the Royal Assent on 28th June, 1888, the chief obstacles to the investment of capital in central lighting stations have been removed. Although the alteration of the law does not meet all wishes, nevertheless the extension from 21 to 42 years of the period after which the local authorities can require the undertakers to sell, and the improvement in the terms of purchase which the Act effects will be of material benefit to the industry.

"There are, indeed, good grounds for hoping that the recent amendment of the Act of 1882 will prove a turning point in the history of the industry, and there are already many indications that the long-anticipated revival in the electric lighting business is now at hand.

"Among the electric lighting companies which have already been formed for the supply of electricity may be mentioned the Chelsea Electricity Company, in which the Corporation are interested as contractors for the generating plant.

"This company, which has been established for the purpose of supplying electricity to one of the most important residential districts of London, possesses a Provisional Order which secures to the company the benefit of the new Act. It proposes to put down plant in the first instance sufficient to supply 6,000 lights. The system of distribution which is being adopted is one in the economy and efficiency of which the Directors have the fullest confidence. The electricity generated at the central station will be conveyed by underground mains to sub-centres where accumulators, which the Electrical Power Storage Company are supplying, will be charged. From these storage stations the current will be distributed to the surrounding buildings.

"The Corporation have also made arrangements for establishing central stations at Bournemouth and other places.

"The negotiations with the Commissioners of Sewers with a view to the electric lighting of a part of the City of London have been resumed, and the Corporation having submitted to the Commissioners' proposals, which will meet the objections made by some of the members of the Commission to the former scheme, there is every reason to hope for a satisfactory issue.

"The volume of the Corporation's business during the year shows a very considerable increase as compared with the corresponding period of previous years, and the factories are at present fully employed.

"Among the more important and remunerative work that has been done may be mentioned the contracts in connection with the Glasgow, Barcelona and Melbourne Exhibitions.

"At the Melbourne Exhibition the Australasian Electric Light and Power Company has installed, besides a large Victoria incandescence plant, about 40 Brush arc dynamos and 1,000 arc lamps. The whole of this plant was supplied by the Corporation, and shipped within a period of two months, and is now in very satisfactory operation in the Antipodes as the largest temporary installation on record.

"The Continental business of the Corporation is also developing very satisfactorily. The factory at Vienna is now a source of revenue, and at

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Temesvar, where the lighting has hitherto been confined to the streets, the Corporation are putting down extensive plant, with a view to supplying the light to private consumers. The theatre and other buildings are already supplied, and the demand for the electric light has very largely increased.

"In July last the Directors had reason to congratulate the shareholders on the decision of Mr. Justice Kay in the action brought by the Edison and Swan United Electric Light Company, by which judgment was given in favour of the Corporation upon the main issue, viz., the Edison patent, and in favour of the Edison-Swan Company upon the minor issue of the Cheesbrough patent.

"The well-known 'Victoria' incandescent lamp, which is manufactured by the Corporation, is absolutely independent of patents other than those held by this Corporation, and is superior to any in the market either in this country or abroad, in cheapness, durability, and efficiency. In order to cope with the increasing demand, a new factory for the manufacture of these lamps upon a very large scale is being fitted up in the neighbourhood of London.

"The Directors feel they are able to congratulate the shareholders upon the improved prospects of the electrical industry generally, and having regard to the fact that during the past few years of comparative stagnation the efforts of the Corporation have been directed to developing its resources for undertaking large contracts, it is now in a very favourable position for profiting by the revival which is at hand.

"By order of the Board,

"E. GARCKE, Manager and Secretary.

"112, Belvedere-road, Lambeth, 3rd October, 1888."

COMPANIES' MEETINGS.

Eastern Extension, Australasia and China Telegraph Company (Limited).

The thirtieth ordinary general meeting of this Company was held on the 10th inst., at Winchester House, 50, Old Broad-street, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. F. E. Hesse) read the notices convening the meeting and the minutes of the last meeting, which were confirmed by the present meeting, and signed as correct by the Chairman. The report of the Directors was taken as read.

The CHAIRMAN: Before asking you to approve of the first resolution, I will, as usual, go over some of the details in the report, so as to give you a more accurate idea of the working of our system during the last six months. The gross receipts for the half year amounted to £239,926, against £219,201 for the corresponding period of 1887, or an increase of £20,725, which is due to general increase of business throughout the system. The working expenses for the half-year have been £69,297, against £76,241 for the corresponding period of 1887, showing a decrease of £6,944, of which nearly £4,000 is on account of the repairing ships—a fluctuating item as you know—and the remainder is spread over the general working. The net revenue for the half year amounted to £125,804, against £97,662 in the corresponding period of 1887, showing an increase of £28,142. One interim dividend of 1½ per cent. has been paid for the six months, and another of like amount will be distributed on the 16th inst., leaving a balance of £47,903 to be carried forward, after charging against revenue £15,401, the balance of the cost of the Singapore-Saigon cable renewal, to which full reference was made at the last meeting. Now, gentlemen, before going a little into the details of what we have done during the last six months I think it is only right and respectful to an old shareholder that I should refer to the subject of the bonus. I do not know whether Mr. King is present, but he addressed me on the subject of paying the bonus half yearly, instead of at the end of the year only. Mr. King, however, has overlooked the fact that 12 months ago we laid down the principle, after full discussion, that it was not wise to pay a bonus before we had made up our accounts to the end of the year. This is, as you are aware, only the interim half year, consequently we are adhering to the policy which was then accepted by the shareholders, and upon which we have decided to act in the future. I think we are fully justified in taking this course. In the first place, by keeping in hand such a sum as we carry forward at the present time—because we simply carry it forward—we maintain in the market a more uniform rate for our shares. Those who hold our shares as a permanent investment have the satisfaction of seeing the value of their property from day to day rather increasing than decreasing; and, on the other hand, those who are disposed to sell their shares at any particular period during the three months, or the six months, receive a higher market price than they would obtain if there was a smaller reserve. I think that that is a very clear and good reason for paying our bonus at the end of the year. There is another reason, and a very important one, too. Those who are watching our system closely observe that we have interruptions, and during the past six months we had the two Australian cables suddenly and simultaneously interrupted for nineteen days, cutting off Australasia from telegraphic communication with the rest of the world. That might have had a tendency to cause almost a panic in regard to our property, had we not our large reserve; but the event passed off without any material change taking place in the value of our property. We found that the breaks arose from volcanic action, and, curiously enough, when we picked up the cables we found all sorts of things attached to them, even roots of trees. The whole thing seemed to be a great upheaval of Nature. In order, however, to avert a recurrence as far as possible of the inconvenience caused to the telegraphing community by the interruptions, your Directors resolved without any hesitation to have a third cable laid between Java and Australia, the policy of the Company being to do its work in such a way as to command the confidence of the public; and when we see that we can do anything to strengthen our system we do not fail to do it. We purpose connecting that cable with the land lines of Western Australia, which will give an alternative land system to the existing South Australian overland line. The manufacture of the new cable is all but complete, and we believe that within a comparatively short period the cable will be laid, with the approval of the Western Australian Government and of our Home Government; and altogether this active and prompt operation is one that should, I think, reflect credit on the Company, and give satisfaction to the telegraphing public, besides which it has put aside a competition which threatened to lay a line from a certain point in Western Australia to India, and left us, as we ought to be, masters of the position. I have given you these details, gentlemen, so as to show you that your interests are daily—I may say, hourly—cared for, and that what we are called upon to do requires a great deal of ready money at hand. Look at the changes that take place suddenly in the value of money. If we had had to go to our bankers before we contracted for this cable, we should probably have been in rather an uncomfortable position to-day; but, as things are, we have been able to undertake this work in such a manner as will, at all events, give a greater amount of permanency to your dividends, even if it does not add to them. The last time I addressed you I referred to certain renewal operations which were going on, since which we have sent out some two hundred miles of new cable of the most improved type to be inserted in the Java-Australian sections, off the Lombok Straits, near Banjoewangie, where we have experienced serious troubles from time to time, owing to the cables at this spot being on bad bottom and in too close proximity to each other. The Company's steamship "Sherard Osborn" is now engaged on the work, and although every care was taken to avoid interrupting the duplicate cable till the work on the original line was finished, we have this morning heard that the communication with Australia is interrupted about eighty miles from Banjoewangie. I believe, however, that before the day is over we shall hear of its repair. The ship is on the spot, and we believe that the vessel engaged in working on the one cable has caused the interruption to the other. A great deal has been said in the Colonies in regard to the interruptions which occur. I see that the Government of Queensland even considered it so important as to have the subject alluded to in the speech which was delivered in August last, on the opening of Parliament, by the late Governor, Sir Anthony Musgrave, whose sudden death, I regret to state, took place yesterday morning. He was Governor of Queensland for a considerable time, and his death is a great loss to that colony and to the country also, for he was a very valuable servant of the Crown. In his speech last August—the speech, no doubt, being inspired by the Premier of the day—it was stated that it was very desirable to encourage a competing cable in the Pacific as against this Company, simply for the purpose of reducing what they consider the very exorbitant rates we charge. I may say in regard to Queensland that from the very beginning that colony has given no credit whatever to the Company as the pioneer of cable communication, though deriving immense benefit from our connecting them with the mother country and the other colonies. The whole cry in Queensland has been, get a competing system and reduce the rates. I may tell you that we have done everything we possibly could to meet the requirements of Queensland, but it seems to me that nothing will satisfy them. I therefore beg publicly to say—and probably I shall take the opportunity of making my remark better known in the colony—that when Queensland comes forward and shows that she is in earnest in doing something to reduce the rates we shall be only too pleased to negotiate with her. The Company submitted a proposal some time ago to all the Australian Colonies by which a 4s. or even a lower tariff could be brought about, provided the Governments would guarantee the Company three-fourths of the receipts from the Australian traffic, the Company accepting the remaining one-fourth of the guarantee risk. So far, however, they have declined to give us this guarantee, or to take any part with the other colonies in reducing rates. What they are prepared to do, as I understand, is this, though I doubt if they are ready to find any money to do it—but, so far as I understand, they are prepared to join the other colonies to form a Pacific line, so as to force down our rates by competition, losing sight of the fact that if two cables are liable to interruption, as above explained, a single line *vid* the Pacific, consisting of long stretches of cable across enormous and practically unsurveyed depths, terminating in coral reefs, would inevitably be exposed to greater danger of interruption. Moreover, if the rates were forced down, as advocated in the Governor's speech, the traffic would probably be found to be so unremunerative that when interruptions took place the companies would be unable to bear the expense of repairing them. I am glad to say that our connection with the other colonies has been of a very satisfactory and pleasant character. They acknowledge that we have been the pioneers in this great enterprise, and they appreciate the work that we have done for them. Since direct telegraphic communication with Australia was established in October, 1872, until 1880, when the duplicate cable was laid, only two total interruptions occurred, namely, in 1877 for 38 days, and in 1879 for 18 days, making a total of 56 days, or an average of seven days per annum. From the date of duplication until the present date the communication has been thrice interrupted, aggregating 32 days, including the recent breakdown from volcanic disturbance already referred to, or an average of less than four days a year. I now pass from that matter to the next point, and I am again brought back to the subject of interruptions, and

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the necessity for looking ahead, with the view of preventing any interruption in our traffic. We have at the present moment our Madras-Penang cable interrupted. That is a most unfortunate part of our system, because our cable lies on very bad ground near the Nicobar Islands, where nearly all the interruptions to this cable have occurred, and the time is not far distant when, to meet the steady increase of traffic, we shall have to lay a second cable between Madras and Penang. We have, however, lately had a survey made, with the view to finding, if possible, a better ground. All this leads me to the point from which I started—that we must not forget that these important additions require money, and therefore, by keeping in hand the reserve to which I have referred, we are enabled to do our work more promptly and more cheaply. I think all the prophesies I have made during many years as to the progress of this system have been pretty well verified. I think you will also agree with me that you have received your dividends very regularly, and we are particularly anxious that they should be continued to be steadily paid. To ensure that, however, we have to keep a sharp look out, and keep ahead in every respect of the work we shall require to do, and avoid interruptions as much as possible occurring in our system. Curiously enough, shortly after our two Australian cables were repaired, we had two cables interrupted for a short time between Aden and Bombay. It is our desire and intention to keep our system so well up to time that there can be no complaint on the part of any of our customers, and we also wish to establish this point—that we have surrounded ourselves in such a way as to render our position, I may say, invulnerable, and being invulnerable, other people will be prevented from coming into our waters, because I do not believe it is possible for any one to go into those waters and live. Occupying the position we do we must not assume the position of monopolists, but we must conduct our business on such broad and liberal principles as will satisfy you with the dividends, and the general telegraphing public with a cheap, efficient, secure, and expeditious system of telegraphy. Before I conclude, I may say that we are on very friendly relations with the Dutch Government. We have just finished some important work for them, which has been executed in a spirit which they appreciate, and at such a price that they could not do better elsewhere. All this work will, we hope, become an important feeder to our system. Whenever a Government is disposed to help themselves we are ready to assist them as far as lies in our power. I now beg to move—

"*That the report and accounts now submitted be received and adopted.*"

The Most Hon. the MARQUIS of TWEEDDALE: I beg to second that.

The CHAIRMAN: If any gentleman is desirous of making any remarks I shall be very pleased to answer them to the best of my ability before I put the resolution.

No shareholder rising to address the meeting he put the motion in the usual way, and declared it carried unanimously. Continuing,

The CHAIRMAN said: This being only the half-yearly meeting, and merely a meeting for giving you information, I am glad to state that the business is now concluded.

Mr. L. J. BAKER (Liverpool): Before we separate I beg to propose a vote of thanks to the Chairman for the remarks he has made and the enlightenment he has given us respecting the affairs of the Company and the progress it is making.

Mr. WELLS: I beg to second that.

Mr. BAKER put the motion, which was carried unanimously.

The CHAIRMAN: Gentlemen, on behalf of my colleagues and myself, I beg to return you our thanks. Looking at the care which we are obliged to give to your system, there is nothing so encouraging and gratifying as to find at a meeting like this that you are all so well satisfied that you have not one question to put to me. I am always pleased to listen to any remarks from the body of the meeting, but apparently, from your silence to-day, you are all perfectly satisfied, and you cannot pay us a greater compliment than we have received to-day. We thank you for it, and it will make us more earnest, if possible, in looking after your affairs in the future.

The meeting then separated.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

13,629. W. H. SCOTT. Lakenham. Improvements in brush holders for dynamo-electric machines. September 21, 1888.

13,643. W. SNELGROVE. Birmingham. Improvements in circuit making and interrupting devices for electric bells and other purposes. September 21, 1888.

13,653. E. R. WIDDICOMBE. Forest Gate. An electrical automatic money call box. September 21, 1888.

13,687. R. E. B. CROMPTON. Chelmsford. Improvements in and connected with electrical furnaces. September 22, 1888.

13,717. S. ELOESSER. London. Means for automatically feeding electric batteries with induction liquid. September 22, 1888.

13,725. T. M. SARGEANT and O. R. SWETE. London. Improved means or devices for making electrical contacts in coupling-up electric conductors. September 22, 1888.

13,778. T. N. VAIL and J. A. SEELY. London. Improvements in telephone central station apparatus. September 24, 1888. [Date applied for under Section 103 of the Patents, &c., Act, 1883, February 25, 1883.]

13,805. F. WYNNE. London. Improvements in the application of electricity to vehicles on tram and railways, and in the apparatus for effecting the same. September 25, 1888.

13,825. H. H. LAKE. London. Improvements relating to electrical conductors and insulating conduits therefor (R. F. Silliman, United States). September 25, 1888.

13,937. P. NEIL. London. Improvements in transmitters for telegraphic purposes. September 27, 1888.

8,170A. H. J. ALLISON. London. Electric shunting device (The Baxter Electric Manufacturing and Motor Company, Incorporated, United States). June 5, 1888 [Note.—This application having been originally included in No. 8170, dated June 5, 1888, takes, under Patents Rule 23, that date.]

13,954. S. CHARLESWORTH and J. P. HALL Manchester. An improved portable electric light apparatus. September 28, 1888.

13,964. M. MCMULLIN. London. Improvements in the application of portable electrical batteries and incandescent lighting to articles of wearing apparel and other analogous purposes. Septemper 28, 1888.

13,984. B. J. B. MILLS. London. Improvements in electric accumulators (J. Barbier, France). September 28, 1888.

13,987. L. SAUNDERSON. London. Improvement in electric lighting. September 28, 1888.

13,994. J. KENDALL and O. COOPER. London. Improvements in and relating to cut-outs or safety devices for electric circuits. September 28, 1888.

14,030. T. B. GRANT. London. An improved apparatus for generating, graduating the strength of, and distributing electro-magnetic currents for medical and curative applications. September 29, 1888.

14,090. H. C. HAROLD and R. JENKINS. London. An improvement in combination with electric light switches for securing better contact. October 1, 1388.

14,095. J. SWINBURNE. Chelmsford. Improvements in and connected with dynamo-electric machines and electric motors. October 1, 1888.

14,156. W. Y. HARDIE London. Improvements in the precipitation and the mechanical, chemical, pneumatic, and electric treatment of towns' sewage, and the utilisation of the solids therein, as well as the preparing from towns' refuse a deodorising and purifying power, which is also applicable for other purposes. October 2, 1888.

14,161. L. BOLLMANN Vienna, Austria. Improvements in the method of producing electro-magnetic inductions for transformers, motors, or generators, and in the apparatus therefor. October 2, 1838.

14,184. W. BOGGETT. London. Improvements in obtaining electricity for electric lighting, motive power, and other purposes. October 2, 1888.

14,191. S. R. LOWCOCK. Moseley. An apparatus for automatically transmitting electric currents. October 3, 1888.

14,225. R. DICK and R. KENNEDY. Glasgow. Improvements in and relating to continuous current dynamo-electric machines and electro-motors. October 3, 1888.

14,230. J. S. RAWORTH and W. M. MORDEY. London. Improvements in electricity meters. October 3, 1883.

COMPLETE SPECIFICATIONS ACCEPTED.

September 29, 1888.

14,996. E. HOPKINSON. London. Improvements in gear for transmitting motion from electric motors to driving axles of vehicles. November 3, 1887.

15,760. W. WEBSTER, jun. London. Improvements in the electrolytic treatment of sewage and sea water for the production of certain products therefrom, and apparatus therefor. November 17, 1887.

15,877. J. B. WILLIS. London. Improvements in telegraphic apparatus suitable for indicating the position of a ship's rudder. November 18, 1887.

16,185. W. J. S. BARBER-STARKEY. London. Improvements in electric meters. November 24, 1887.

16,772. J. A MACDONALD. Birkenhead. Improvements in electric bells. December 6, 1887.

October 6, 1888.

13,326. J. DOUGLAS and H. ABBOTT. London. Improvements in machinery or apparatus for producing and administering electric shocks and currents. October 1, 1887.

15,063. P. SKRIVANOW. London. Improvements in galvanic batteries. November 4, 1887.

16,623. W. T. GOOLDEN and L. B. ATKINSON. London. Improvements in dynamo-electric generators and motors. December 2, 1887.

17,089. M. IMMISCH. London. Improvements in the construction of the cores of armatures of electro-motors and dynamo machines. December 12, 1887.

5,390. J. SHERRIN and J. V. SHERRIN. London. Improvements in velocipedes and other vehicles propelled by electricity. April 11, 1888.

7,963. M. KOTYRA. London. Improved commutator for magneto or dynamo-electric generators. May 19, 1888.

12,395. A. J. BOULT. London. Improvements in electro-therapeutic belts (H. P. Platt, United States) August 28, 1888.

12,761. A. D. WATERHOUSE. London. Improvements in dynamo-electric machines. September 4, 1888.

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PATENTS SEALED.

September 28, 1888.

10,131. G. FORBES. London. Improvements in meters or apparatus for measuring electricity. July 19, 1887.

10,157. T. A. GARRETT. London. Improvements in and connected with apparatus for transmitting and receiving electrical signals. July 20, 1887.

11,252. H. MOWER. London. Improvements in secondary batteries or electrical accumulators. August 17, 1887.

11,901. R. A. SCOTT. London. Improvements in lamp-holders or sockets for incandescent electric lamps. September 2, 1887.

12,015. W. LÖNHOLDT. Berlin, Prussia. Improvements in incandescent electric lamps. September 5, 1887.

12,718. J. TATE. Bradford. Improvements in electrical speed indicators. September 20, 1887.

3,883. A. J. BOULT. London. Improvements in electrical devices for type-writers (J. F. McLaughlin, United States). March 13, 1888.

4,221. T. COAD. London. Improvements in the construction of holders for incandescent electric lamps. March 19, 1888.

7,852. W. P. THOMPSON. Liverpool. Improvements in or relating to central station apparatus for systems of electric distribution by alternate currents (G. Westinghouse, jun., United States). May 29, 1888.

October 5, 1888.

10,200. H. C. BULL AND CO. (LIMITED) and H. C. BULL. London. Improvements in dynamo-electric generators and motors. July 21, 1887.

11,938. J. G. LORRAIN. London. Improvements in or connected with clocks and apparatus for winding the same by electricity. September 2, 1887.

13,221. J. H. HOLMES. Newcastle-on-Tyne. Improved means or apparatus for controlling in an automatic manner reciprocatory, vibratory or oscillatory movements of armatures and other electrical apparatus. September 29, 1887.

13,333. J. D GIBBS and E. FRESQUET. London. Improvements in secondary generators, transformers or converting of electricity. October 1, 1887.

4,759. H. H. LAKE. London. Improvements in and relating to telephonic apparatus (International Dudley Signal Company, United States). March 28, 1888.

9,332. F. STITZEL and C. WEINEDEL. United States. Improvements in electrical connection of railroad rails. June 26, 1888.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

12,437, 1887. CROMPTON, R. E. B., and SWINBURNE, J. Dynamo electric machines. (Price 4d.)

12,830, 1887. LAKE, W. R. (Lindemann). Electric arc lamps, &c. (Price 8d.)

12,924, 1887. ZANNI, G. Incandescent electric lamps, &c. (Price 8d.)

12,754, 1887. BARBER-STARKEY, W. J. S. Secondary voltaic batteries. (Price 6d.)

9,991, 1888. LAKE, W. R. (Humans). Magneto-electric apparatus. (Price 8d.)

10,954, 1888. GEIST, E. H. Dynamo-electric machines. (Price 6d.)

11,338, 1888. KELNER, L. Telephone line circuits. (Price 8d.)

4,311, 1875. CLARK, A. M. (Bertin). Electric machines. (Price 8d.) Second edition.

12,378, 1885. SCHANSCHIEFF, A. Galvanic batteries. (Price 6d.) Second Edition.

3,394, 1886. VARLEY, C. and S. A. Generating electricity. (Price 6d.) Third edition.

12,418, 1887. DE FERRANTI, S. Z. Conveying electric energy, &c. (Price 11d.)

12,419, 1887. DE FERRANTI, S. Z. Electric railways. (Price 11d.)

12,437A, 1887. CROMPTON, R. E. B., and SWINBURNE, J. Electrical measuring instruments. (Price 8d.)

13,154, 1887. FISHER, H. R. Controlling cocks and valves by electricity. (Price 8d.)

13,561, 1887. KOLLE, H. W. Electricity meters. (Price 6d).

14,226, 1887. JACQUEMIER, M. J. R. Measuring electric currents (Price 1s. 6d.)

15,158, 1887. SINCLAIR, J., and REES, J. P. Electric safety lamps. (Price 8d.)

15,939, 1887. WEBSTER, W. Electrolytic treatment of sewage, &c. (Price 8d.)

16,087, 1887. FARMER, J. S. Electric contact maker for coin-freed apparatus. (Price 8d.)

18,030, 1887. LEBIEZ, L. C. F., and VERCHERE, P. L. Thermo-electric batteries. (Price 8d.)

3,936, 1887. DRAKE, B. M., and GORHAM, J. M. Plates for secondary voltaic batteries. (Price 8d.)

5,586, 1888. LAKE, H. H. (Grivolas). Electric incandescent lamps. (Price 8d.)

11,403, 1888. LAKE, H. H. (Weis). Propelling vehicles by electricity. (Price 8d.)

11,705, 1888. THOMPSON, W. P. (The Westinghouse Electric Company). Measuring electric currents, &c. (Price 8d.)

THE MAXIM-WESTON ELECTRIC COMPANY.

The following is the report recently submitted to the Board of Directors by the firm of chartered accountants who have been instructed to examine the affairs of this Company :—

TO THE DIRECTORS OF THE MAXIM-WESTON ELECTRIC COMPANY (LIMITED).

Gentlemen : In accordance with your instructions we have investigated the accounts of your company, and beg to report as follows :—

We have taken the balance-sheet and profit and loss account for the year ending 31st December, 1887, and have confined our investigation to these accounts, except where we have found it necessary to go back into former years for the purpose of elucidating certain items appearing in the 1887 accounts.

The assets are set forth in the 1837 balance-sheet as follows :—

Patents	£40,737	1	1
Stock of machinery, lamps, &c., at factory	19,817	7	6
Machinery, plant, and tools	3,603	15	2
Furniture and fittings at offices	228	1	8
Shares in the Electric Sun Lamp and Power Company (Limited), estimated value	239	7	6
Debtors	15,001	12	6
Cash	2,370	11	0
	£81,997	16	5

We will deal with these items in their order.

Patents : £40.737 1s. 1d.—This item appeared in the 1886 balance sheet as £38,229 17s. 1d., showing an increase during the year of £2,507 4s. This increase is arrived at by charging to patents account the following sums :—

Renewal of patents	£44	0	0
Wages	718	4	0
Material used and destroyed casting patterns, &c.	325	0	0
Managing director, proportion of salary	750	0	0
Works manager ,, ,,	200	0	0
Secretary's time taken up experimenting on dynamos, lamps, &c.	100	0	0
Clerks' time taken up on experimental work	270	0	0
Men's time	100	0	0
	£2,507	4	0

There being no sinking fund for the gradual extinction of the item for patents, the cost of experimenting such as above should, in our opinion, be paid out of revenue. In our judgment the value of the patents should not be permanently increased by charging to them a large proportion of the salaries of the managing director, works manager, secretary, and clerks, which would have been a charge upon revenue whether experiments had been made or not. The auditor refers to this matter in his report on the 1886 accounts. The amount at which the patents are entered in the books should, in our opinion, be subject to a very heavy depreciation—to the extent of the amount added during 1887, or, say, £2.500.

The amount expended upon the Watt dynamo during 1837, as worked out by the works manager, was :—

Labour	£153	0	2			
Material	158	9	9			
				£311	9	11
and in 1888						
Labour	£129	6	6			
Material	121	10	0			
				250	15	6
				£562	5	5

The amount expended upon the Watt lamp was :—

1887. Labour	£30	12	2			
Material	4	1	11½			
				£34	14	1½
1888. Labour	98	17	8			
Material	37	15	1½			
				136	12	9½
				£171	6	11

Stock	£19,817	7	6
Machinery, plant, &c.	3,603	15	2
Furniture and fittings	228	1	8
	£23,649	4	4

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The stock has recently been re-taken, and the plant and machinery re-valued by the works manager, who puts upon them now a lower value than at 31st December, 1887. Taking his new valuation as the basis it would appear that the value of the stock, plant, machinery, tools, furniture and fixtures, at 31st December, 1887, was about 14,950, instead of £23 649, as stated in the balance-sheet. This shows a difference of, say, £8,700. A comparison of the stock lists will show how this difference is made up.

Debtors: £15,001. 12s. 6d.—The good debts owing at that date were, so far as possible, collected prior to the resignation of your late chairman and managing director. A large sum is represented by plant in the hands of agents, some of which has since been returned, and much is reported by the agents to be unsaleable in their districts. A large proportion of the remaining accounts is in dispute. We have gone carefully into all these accounts, and are of opinion that in order to arrive at a fair estimate of their value a sum of £7,600 should be written off or provided for. The details of this sum we give in a separate list, showing the amount we recommend should be provided for in each case. This item is particularly mentioned in the auditor's report on the accounts to 31st December, 1887.

Shares of the Electric Sun Lamp Company, in Liquidation: £239. 7s. 6d. We can gain no information about this company, and think it doubtful if there will be a further dividend. It would be prudent, therefore, to provide for the amount, or the greater part of it.

Cash: £2,370. 11s.—This item is correct.

Applying the foregoing estimate of the assets to the figures given in the balance-sheet at December 31st, 1887, we find that, in our opinion, the assets are stated in excess of their value at that date, as follows:—

Patents	say	£2,500	0	0
Stock, Machinery, plant, &c., Furniture	,,	8,700	0	0
Debtors	,,	7,600	0	0
Shares in Electric Sun Lamp Company	,,	200	0	0
Total	,,	£19,000	0	0
Deduct balance of profit and loss account	,,	1,555	0	0
Total		£17,445	0	0

Profit and Loss Account.—During the years 1884 and 1885 goods were sent out to various agents abroad, and entered up in the company's books as though actually sold to the extent of £5,334. 0s. 7d., and the assumed profit in consequence was taken into the profit and loss accounts for those years. A few additional items have been sent out since, bringing up the total to £5,412. 10s. 5d.

Of this amount goods to the value of £699. 8s. 5d. only have been sold. The remainder is in the hands of the agents unsold, or has been returned into stock.

Mr. Watt has drawn 5 p. c. commission, amounting to £571. 17s. 6d., on the alleged profits of the years 1884 and 1885, which includes about £145 on the assumed profits on these alleged sales.

In the directors' report accompanying the accounts for 1885 are the following clauses:—

1. "The directors beg to remind shareholders that no allowance was made during the past two years for contingencies, such as referred to in section R of clause 75 of the articles (which states that the directors may 'set aside *out of the profits of the company* such sums as they think proper to meet contingencies, &c.'), and they have now deemed it prudent to pass the sum of £3,606. 5s. 0d. to the credit of a general reserve fund."

2. "After making the above reserve, the total balance to the credit of profit and loss account, including amount brought forward from previous years, is £5,284. 19s. 8d."

It would *appear*, therefore, from the foregoing, that the reserve was created out of profits on trading. It was *actually* created in the following manner:—

Premium on new shares issued				£3,000	0 0
Less paid to cover commission on placing shares	£1,000	0	0		
Brokerage	122	18	4		
				1,122	18 4
				1,877	1 8
On the reduction of capital there was a balance on the books to the credit of the company of				1,729	3 4
The two items added together made				£3,606	5 0

the amount at which the reserve fund appeared in the 1885 balance-sheet.

Clause 6 of the same directors' report is as follows:—

6. "The directors estimate that £600 will cover the total bad debts incurred by the present management, including outstanding debtors."

The "outstanding debtors" amounted to £12,794. 15s. 6l, and this sum included the goods in the hands of agents, amounting at that date to £4,902. 19s. 9d.

During 1886 a sum of £2,074. 11s. 5d. is written off the agency accounts alone, and £1,531. 13s. 7d. from other accounts. These items together absorb the reserve fund of £3,606. 5s., which accordingly does not appear in the 1886 balance-sheet. No explanation of its disappearance is given in the directors' report accompanying the accounts for that year, but the auditor in his report on the 1886 accounts draws attention to the fact. The result of this operation was that the profits of the years 1884 and 1885 were swollen by goods sent out to agents at enhanced prices being treated as sales, without any provision being made for bad debts, or for the contingency that the goods might not be sold. The reserve fund—created by reduction of capital and premium on shares—being utilised to reduce the amount appearing as book debts, the appearance of profit was maintained, and a dividend 7½ per cent. was paid in March, 1886.

A subsequent dividend of 5 per cent. was paid in March, 1837, out of the amount shown as profit in the accounts for the year 1886, no provision being made for loss on book debts during that year.

From the foregoing it will be seen that the results of the trading have not been truly stated in the past by reason of the non-provision for bad debts, and by the over valuation of the stocks.

BOYCE and RAMSAY, Chartered Accountants.

2, Metal Exchange-buildings, E.C.

Mr. Hugh Watt has addressed the following letter to the Editor of the *Financial News*:—

Sir: I regret feeling compelled to beg a few lines of your valuable space to correct the renewed misstatements of Mr. John Marks, chairman of yesterday's meeting of the Maxim-Weston Company. I need hardly say that nearly all which is referred to in his speech has been the subject of correspondence between myself and the company since I resigned my position as director, and all the matters therein referred to were exhaustively explained, as I am entitled to assume, to the satisfaction of the company, as after receipt of my explanations they closed the correspondence. Mr. John Marks is aware that the payments made to me by the secretary were in terms of Board minutes, the validity of which has never

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PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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been disputed, and at the time that I received £650 the company was owing me £600 for cash advances, and from £1,000 to £1,500 more for rent, salary, and disbursements made by me on behalf of the company.

To show the worthlessness of Mr. Marks' statements, I may state that the engines he refers to were taken over from the Lancashire Company, and that no money whatever was paid for them; or, in other words, in partial settlement of a bad debt, and that they were otherwise unsaleable.

With regard to the plant sent to Mauritius, this was all conditionally sold, the condition being that, as the firm who agreed to purchase the plant shipped by us were not strong financially, and could not pay for the plant upon delivery in Mauritius, they undertook to pay our agents there fixed prices in terms of an agreement entered into with the company as soon as they received the money from their customers. I cannot at this date recollect the cause of the failure of this agreement, which was either owing to the firm in question retiring from business, or their having been unfortunate, and thus unable to carry out their agreement. All the plant which was sent abroad was unsaleable in this country, and was taken over from the original management in 1883.

With regard to the Lancashire plant spoken of, no one, I think, could have foreseen the death of a mortgagee, which compelled the company in question (which was then in a sound financial condition) to go into liquidation; but Mr. John Marks is either unaware or has not the common honesty to state that a large business resulted from this introduction, which would have been five times larger had the company been in a financial position to undertake extensive contracts which were offered them, including the lighting of the entire town of Birkdale.

I cannot understand Mr Marks' statements with regard to another Lancashire account referred to; but, speaking from memory, I feel satisfied that I am right in stating that the transaction referred to left a profit —or, in other words, the plant, which was valued by us as worth £1,000, was returned intact, and £300 (assuming his figures to be correct) obtained in cash from the hirers of the plant in question.

From what Mr. John Marks states as to the accounts for 1887, it would be inferred that these were not passed. Allow me to remind him that Mr. J. M. Klenck proposed the passing of the accounts, and, if I am not mistaken, Mr. John Newton (another member of the committee) seconded this motion, which was carried unanimously.

Mr. Marks states that I owe the company £2,113; but it is surely extraordinary that the committee were appointed in March and exhaustively examined into my connection with the company, and that they did not discover till the middle of September that I was owing the company any money at all. I regret I am unable to go into details of this extraordinary claim, the matter being now *sub judice;* but would state that the total sum represented by my two actions against the company amounts to about £2,500.

The insolence of Mr. John Marks with regard to my staff is almost unworthy of notice, and I might have treated it with silent contempt; but I would, in conclusion, venture to repeat that the total sum I received from the Maxim Company was £2. 18s. per week in excess of the sum received for transfer fees; that my staff at that time consisted of 16 clerks; and that the character of the assertion that the company were paying for my staff, when the total sum received was little more than half the salary of one of them, is worthy of the source from which it emanated. —I am, sir, yours &c.,

HUGH WATT.

78, Queen Victoria-street, E.C., October 4th.

The secretary of the Maxim-Weston Company has addressed the following letter to the Editor of the *Financial News* in reply to the above:—

Sir: In the absence of the chairman, who is out of town, I do not propose replying at any length to the letter from Mr. Watt, which appeared in your issue of yesterday.

I will merely give one instance of the manner in which he represents facts, which can easily be ascertained on reference to the company's books.

In the last paragraph of his letter he says, with reference to clerks, "the total sum I received from the Maxim Company was £2. 18s. per week *in excess of the sum received for transfer fees.*"

Mark the words which I have italicised.

The amount actually paid during 1887 for salaries of clerks (exclusive of secretary) was £462. 8s. 1d., or nearly £9 per week.

The value of Mr. Watt's other assertions may be estimated by the above specimen.—I am, sir, yours, &c., SAMUEL J. BOYCE, Secretary.

The Maxim-Weston Electric Company (Limited),
2, Metal Exchange-buildings, 95 and 97, Gracechurch-street,
London, E.C., October 6th.

NEW COMPANIES REGISTERED.

WARD ELECTRICAL CAR COMPANY (LIMITED).—This company was registered on the 2nd inst., with a capital of £300,000 in £10 shares, to carry on business as electrical and mechanical engineers, carriage builders, railway, tramway and road proprietors. An unregistered agreement of 1st inst., between Michael Radcliffe Ward and A. A. Mackintosh, will be adopted. The subscribers are:—

	Shares.
J. W. Oxley, 29, Muriel-street, N., shorthand writer	1
H. Mayor, 9, Bridgewater-square, E.C., shorthand writer.....	1
L. H. Benjamin, 29, Sandringham-road, E., clerk	1
A. V. W. Capps, 18, Kelvin-road, N., shorthand writer	1
A. W. Wells, Greenhill-park, Harlesden, accountant.....	1
J. B Lawson, 30, Cambridge-street, S.W., assistant secretary	1

The number of directors is not to be less than 3, nor more than 7; the subscribers are to appoint the first, and act *ad interim*; qualification, 50 shares; remuneration, £2,000 per annum.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—We are informed that the accounts of this company, subject to audit, show a profit sufficient to enable the directors to recommend a final dividend of 3s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended 30th June, 1888, and also the payment of a bonus of 2s. per share, both free of income-tax, which, together, will amount to £32,500, being a distribution in the aggregate of 7 per cent for the past year, leaving a balance of £34,539. 3s. 7d., of which amount £30,000 has been placed to the reserve fund, increasing that fund to £170,175. 11s. 5d., and £4,539. 3. 7d. carried forward. The above dividend and bonus will be payable on the 31st inst. The traffic receipts for the week ended October 5th, 1888, amounted to £5,216.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of September was 3,550, estimated to produce £2,700, against 3,069 messages, producing £2,494, in the corresponding month of last year.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of September, 1888, amounted to £41,095, against £36,400 in the corresponding period of 1887.

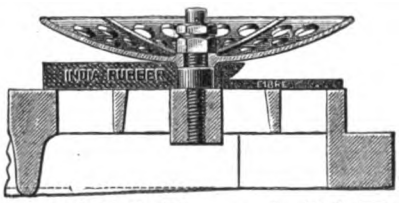
GLOBE TELEGRAPH AND TRUST COMPANY.—The Stock Exchange Committee have appointed Tuesday, October 16, as special settling day for Ordinary shares Nos. 179,178 to 180,227, and Six per Cent. Preference shares Nos. 178,993 to 180,042.—The directors of this company have declared an interim dividend of 3s. per share on the preference shares, less income-tax, and of 1s. per share on the ordinary shares, free of income-tax, for the quarter ending October 18, payable on and after that date.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for September amounted to £23,400, and for the period from 1st January to 30th September to 202,600. For the corresponding months of 1886 and 1887 they amounted to £195,560 and £197,720 respectively.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended October 5th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £4,359.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Oct. 10, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Oct. 10, 1888.	
£					£. s. d.		Highest.	Lowest.
			TELEGRAPHS.					
1,770,360	Stock	5/0	Anglo-American	48 49	2 16 9	Jan., Apr., July, Oct.	49⅛	47⅝
2,614,820	Stock	10/0	Do. Preferred	80½ 81½	3 7 6	,, ,,	82	79
2,614,820	Stock	nil.	Do. Deferred	16¾ 17¼	...	February	17⅜	16½
130,000	£10	3/0	Brazilian Submarine	13⅛ 13½	5 3 4	Mar., June, Oct., Dec.	13⅜	13⅜
16,000	10	9/0	Cuba Submarine	13¾ 14¼	5 19 9	February and August	14	...
6,000	10	10/0	Do. Preference	18 19	5 5 3	,, ,,	18	...
12,931	5	4%'87	Direct Spanish (£4 paid)	4 4⅛	3 11 1	March & September	4⅛	4
6,000	5	5/0	Do. Preference	9½ 10⅛	4 15 3	April and October	...	...
60,710	20	2/0	Direct United States	10¼ 10⅜	3 16 2	Jan., Apr., July, Oct.	10⅛	10¼
380,000	10	4/6	Eastern	12¼ 12⅜	4 16 0	,, ,,	12⅜	12¼
70,000	10	3/0	Do. 6 per Cent. Preference	14¾ 15¼	3 19 0	,, ,,	15¼	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	3 18 0	February & August	...	...
250,000	10	2/6	Eastern Extension	13 13¼	4 18 1	Jan., Apr., July, Oct.	13¼	13
22,050	10	8/3	German Union Telegraph and Trust	9 9⅜	7 7 4	January and March	...	...
179,177	10	3/0	Globe Telegraph and Trust	7⅛ 7⅜	4 15 0	Jan., Apr., July, Oct.	7⅜	7⅛
178,992	10	3/0	Do. 6 per Cent Preference	14⅜ 14⅝	4 3 6	,, ,,	14⅝	14½
150,000	10	5/0	Great Northern	13¾ 14¼	5 5 3	Jan., July, and April	14¼	14⅛
17,000	25	37/6	Indo-European	38 40	6 5 0	April and October	...	...
33,348	10	3/0	London Platino Brazilian	6 6½	...	May and November	...	...
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	...	...
338,225	Stock	13½%	Submarine	135 145	10 0 0	February & August	142	...
30,000	10	6/0	West Coast of America	7⅜ 8¼	6 1 3	January and July	8	7⅞
150,000	Stock	8%	Do. Debentures	114 119	6 14 6	June and December	...	...
88,321	10	nil.	West India and Panama	1⅜ 1⅝	...	...	1 11/16	1 7/16
34,563	10	*10/0	Do. 1st Preference	12 12½	7 12 0	April and October	...	...
45,181	15	9/0	Western Brazilian	12⅝ 12⅞	...	March & September	12⅞	12⅝
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 6	March & September	100⅜	...
			TELEPHONES.					
224,850	14/0	£5 7s. %'87	Consolidated Telephone and Maintenance	2 1/16 3 1/16	5 10 0	Yearly	...	...
220,000	£1	2½%'87	Oriental (11s. paid)	7/16 9/16	3 9 0	...	...	...
80,000	5	10/0	United	13¼ 13⅜	5 9 1	June and December	13⅝	13½
275,000	5	4/6	United River Plate	5⅝ 5⅞	...	July and January	5 15/16	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3½ 4	...	...	3⅞	3 13/16
23,692	5	nil.	Do. (fully paid)	4½ 5	...	February & August	4⅝	4½
79,934	5	nil.	Swan United (£3. 10s. paid)	2⅝ 2⅞	...	...	...	...
312,000	½	5% '86	Maxim-Weston	1/16 3/16	...	February	1/16	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	38½ 39½	6 1 3	March and July	39⅜	38⅞
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 3	February & August	17¼	16⅝

* On account of arrears of dividend.

SEVENTH YEAR OF PUBLICATION.

IN PREPARATION,

The Electricians' Directory

AND

HANDBOOK FOR 1889.

The Editors of "THE ELECTRICIANS' DIRECTORY AND HANDBOOK" will be glad to receive New Names and Addresses, and Corrections of those previously appearing, from all persons engaged in Electrical and cognate Trades. These Names and Addresses are inserted

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

No. 544.—Vol. XXI. FRIDAY, OCTOBER 19, 1888. Price 4d.

NOTES.

The new views of electrical action which are being developed with such rapidity and apparent success by the work of Hertz, Lodge, Thomson, Hicks, FitzGerald, Lindemann, and others, are, we need hardly say, now being studied with avidity by students of electrical science of every grade, more especially since nearly all the experiments can be repeated without the slightest difficulty by anyone who possesses the usual appliances for the study of static electricity. We are also persuaded that even the practical electrical engineer cannot safely neglect a new departure so fundamental and wide-reaching in extent. No "practical application" may at this moment be in view, or may even be imaginable; but, nevertheless, the extension of our knowledge of the relation between electricity and light, and of the nature and functions of the ether, can hardly fail, sooner or later, to have a powerful influence upon our present rough-and-ready methods of utilising electric energy. Meanwhile we are happy to believe that with the valued co-operation of Dr. Lodge and Mr. de Tunzelmann we have been enabled to present our readers with the results of the latest and most advanced theoretical and experimental research in a form at once accurate and easily intelligible to the non-mathematician.

Of the many crucial and far-reaching questions upon which the Hertz experiments will almost certainly throw much new light, one of the highest theoretical importance is that which has been referred to as "the murder of Ψ," about which Dr. Lodge says something in his "Sketch of the Electrical Papers in Section A" (*The Electrician*, September 21st, 1888, p. 624). This, as many of our readers will recollect, relates to the question of the manner and the velocity of the transmission of electrostatic potential. The elimination of Ψ (electrostatic potential) from the general equations of the electro-magnetic field has long been aimed at by mathematicians, and during the recent British Association meeting the informal suggestions of Profs. Rowland and FitzGerald to this end were received with some acclaim. As explained by Dr. Lodge in the Paper above referred to, this amounts to the suggestion that "an electrostatic field is not developed *sui generis*, but is always the consequence of a previously existing electro-magnetic one, which, on subsiding, leaves it as its permanent record." Thus Ψ breathes its last. But ere the last gasp comes Dr. Hertz to the rescue. The experiment (described by Mr. de Tunzelmann on p. 726 of our last issue), which proves the existence of a region in which the direction of the resultant of the electrostatic and electro-magnetic E.M.F. is indeterminate, can be explained only—so far as has yet been suggested—on the supposition that the electro-magnetic and electrostatic potentials possess different velocities. If this be established, it would seem to be inconsistent with the view that electrostatic potential is merely the result of the dying-out of electro-magnetic potential, so that the fate of Ψ is still left hanging in the balance.

Prof. Lindemann has recently shown reason for believing that if a particle of matter easily susceptible of electrification be made to approach a source of light with a velocity *exceeding that of light* by a certain definite amount it will become electrified. The higher the refrangibility of the light rays the greater will be the effect. The experimental verification of this prevision might at first sight appear to be a task of some difficulty. We hope shortly, however, to publish a *résumé* of Prof. Lindemann's research, from which it will be found that the theorem is applied to the explanation of striæ in vacuum tubes—a phenomenon which has never yet been satisfactorily accounted for—and in this way indirect evidence of at least a high degree of probability is obtained.

A valued correspondent writes as follows:—

"I appreciate your article on Practice *v.* Theory, but it hardly goes far enough. The distinction between a complex phenomena in practice and the simplified aspect of it which is suitable for calculation is undoubtedly true; but there is more in the controversy than that. The so-called 'practical' man not infrequently misunderstands the whole problem, and is unable or unwilling to seize the true mode of regarding the facts. It is not only a question of perturbing effects—the fundamentals themselves are differently regarded. But usually the only cure for the 'practical' generation is to die off, and for a new generation to arise. They are usually one generation behindhand."

If this is severe, it is, perhaps, not wholly unmerited. Our own purpose last week, however, was, if possible, to play the part of moderator. We may add that some remarks on the same subject from Mr. Oliver Heaviside will be found in our correspondence columns.

The Waterhouse system of regulation for constant current which we described last week bears a striking resemblance to a method which is credited to Edison, and which was described by Mr. Mordey, in our issue of July 31st, 1885, in the follow-

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ing terms:—"A combination of the two methods of brush movement and shunt-current alternation was proposed by EDISON, viz., to use an additional brush, to which one end of the field shunt was connected, the other end of the shunt being joined in the usual way to one of the ordinary brushes or terminals. This additional brush was to be moved on the commutator, between the two main brushes to the position which was necessary to obtain the proper current for the shunt. As any difference of potential, up to that maintained between the brushes, could in this way be obtained for the field circuit, the shunt current could be varied without the use of additional resistance coils, or the employment of divided field windings. Perhaps the difficulties connected with the construction of incombustible and infusible brushes prevented the extensive application of this very ingenious idea." It will be seen that the only difference lies in the fact that EDISON proposed to adjust the position of the brush; in the Waterhouse system the resistance in shunt on the field is varied. We doubt whether either system is consistent with the conditions of maximum efficiency.

IN the *Berichte der Berliner Akad.* C. BRAUN claims to have discovered a new method of producing an electric current. This is a claim which should be supported by the fullest proof before it can expect to receive recognition, and therefore we regret that the author does not furnish more exact information. The experiment is, however, sufficiently simple, and many of our readers will doubtless repeat it. A wire of nickel—though we learn afterwards that any other metal will serve—is twisted into a spiral, and the two ends are connected to a sensitive galvanometer. When the spiral is sharply extended a deflection is observed, and when it is again compressed the needle is deflected in the opposite direction. "This phenomenon," says the author, "is the more astonishing since the spiral being perfectly symmetrical there is no apparent cause by which the direction of the current is determined." We think, however, that it will immediately occur to most people that this is perhaps an instance of the Thomson effect. In winding the spiral it seems quite probable that in each turn one side of the wire will undergo a slightly greater molecular change than the other; then the change in temperature due to the alteration of configuration would set up differences of potential in each turn, which would be added together at the galvanometer terminals. The author mentions the effect of induction in the earth's field, but he thinks this is not sufficient to account for the observed deflections; he also finds that when the spiral is heated or cooled *as a whole* the same phenomenon is produced.

AMONGST our correspondence this week will be found an interesting letter, in which Mr. H. E. DOLAN describes an electric tramway in the neighbourhood of Toronto. Before the introduction of electricity the passengers were accustomed to be asked to walk up the steepest hills; now we are told a car 16ft. in length has carried as many as 127 people, and, though its back was broken by the load, "it got there all the same." In fact, the line is evidently worked with the usual American vigour and with the usual American success. We commend this letter to the attention of all who are interested in the commercial development of electric traction.

WE would call the attention of our readers to the circular (which will be found in another column) issued by the Secretary of the London Chamber of Commerce, convening a meeting of the Electrical and Allied Trades Section for Monday afternoon, at which, the report of the Provisional Committee having been read, a permanent committee will be elected. Up to the present over 180 members have joined, so that the movement already rests on a substantial basis.

A PROVINCIAL paper states—we know not with what degree of accuracy—that many of the fishermen of the Welsh and South West Coast are now regularly employing the glow lamp in night-fishing, the current being furnished by accumulators. Even if this statement be a little too "previous," as the Yankees say, yet there certainly appears to be some reason to believe that at the larger fishing ports a profitable business might be done in the charging of accumulators for this purpose. As to the efficacy of the light in attracting fish to the nets, this has been proved over and over again. In some recent experiments, which were attended by several gentlemen who are interested in the question, two nets were let down in the first instance, one with and the other without a single glow lamp. The former came up full of fish, the latter was comparatively empty. This was repeated several times at different depths. Both nets were then illuminated and taken up after a certain time with a good catch; they were then sunk for the same time without the lights and came up nearly empty. With a little judicious management in the preliminary stage, there certainly ought to be a demand for accumulators in this line of business.

"WE are glad," says the *Electrical World*, "to see that Prof. AYRTON has a good word to say for telpherage." There is a refined and delicate sense of humour in this remark which is very enjoyable. But on second thoughts we are seized with a painful doubt; surely our esteemed contemporary is not referring to telpherage as an American invention?

Telephone between Vienna and Prague.—A telephone line between these two cities is under construction by the Austrian Posts and Telegraph Department.

Repairs to the Australasian Cables.—The Eastern Extension, Australasia and China Telegraph Company notify that telegraphic communication is now restored with Australia and New Zealand.

The Submarine Cables Convention.—The English Government has notified the adhesion to the Submarine Cable Convention of Canada, Newfoundland, the Cape, Natal, New South Wales, Tasmania, Western Australia, and New Zealand.

The Waterhouse System.—Messrs. Shippey Bros. inform us that the Waterhouse System, particulars of which were illustrated in our last week's issue, has been awarded two diplomas and the gold medal at the Cincinnati State Exhibition.

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A Correction.—In our last issue we stated that Mr. G. S. Hooker had resigned his position as electrician in charge of the Bath installation, and that Mr. Orlando V. Thomas had been appointed in his place. We should have said that Mr. G. S. Hooker having been appointed to take charge of the Bath installation, Mr. Orlando V. Thomas had succeeded to the Taunton station.

The Van Rysselberghe System.—According to the *Indépendance Belge*, the inter-urban telephone lines on the Van Rysselberghe system yielded a revenue of 50,000fr. in 1887, and it is expected that the State will by the end of the current year have recouped itself for the outlay in adapting the telegraph lines to this system.

Redruth.—A local paper says:—"It seems the rumour which has been afloat that an electric light company is about to be formed at Redruth will most likely become a reality. A meeting of those interested in the movement was held last week, when an engineer versed in lighting by electricity was present to give information on the subject. Although, we believe, nothing decisive was arrived at, a syndicate was formed with the view of seeing what could be done to form a company."

Blyth.—A public meeting of the ratepayers of the Cowpen township, Blyth, was held last week, under the auspices of the Cowpen Local Board, to take into consideration the advisability of lighting the Cowpen township with electricity. Mr. William Thompson, of Waterloo, occupied the chair. Having heard the estimated cost of lighting by electricity and by oil the meeting unanimously agreed to urge upon the Local Board the advisability of adopting the electric light without further delay.

The Biography of the late Sir William Siemens.—We learn that the executors of the late Sir William Siemens have placed the preparation of his biography in the hands of Dr. William Pole, F.R.S., who was a personal friend of Sir William and his family. The work will be published shortly, in one volume, by Mr. Murray, and will be followed by other volumes, containing reprints of Sir William's most important scientific Papers, lectures and addresses, edited by his secretary, Mr. E. F. Bamber.

The "Popular Educator."—A new and revised edition of Cassell's "Popular Educator" will be commenced at the end of this month. The text will be revised throughout, and a considerable portion of the work rewritten; it will be furnished with new illustrations, and a series of coloured plates and maps will form an entirely new feature, whilst the work will be reset in clear type. Inasmuch as it will thus be practically a new work, it will be issued under the title of Cassell's "New Popular Educator."

The Electric Lighting of French Steamships.—The French Steamship Companies are gradually introducing the electric light into their vessels. The Messageries Maritimes has just placed it on the "Rio Grande," and has ordered the "Senegal," the "Amazone," and the "Mendoza" to be furnished with it. The "Rio Grande" possesses 100 incandescent lamps of 10 candles. The "Eugène Pereire," running between Marseilles and Algiers, has 300 lamps, and the packet "Amerique" has just been furnished with installations of 350 lamps.

Ivory Tablets.—The Endolithic Ivory Company, of 24, Well-street, Jewin-street, E.C., have submitted to us a sample of their method of writing or printing on bone or ivory, which seems to possess several advantages for switch board labels and address tablets. In this process the ink sinks into and combines with the material, so that it is practically indelible, and the surface, including the letters, takes a high polish. The process is said to be cheaper than engraving, and the company guarantees the durability of the lettering.

Cheltenham.—The Cheltenham Town Council, notwithstanding their advanced views in the matter of electric lighting, are hard to convince that it would be to their benefit to allow the West of England and South Wales Telephone Company to connect the Police Station and Fire Brigade with the local Exchange. Seeing that the company, with their customary generosity, ask only to be allowed to make the connection free of charge, this hesitation is really very difficult to understand. Is Cheltenham so small a village that the advantages of the *fernsprecher* are inappreciable?

Liverpool.—The Liverpool Electric Supply Company have been for some time engaged in negotiations with the Corporation with regard to the laying of their mains for lighting the streets and public buildings by electricity. The impervious pavement which is universally adopted in Liverpool has given rise to many difficulties, for when once it is laid it cannot be broken into without at once destroying its principal advantage. A satisfactory arrangement has, however, at last been made, and the cables are now being laid. This is the third attempt to light the public streets by electricity.

Mica in Australia.—An important discovery of mica has recently been made in the northern territory of Australia, by Mr. David Lindsay, F.R.G.S. The discovery consists of two mica outcrops, one showing 30 feet in width. Sample slabs of this valuable mineral have been sent to London, and brought to the Society of Arts. These, though taken from the surface, are of large size. As the consumption of mica is rapidly increasing through its use in electrical apparatus, and as sheets of large size are comparatively scarce and expensive, any new source of supply of the mineral is of considerable importance.

Electric Lighting at Sea.—The ss. "Cambria," of the Dundee, Perth, and London Shipping Company, has lately been fitted throughout with the electric light by Messrs. Paterson and Cooper. The plant comprises a Phœnix compound dynamo, driven by a 12 horse-power engine, and supplying 90 sixteen candle-power Edison-Swan lamps. The lamps are arranged in five circuits, to suit the working requirements of the vessel. Messrs. Paterson and Cooper have contracts at the present time for three ship installations, besides a contract for lighting the London wharf of the Dundee, Perth, and London Shipping Company.

Proposed Electric Lighting at Harrow.—On the 10th inst. a meeting of the ratepayers of Harrow was held to consider the advisability of adopting electric lighting in the town. Mr. Russell Biggs presided. Mr. Frank Taylor expatiated on the advantages of the electric light, remarking that this light was bound to come sooner or later, and that the time had arrived when it could be supplied as cheap as, or cheaper than, gas. He did not, however, cite Barnet as an instance of the successful introduction of the system of illumination he advocated. After some discussion it was resolved to ask the Local Board to investigate the matter.

A New Method of Amalgamating Zincs.—A Mr. Beattie has devised a new method of amalgamating zincs, which he says gives results far superior to those obtained by the ordinary process. It consists in melting together a mixture of zinc, mercury, bismuth, and antimony. Mr. Beattie tested his zincs in a Callaud gravity battery, which is largely used in the United States in connection with fire alarms. While the E.M.F. of a battery furnished with ordinary zincs was only 8·5 volts on starting, and fell to 8 volts at the end of 38 days

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and to 7·2 volts at the end of 54 days, the E.M.F. of a similar battery having the new zincs remained at 9·2 and 9·6 volts for a period of sixty days.

The Influence of Joints in the Magnetic Circuit of Dynamos. M. Larroque has recently carried out a series of experiments on this subject, which, although apparently not so exact as those of Prof. Ewing and Mr. Low (see *Electrician*, Sept. 30th, 1887, p. 439), lead to the same conclusions. It is therefore confirmed that the magnetic resistance of a joint diminishes as the pressure between the two surfaces increases, and that for the same applied pressure the resistance of the joint decreases as the total induction is increased. M. Larroque adds to this that in a practical machine when the iron approaches saturation the influence of mechanical vibration is so marked that the field is equivalent to that of a magnet of the same size and form without any joint.

Electric Lighting in a South Wales Colliery.—The Albion Steam Coal Company have decided to light their new colliery near Pontrypridd with electric light. The installation, which is to be of a very complete character, has been placed in the hands of the Gülcher Electric Light and Power Company (Limited), who also lighted the Ynishir colliery some two years ago with highly-satisfactory results. The installation for the Albion Company will consist of a horizontal engine, with automatic gear, driving a Gülcher dynamo, which will supply current to 114 16 candle-power incandescent lamps, 54 of the lamps being under ground; in all cases exceptionally strong fittings will be used in order to withstand the rough wear and tear of colliery work.

"Parts of Steam Engines."—Under this title the well-known firm of Tangyes (Limited) has issued a catalogue which involves a somewhat new departure in the engineering trades, the idea being to enable customers to purchase parts or portions of steam engines, either in the rough casting or forging, or partly or wholly machined. There can be no doubt that this arrangement will prove a convenience to many of the users of Tangye engines, as well as to others who have the necessary machinery for turning out work of a special kind, but who have neither patterns nor tools of the kind required. The catalogue is well printed and illustrated, and contains detailed dimensions of a large number of engine parts, such as steam cylinders, pistons, crossheads, connecting rods, lubricators, excentrics, &c.

Steam Power at the Paris Exhibition, 1889.—Messrs. Davey, Paxman and Co., of Colchester, have been selected by the executive committee to supply the whole of the steam power required for driving the machinery in the British section of the Paris Exhibition. Their engines have also been selected for supplying a portion of the motive power in the French section of this exhibition. It will be remembered that Davey, Paxman and Co.'s engines and boilers were selected four years in succession for supplying the whole of the motive power required for driving the electric light machinery at the Great International Fisheries Exhibition, 1883; the International Health Exhibition, 1884; the International Inventions Exhibition, 1885; and the Colonial and Indian Exhibition, 1886; receiving on each occasion a gold medal and diploma of honour.

Forthcoming Books.—Amongst the new works which will shortly be issued by Messrs. Crosby, Lockwood and Son, are the following:—"The Mechanical Engineer's Office Book." By Nelson Foley. Second Edition, much enlarged.—"Turning," a Text-book on the Elementary Principles and Practice of Using the Lathe, with numerous Engravings and Diagrams. By P. N. Hasluck. Crown 8vo.—"The Number and Weight Calculator," showing in single tables the value at 421 different rates (from $\frac{1}{8}\frac{1}{4}$th of 1d. to 20s.) of any number of articles from 1 to 20,000, or any number of tons, cwts., qrs., and lbs. from 1 to 1,000 tons. By Wm. Chadwick. Second Edition. 8vo. Revised and specially adapted to the apportionment of mileage charges for railway traffic.—"Modern Workshop Practice." By J. G. Winton. A new edition. Carefully revised and much enlarged.

The Institution of Civil Engineers.—The Institution of Civil Engineers has issued the annual list of subjects on which Papers are specially invited during the Session 1888-89. The following are the subjects connected with electricity: The Generation of Alternating Currents in Dynamo Electric Machines, and their Utilisation for Lighting and Power Purposes; Electric Meters for Recording the Consumption of Electrical Energy; the Construction and Maintenance of Secondary Batteries; Central Station Electric Lighting; the Application of Electricity to the Working of Street Tramways, and of Railways; the Application of Electricity to the Working of Cranes, Pumps, Tools, &c.; the Application of Electricity to Smelting and Metallurgical Operations; the Application of Electricity to the Purification of Water and Sewage; the Purification of Copper and the Reduction of Copper Ores by Electrolytic Processes.

Obituary.—Herr Carl Dornfeld, electrical engineer attached to the German Commission to the Melbourne Centennial Exhibition, died on Saturday, August 18th, after an illness of only 26 hours' duration. The *Melbourne Age* says Herr Dornfeld's great intelligence and superior professional knowledge in the various branches of engineering work have been of excellent service in the management of the German machinery court, while his amiable character enabled him to make a host of friends during his short stay in the city. He had been for some years partner in a leading firm of electrical engineers at Cologne, and he was at one time superintendent of the famous steel works of Krupp in Essen. His visit to the colony, made primarily for the benefit of his health, was also as representative at the Exhibition of several important engineering firms. His untimely death, at the age of 43, has occasioned much regret among the German residents in Melbourne.

Electric Lighting in Denmark.—Although the electric light, writes our Copenhagen correspondent, has been very slow in finding favour in Denmark, compared with Germany, Sweden, and Norway, there are at present several rather large installations either in contemplation or already in course of erection. The contract for the large "National" establishment, comprising a theatre, restaurant, &c., has been secured by the representative of S. Schuckert, of Nürnberg, Mr. Ludvig Lund. The contract is for about 28 arc lamps and 250 incandescent lamps. The boilers of 60 horse-power will be supplied by the large Belgian firm of De Nayer. There is also some talk of the Theatre Royal being lighted by electricity, but nothing definite has transpired in connection with this. Some of the buildings of the army are also having electric light installed, and there seems altogether to be more inclination to move in the matter. The first attempt to light a Danish town by electricity has just been made; it is an exceedingly modest one, however, viz., the small town of Lyngby, close to Copenhagen, where incandescent lamps have been substituted for petroleum lamps.

North of England Mining Institute.—At a meeting of the members of the North of England Institute of Mining and Mechanical Engineers, held on Saturday in the Wood Memorial Hall, Newcastle, Mr. Oswald Swete exhibited an electric safety miner's lamp, made by the New Portable Electric Lamp and Power Syndicate Company, London. He briefly explained the

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construction of the lamp, in which improvements had been made since it was shown to the members of the institute early this year. The weight of the lamp is 4½lb., its first cost about £1, and the cost of maintenance 3d. per week of six days per week, and running twelve hours per day; the 3d. includes the cost of repairs, interest on plant, depreciation of machinery, and renewals of incandescent lamps when necessary. A one-unit dynamo will charge 130 lamps. The light is protected by toughened glass, and if the glass should be broken a lever falls forward and puts out the light. The lamp has not any apparatus for detecting the presence of gas; but Mr. Swete stated that he hoped to succeed in getting such an apparatus. On the motion of Mr. G. B. Forster, seconded by Mr. Stevenson, a vote of thanks was passed to Mr. Swete.

Vestry of St. Margaret's and St. John's.—At a meeting of the St. Margaret's and St. John's Vestry (Westminster), last week, Mr. C. C. Piper presiding, the Parliamentary Committee submitted a report dealing with the lighting of the district by electricity. They recommended that the applications for licenses by the London Electric Supply Corporation, Limited, and the Metropolitan Electric Supply Company, Limited, be objected to on the grounds that the Vestry should retain the control of the lighting of the parish in its own hands; and, in view of the importance of the subject, have to ask the Vestry for an expression of opinion as to applying for a license empowering the Vestry to undertake the lighting of the parish. Mr. Thomas Horn moved the adoption of this, and, as a practical man, said that the electric lighting of districts up to the present time had been an utter failure. Mr. Henry Verity said that the opposing of such a grand improvement as this would lay them open to the charge that they were interested in the gas company. After a long discussion, the Vestry adopted the report and recommendation by a large majority. The committee, however, were requested to prepare a report as to the suggestion of the Vestry itself taking the necessary steps to supply electrical power for lighting.

St. James's Vestry.—At the last meeting of this Vestry the Lighting Committee, in answer to an application on behalf of the Metropolitan Electric Supply Company (Limited) for consent to apply to the Board of Trade for a license under the Electric Lighting Acts, recommended a reply to the effect that the Vestry was not prepared to assent to a license in the form submitted by them; but with a view to expedite the commencement of operations they would be disposed to consent to an application for a license in the form of the South Metropolitan Electric Lighting Order, 1888, which is awaiting confirmation by Parliament. Also that Messrs. Deacon, Gibson and Medcalf be informed, in reply to their application on behalf of the London Electric Supply Corporation (Limited) for consent to apply to the Board of Trade for a license under the Electric Lighting Acts, that the Vestry have already consented to the establishment of two electric-lighting installations in this parish, and that they are not prepared to assent to any further license or provisional order until these installations are either fully at work or have been abandoned.—This was adopted.—Mr. Pool thought two or three competing companies not at all bad, and objected to the streets being in an uproar with wires to be laid down underground.

Exports of Telegraph Wires.—The trade returns for September, as regards the exports of telegraph wire, &c., are again very disappointing. Our exports of iron and steel wire and manufactures thereof, except telegraphic wires, continue to expand, the total shipments from January 1 to September 30 this year having been £643,097, as against £450,761 in the same period of last year, and £417,632 in 1886. The reverse has been the case with telegraph wires, &c. The September shipments were the smallest of the year, and the total exports to date show a considerable shrinkage, which is especially noticeable in face of the appreciation in prices and the reports of an improvement in the electrical industries of the country. The following is the usual comparative table:—

Exports of Telegraph Wires and Apparatus connected therewith.

	1886.	1887.	1888.
First quarter	£124,074	£131,879	£88,077
Second „	354,331	56,933	156,136
Six months	£478,405	£188,812	£244,213
July	219,463	195,950	21,571
August	154,789	114,162	110,323
September	37,964	158,140	21,032
Nine months	£890,621	£657,064	£397,139

Paddington Vestry.—At a meeting of this Vestry on October 9th, the Electric Lighting Committee recommended "That they are of opinion that, after full consideration of the Electric Lighting Acts, and the rules thereunder, and having considered the report of Mr. Mackie, and the various notices and applications from electric lighting companies, the Vestry will be best studying the interests of the parishioners and inhabitants of Paddington by at once taking the necessary steps to apply this year for a provisional order or license. That the Vestry oppose the granting of all applications for provisional orders or licenses which may be made by any public companies, and that the solicitor be instructed accordingly."—Mr. Judge objected to this, and proposed that they should not yet apply for a provisional order, but ask the Board of Trade whether they would consent to dispense with any application for a license or provisional order during the present year, and in the meantime he would oppose all applications of companies, &c., pending the decision of the Vestry. He moved as an amendment that the whole question of electric lighting, together with the reply of the Board of Trade, be referred to the Electric Lighting Joint Committee for consideration and report.—Sir George Harris seconded this.—The amendment was put and was carried by 15 to 13.

Personal Experience of a Shock.—"Thinking some of the readers of the *Electrical World*," says Mr. T. D. Bottome, "might be interested in a personal experience of a shock by an intermittent current, I will give an account of one that occurred to me. On touching two terminals to close a circuit on some experimental apparatus, I thought, of course, I had grasped the insulation, but the bare end of a flexible wire managed to touch my right-hand fingers while I held the binding screw in the other hand. I was instantly thrown down and held perfectly rigid, unable to speak, it seemed to me, for two or three minutes, but probably twenty or thirty seconds would be nearer the actual truth. I felt unconsciousness coming on, when suddenly I became loosened, and I lay perfectly limp a moment or so. I got up, but was scarcely able to walk, the pains being greatest in the hips. However, I got a voltmeter, and found 140 volts on the circuit, and the alternations or intermittances were 150 per second, while I found my resistance, under the same conditions, to be 4,500 ohms. The wire that slipped out of my hand left a burn on my forefinger in the shape of an elliptical hole about $\frac{5}{32}$ inch deep, and scarred the flesh about the hole at a radius of ¼ inch. During the contact I felt difficulty in breathing, but five minutes afterwards my skin was all aglow, as if a bath brush and Turkish towel had been used vigorously, while the respiration became full and a trifle quickened. Two days afterwards I was all right, except a little soreness all over."

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Electric Transmission of Energy in the Comstock Mines.—The *Mining Industry* (an American journal) says that the Brush Electric Light Company has shipped to the Nevada mill two dynamos and motors of an improved pattern, and it assures the Nevada mill people that it will be able to put upon the stamps 80 per cent. of the power generated at the bottom of the shaft. There are to be six dynamos, one always to be held in reserve, and six Pelton wheels 40 inches diameter, instead of one of 11 feet diameter, to be made of phosphor-bronze, to drive them, each attached to the dynamo shaft directly. As already explained, these wheels will be set up at the Sutro tunnel level of the Chollar mine, in a large chamber already prepared to receive them. A column of water brought down the side of Mount Davidson in a wrought-iron pipe will be delivered through a proper nozzle upon the surface Pelton, which stands in the mill, under a perpendicular pressure of about 460ft. This wheel is 10ft. 10in. in diameter. After the water leaves the wheel it is piped to the main shaft of the Chollar mine. Down this shaft (and the incline at its bottom) the water is conveyed in two pipes to the electric chamber on the Sutro tunnel level. The water will be put upon the wheels under a perpendicular pressure of 1,630ft. In no place in the world has water been used on a Pelton wheel under such a tremendous head. The water will be delivered upon each wheel through a nozzle somewhat less than half an inch in diameter. Each wheel is intended to develop about 125 horse-power. This will make a total of some 750 horse-power delivered by the six wheels. As this is the first attempt in the history of mechanics to operate water-wheels under such an enormous pressure (as well as the fact of the utilisation of the power by electrical transmission), the result of the experiment will everywhere be anxiously awaited.

Electrical Lifts for the Eiffel Tower.—Two lifts are suspended at the two ends of eight steel cables passing over a pulley, and move up and down in two cylindrical adjacent cages, being kept vertical by the aid of guides. Each lift is divided into three compartments, one over the other. The two upper compartments are designed to hold one hundred passengers; and the lower compartment contains a dynamo of 25 to 30 horse-power, to which the electricity is conveyed by a wire from generators on the ground. The dynamo gives a rotating motion to a truck connected axially with the bottom of the lift, which rolls, by means of four projecting wheels placed radially, along a helicoidal rail winding round the side of the cage. There are two of these helicoidal rails placed slightly further apart than the diameter of the wheels, so that the wheels roll on the top of the lower one when the lift is descending, and revolve on the bottom of the upper one during its ascent. The suspending cables are exactly counterpoised by similar cables, attached to the bottom of both trucks, and rolling round two pulleys below the base of the cages. It is assumed that in practice the utmost difference between the load of the two lifts will be fifty passengers, or a weight of $3\frac{1}{2}$ tons, whereas the resistance of the system to motion is calculated at 4 tons, so that the lifts will not be liable to move of themselves; and though the machines are furnished with a brake, the stopping of the dynamos will stop the lifts. The descending truck, revolving under the action of its dynamo, will draw down its lift, and draw up the other lift, which will be lightened by the action of the dynamo in the truck below it. For a speed of $1\frac{2}{3}$ foot per second, the power required when the lifts are equally loaded will be 27 horse-power; when the descending lift has the maximum excess of fifty passengers, it will be 5 horse-power, and in the reverse case, 48 horse-power. Under the ordinary conditions of traction there will always be a space between the lift and its revolving truck; but if the cable broke, the lift falling freely on the connecting axle would overtake the revolving truck, and thereby arrest its rotation and prevent any further movement, thus securing the safety of the lift in the event of a fracture. A telephone will place the two men working the lifts in communication, so that they can always work in concert. The lift is to take passengers from the second to the third floor of the tower, a vertical height of 492ft., without a stoppage, in about five minutes.

New Technical Schools at the People's Palace.—Another addition to the number of technical schools in the metropolis was made by the opening, on Friday evening last, of the new technical schools at the People's Palace, Mile End, which have been built and fitted at the expense of the Drapers' Company, at a cost of £20,000. The building, which has been erected at the side of the Queen's Hall, from which it is separated by a wide corridor, comprises, in the basement, the engine and boiler room, engineer's shop, pattern making and moulding shop, brickwork and masonry shop, and the electric laboratory. The ground floor is occupied by the lecture room, trustees' and school offices, mechanical drawing room, and two class rooms. On the first floor are the building construction drawing room, head master's room, teacher's room, and two class rooms. The second floor is occupied by the chemical laboratory and three class rooms, whilst above this is the photographic studio. The power for both the engineer's shop and the electrical laboratory is taken from a 6-horse nominal Tangye engine, with air pump and condenser, the engine being fitted with the Tangye-Johnston automatic expansion gearing. Steam is supplied from a Cornish boiler, tested to a pressure of 120lb. per square inch; the working pressure, however will not exceed about 40lb. In the engine room there are three forges, one being fitted with a Roots blower. The engineers' shop contains a screw-cutting lathe with 8-foot bed and 5-inch centre, a screw-cutting gap lathe, 5-foot bed 5-inch centre, a shaping machine, a small planing machine, eight lathes for general work, and twenty vices. A special lathe is also being laid down with 18-foot bed and 6-inch centre, fitted with four headstocks. The pattern-making and moulding shop contains four vices, two moulding troughs, and a lathe for wood turning. The electrical laboratory contains a Victoria dynamo, running at 1,500 revolutions per minute, specially designed for educational purposes, to give 3,000 watts (4 horse-power), self-regulating for constant electromotive force, and having a rotary drum commutator by which the fields can be arranged on the shunt, series, or compound system in various combinations; also provided with a separate search coil, connected to special collector rings and brushes. There are also a 2 horse-power electric motor, an alternator, and two Mordey transformers. The laboratory also contains a complete installation of arc and incandescent lamps and sets of testing apparatus, comprising a Wheatstone bridge, tangent, Thomson's reflecting and astatic galvanometers, &c. The course of instruction is arranged to extend over a period of two years, and will embrace the study of mathematics, mechanical and industrial drawing, science, with laboratory practice and handicraft work and the use of tools. Particular attention will be paid to giving students a thorough technical and practical knowledge of the nature of tools, of setting out working drawings, of the uses of chemistry in various trades, of electricity, and of the nature and use of steam. The engineering course will include drawing, pattern-making from drawings and to measurement, metal turning and lathe work, and the construction of models from drawings of the students' own execution.

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REMARKS ON SOME OF OUR TELEPHONIC SYSTEMS.

BY J. MUNRO.

I have recently had an opportunity of seeing some of the Provincial as well as the Metropolitan systems of telephony, and it may be interesting if I give your readers an account of these, especially as there seems to be some misapprehension on the subject.

The centres I shall speak of are some of the most important in the country, namely, Manchester, Liverpool, Glasgow, Edinburgh, Dundee and London. I shall treat them in that order, taking first the overhead work, and, second, the exchanges in each place.

The overhead system of Manchester has recently undergone a change. In place of several small exchanges in different parts of the town, there is now one large central exchange situated in the Royal Exchange-buildings. No. 11 galvanised iron wire was formerly used, but No. 16 B.W.G. copper has been substituted both for trunk and subscribers' lines. These are supported chiefly on strong wooden standards by means of cross-arms. Shackles are employed for the over-house work; but these, I understand, are to be replaced by insulators. The trunk lines to Liverpool and elsewhere are single, the wire running on insulators supported by tall wooden poles. There is a good deal of "cross-talk" or "over-hearing" upon them, which, however, is somewhat reduced by cross-connections at the poles.

Several aerial cables are used in Manchester, especially as leads to clear away from the roof of the Exchange-buildings; but none of them are over half a mile in length. They are of different types, the more recent being Glover's "Anti-Induction" cable, and to diminish the "cross-talking" the metallic sheathing of the cable is connected to earth at intervals. The indoor leads are carefully boxed in on their way to the board.

The new switch room, opened this year, is a long, handsome apartment, well lighted from the roof. An older form of board has been replaced by a "multiple" switch-board of the small pattern, at present fitted for 1,600 subscribers, but capable of taking 4,200. There are now some 1,400 subscribers on the service. The practical advantage of the multiple board is that each operator has within reach the wire of every subscriber on the exchange, so that she (or he) can make the cross-connection which is required herself, without moving from her place, or asking any other operator in the exchange to assist. This convenience not only saves time, but prevents noise in the room. This new board is fitted with polarised "ring-off" indicators, forming "tap" connections to earth when any two subscribers are talking. This arrangement enables a subscriber to ring up his correspondent direct should a conversation be temporarily dropped, without calling the exchange. Moreover, when the conversation is quite finished, either of the two subscribers can notify the exchange of the fact. It is a question, however, whether this advantage is not counterbalanced by the tap connection to earth lowering the talk, especially on long lines. The company's electrician has introduced some improvements in the arrangement of the wires. The test-board admits of the tests being very readily made. The multiple board at New York is arranged in the form of the letter U; at Manchester like the letter L. A separate table, situated in front of the base of the L helps to work the trunk lines. Each local call for a trunk connection is transferred to the operator at this table, who makes out a ticket, stamped with the time, and hands it to an operator on the trunk-board immediately behind her. The latter thereupon completes the connection.

The subscribers' calls at Manchester are made with battery currents. In Liverpool the lines are constructed as at Manchester. Insulators are used, however, on the new line to Bootle, by the docks; and a Felten-Guilleaume cable runs through the Mersey Tunnel to Birkenhead.

In Liverpool the majority of the subscribers are concentrated in one central exchange in the Royal Exchange-buildings. The switch-board here is the first of the Western Electric multiple type fitted up in England; but it is to the credit of the United Telephone Company that prior to this they had introduced into their Chancery-lane Exchange another multiple switch-board on the same principle originally invented by one of their *employés*. The Western Electric Company subsequently claimed that their patents covered this board; but a friendly arrangement was made, and the board has continued in use till now, when it is being replaced by a new multiple of the latest pattern. The subscribers' calls at Liverpool are given with magneto currents; and the ringing currents are generated at the exchange by small magneto-electric machines, driven off a "Thirlmere" water motor by the pressure in the supply pipes.

The system in Glasgow has recently been so fully described in your columns by the company's engineer that I need only refer to it very briefly. The lines are of No. 18 B.W.G. bronze, carried by brown earthenware insulators, and supported on tubular standards of wrought iron by channel-iron cross-arms. At the Royal Exchange, where the central exchange is situated, several large standards are braced together, and carry several hundred wires. These bronze wires are said to give no trouble from the "singing" noise made at the poles. The trunk wires at Glasgow are of No. 14 B.W.G. copper; they are double, and run on white ware insulators, supported by creosoted wooden poles. They are worked with induction coils in the loops. A few cables are used to clear away from the roof of the Exchange—one being of the Paterson type, as supplied by the Western Electric Company. Besides the large central exchange there are several small ones in Glasgow. The central switch-board is of the ordinary multiple type and large pattern, but more modern in make than that of Liverpool. It comprises some 1,500 subscribers, but additional boards have been fitted in another room to take more subscribers eventually. The ringing and call system is the same as in Liverpool. Altogether the Glasgow system appears to be very well carried out.

In Edinburgh No. 18 B.W.G. bronze wires are also used. They are run on white insulators, supported on wooden standards. The trunks are double, crossed at intervals, and worked with induction coils. That to Glasgow is "crossed" for a part of the way and "twisted" for the remainder. There is no large central exchange in Edinburgh, the lines being distributed amongst five small exchanges, comprising in all about 600 subscribers. The largest is in George-street, and has about 150 subscribers. The switch-board is of a very old type.

In Dundee the wires are also of No. 18 B.W.G. bronze, and supported as in Edinburgh. There is one central exchange in the town, with smaller ones in the suburbs. Some 450 subscribers are connected on the central. The switching is performed by a modification of the Law system, each subscriber, besides his ordinary wire, having the means of calling the exchange on a special circuit wire common to 50 or 100 subscribers, at which an operator in the exchange is constantly listening for a call from any of the group. In the Law system the group of subscribers are joined in series on the common wire. In the Dundee modification each subscriber is connected to the common wire by a tap to earth. Each subscriber after being connected at the exchange rings up his correspondent direct, no ringing being done at the exchange. A subscriber can leave his telephone, discontinuing his conversation for a space, and return to it without any fear of the exchange meanwhile disconnecting him. When he has quite finished he can, by the special circuit wire, instruct the exchange operator to that effect. The ringing at Dundee is done by magneto-currents.

The board is of the old Bell type; the indicators not being used unless any of the special circuit wires, above described, are out of order. All the operators are continually listening at their telephones on the circuit wire for calls, and each is provided with a set of keys, enabling her to connect her own instrument with that of any other operator in the exchange. In this way cross-connections are effected between the various sections of the board without speaking *viva voce* across the room.

Subscribers in Dundee are connected by name, not by adopted numbers as in other towns. The custom has grown up since the beginning of the service, and has not yet been changed. It may be feasible in a comparatively small town like Dundee, but it would, evidently, be not merely wasteful of

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time, but quite impracticable in London or other large cities. The switching system of Dundee, too, though apparently well adapted to the town, would be extremely difficult of application in a large city with several big exchanges.

At all the places mentioned the exchanges are kept open night and day. Public call-offices, where any person, whether a subscriber or not, can speak to a subscriber, have been introduced in all these towns. At Glasgow and Manchester automatic call-boxes, requiring no attendant, and serving the purpose of a public call-office, are also in use, there being about a hundred in operation. I am unable to speak personally as to their efficiency.

In the metropolis the conditions of working are very different from those in the provincial towns I have referred to. This remark applies not only to the overhead lines, but to the exchange system. To begin with, the work has to be carried out on a much vaster scale in London, which must be regarded as a congregation of cities. The difficulties of the overhead work are greatly enhanced by the irregularity of the streets and the rickety character of many of the roofs. The regular streets and solid buildings of Edinburgh and Glasgow, for example, offer facilities for running wires which the huddled rookeries, so common in London, with their broken-backed, red-tiled roofs and infirm brick chimneys do not afford. It is impossible to fix or stay a pole on many of these roofs; moreover, the difficulty of getting way-leaves is exceptionally great. At the principal exchanges large wrought-iron structures, called derricks, are erected, which are so made as to require no stays, and are capable of taking an enormous number of wires. Most of them are at present fitted to accommodate from 1,000 to 1,200 wires, and provision is made for the attachment of cross-bars to take at least as many more. They are built in stories, and admit of the easy manipulation of the wires from platforms inside. The single poles erected on housetops are of tubular wrought-iron, similar to those of Glasgow. This class of pole was first introduced for telephonic purposes, by the United Telephone Company, in the year 1880. Where they are used as junction poles—that is, for wires radiating in all directions, they are mostly without cross-arms; but where they form part of a line carrying a number of wires in one direction, they are provided with cross-arms. In many instances two of these tubular poles are erected side by side, and braced together by means of the cross-arms. All the ground poles are of wood. Whenever possible creosoted poles are used; but where, owing to their unsightliness, these are objected to, as, for instance, in private gardens, English larch is employed, and the poles are painted.

The wires in London are either iron or copper. I have seen it stated in a recent article that they are of No. 8 *steel*, but the blunder is so egregious that, though it did not stand alone, I presume it may have been an inadvertence. Where iron is used for overhouse work it is in the form of a strand, composed of three No. 16 B.W.G. galvanised iron wires twisted together. Where it is run on ground poles it is a single conductor of No. 11 gauge. Where copper is used for overhouse work it is a strand of three No. 18 B.W.G. wires twisted together, and where it is used on ground poles it is either single No. 17 or No. 14 B.W.G. The trunk line which is now being constructed by the United Telephone Company is of No. 12½ copper. Copper, in fact, is gradually superseding iron wire in London, the relative amounts at present being about equal. For overhouse work in London strand wire has almost always been employed, both by private companies and the Post Office, in consequence of its freedom from the "singing" which generally accompanies single wires, and which in the residential districts of London, as well as in the City, where many caretakers live, renders the use of single wire impracticable. When bronze wire was first introduced into England some years ago a considerable quantity of it was erected by the United Telephone Company in London; but it proved to be of such inferior manufacture that it had to be abandoned in favour of the more reliable iron and copper. Whilst insulators are used on ground poles, shackles are mostly employed for overhouse work, on account of their mechanical strength and, having regard to the enormous number of crowded streets which have to be crossed, their safety. Aerial cables of various types are much used in London wherever way-leave difficulties prevent large numbers of open wires being carried. Some of these cables are several miles in length, whilst the longest I am aware of in the provincial towns is only about half a mile.

With regard to what I may call the indoor work, there are a number of large local exchanges in London, each of which should be regarded as the central exchange of a separate town. Just as it would be impracticable to run all the subscribers' lines from the various outlying smaller towns around Manchester or Glasgow into the central exchanges in those cities, so it is impracticable to concentrate all the subscribers' lines from the various districts of London into any one central exchange; in fact, most of the London branch exchanges are, practically, central exchanges connected by trunk lines. The United Telephone Company have, however, for some years, been working in the direction of concentrating their lines, and several minor exchanges which formerly existed have been closed, the wires being carried to the nearest larger exchange, and arrangements are well advanced for merging several of these large exchanges into one.

To secure, however, as far as possible, the advantages of a single central exchange, each branch exchange is provided with trunk wires, not only to its neighbouring exchanges, but also to a common central trunk exchange, where, as the exigencies of the service require it, the branch exchanges are directly connected together. This is a special arrangement peculiar to the metropolis, and due to the conditions existing there. It minimises the number of trunk wires, and secures the maximum of use from each. In most cases the trunks between any two exchanges are divided into two distinct groups, one for the up, and the other for the down traffic—an arrangement which has been adopted in New York. Judging from a Paper read by Mr. Sherwood at the recent Telephone Convention in America, there are many other striking similarities between the New York system in general and that of London.

I may mention in passing that there are some 550 trunk wires in London, some of them being eight or ten miles long. There are some 8,000 miles of wire in the system altogether, of which from 1,200 to 1,300 miles are in cables. There are in all 4,900 subscribers on the exchanges, and from 1,300 to 1,400 private wires.

In seven of the principal London exchanges multiple boards are used, and at four others are in course of erection. Whereas the battery method of ringing was formerly employed, it is gradually being superseded by the magneto system, a process which necessarily takes some time in a system so extensive as that of London. At present about half the subscribers have been provided with the magneto. All private wires have the magneto only. At the exchanges small magneto-electric machines, driven by a Koerber hot-air motor, are also adopted.

At the provincial towns above mentioned lady operators are employed; in London most of the exchanges are worked by the same means, and one or two of them by youths.

There is a night service in London as in other towns, but here, owing to the custom of residing in the suburbs and deserting the "city" at night, it is found needless to keep all the exchanges open. The exchanges in the residential portion of the metropolis are always open; and any subscriber in the business part who desires it is connected at night by a trunk wire to one of these.

It was in London that the first public call-offices were opened, and there are now a large number in operation. Subscribers have the use of these free of charge, but non-subscribers pay a small fee.

In conclusion, I may remark that the work in the different towns referred to is highly creditable to the respective engineers concerned. It is not my intention to make a critical comparison of the different systems, more especially as it appears to me that the conditions under which the work has to be carried out are different in each place. On the whole there seems little to choose between the systems; each is apparently the outcome of the peculiar circumstances obtaining in the locality.

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HERTZ'S RESEARCHES ON ELECTRICAL OSCILLATIONS.

BY G. W. DE TUNZELMANN, B.SC.

(*Continued from page 726.*)

Dr. Hertz's next Paper in order of publication in Wiedemann's *Annalen*, "On Some Induction Phenomena arising from Electrical Actions in Dielectrics" (Wiedemann's *Annalen*, Vol. XXXIV., p. 273), contains an account of some researches undertaken with a view of obtaining direct experimental confirmation of the assumption involved in the most suggestive theory of electrical actions, viz., that of Faraday and Maxwell, that the well-known electrostatic phenomena observed in dielectrics are accompanied by corresponding electro-dynamic actions. The method of observation consisted in placing a secondary conductor adjusted to unison, as regards electrical oscillations, with the primary, as near as possible to the former, and in such a relative position that the sparks in the primary produced no sparking in the secondary. As the equilibrium could be disturbed and sparking induced in the secondary by the approach of conductors, it formed a kind of induction balance; but the point of special interest in connection with it was that a similar effect was produced when the conductors were replaced by insulators, provided the latter were of comparatively large size. The observed rapidity of the oscillations induced in the dielectrics showed

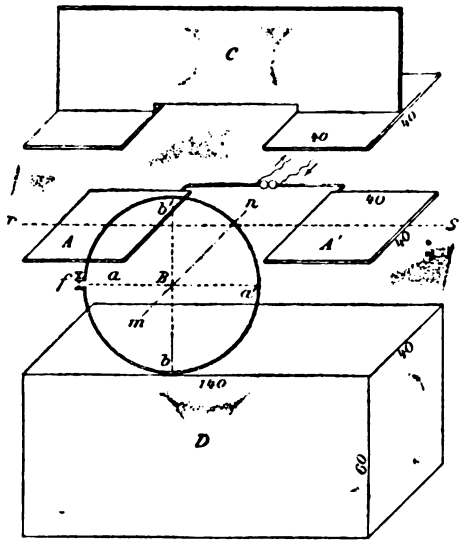

FIG. 10.

that the quantities of electricity in motion under the influence of dielectric polarisation were of the same order of magnitude as in the case of metallic conductors.

The apparatus employed is shown diagrammatically in Fig. 10, and was supported on a light wooden framework, not shown in the illustration. The primary conductor consisted of two brass plates, A A', with sides 40 centimetres in length, joined by a copper wire 70 centimetres long and half a centimetre in diameter, containing an air space of three-quarters of a centimetre, with terminals formed of polished brass spheres. When placed in connection with a powerful induction coil, oscillations are set up, the period of which, determined by the dimensions of the primary, can be determined to within a hundred millionth of a second. The secondary conductor consisted of a circle, 35 centimetres in radius, of copper wire two millimetres in diameter, containing an air space, the length of which could be varied by means of a screw from a few hundredths of a millimetre, up to several millimetres. The dimensions stated were such as to bring the two conductors into unison, and secondary sparks up to six or seven millimetres in length could be obtained.

The circle was movable about an axis through its centre perpendicular to its plane, to enable the position of the air space to be varied. The axis was fixed in the position *m n* in the plane of A and A', and halfway between them. The centre of the circle was at a distance of 12 centimetres from the nearest points of A and A'.

When *f* was in either of the positions *a* or *a'* lying in the plane of A A' no sparking occurred in the secondary, while maximum sparking took place at *b* and *b'* 90° from the former positions. The E.M.F. giving rise to the secondary sparks is, as in previous experiments, partly electrostatic and partly electromagnetic, and the former being the greater will determine the sign of the resultant E.M.F. The oscillations must, for the reason previously explained, be considered as produced in the part of the secondary most remote from the air space. Assuming the E.M.F. and the amplitude of the resulting oscillation to be positive when *f* is in the position *b'*, they will both be negative when *f* is at *b*.

When the circle was slightly lowered in its own plane the sparking distance was increased at *b'* and diminished at *b*, and the null points lay at a certain distance below *a* and *a'*. The electrostatic E.M.F. is scarcely affected by such a displacement, but the integral of the E.M.F. of induction taken round the circle is no longer zero, and therefore gives rise to an oscillation which will be of positive sign whatever be the position of *f*, for the direction of the resultant E.M.F. of induction is opposite to that of the electrostatic E.M.F. in the upper half of the circle, and coincides with it in the lower half where the electrostatic E.M.F. has been assumed to be positive. Since the new oscillation so produced is in the same phase as the previously existing one their amplitudes must be added to give the resultant amplitude, which explains the phenomena.

Effects of the Approach of Conductors.—In making these observations it was found necessary to remove all conductors to a considerable distance from the apparatus, in order to obtain a complete disappearance of sparking at the points *a* and *a'*. Even the neighbourhood of the observer was sufficient to set up sparking when the air space *f* was in either of these positions, and the sparks had therefore to be observed from a distance. The conductors used for the experiments was of the form shown at C (Fig. 10), and consisted of thin metal foil. The objects kept in view in selecting the material and dimensions were to obtain a conductor which would give a moderately large effect, and having an oscillation period less than that of the primary.

When the conductor C was brought near to A A', it was found that the sparking distance decreased at *b* and increased at *b'*, and the null points were displaced upwards—that is, in the direction of C.

From the results of experiments already described it is evident that the effect of displacing A A' upwards would be the same, qualitatively, as that of a current in the same direction as that in A A' directly above it. The effect produced by the approach of C was the reverse of this, and could be explained by an inductive action, supposing there were a current in C in the opposite direction to that in A A', which is exactly what must occur; for the electrostatic E.M.F. would give rise to such a current, and since the oscillations in C are more rapid than those of this E.M.F., the current must be in the same phase as the inducing E.M.F. The truth of this explanation was confirmed by the following experiments. The horizontal plates of the conductor C being left in the same position as before, the vertical plate was removed, and successively replaced by wires of increasing length and fineness, in order to lengthen the oscillation period of C. The effect of this was to displace the null points more and more in an upward direction, while at the same time they became less sharply defined, a minimum sparking taking the place of the previous absolute disappearance. The sparking distance at the highest point had previously been much less than at the lowest point, but after the disappearance of the null points it began to increase. At a certain stage the sparking distance at the two positions became equal, and then no definite minimum points could be found, but sparking took place freely at all positions of *f*. Beyond this stage the sparking distance at the lowest point diminished, and very soon two minimum points made their appearance close to it, not clearly defined at first, but gradually becoming more distinct, and at the same time

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approaching the points $a\,a'$, with which they ultimately coincided, when the minimum points again became absolute null points. These results are in agreement with the conclusion drawn from the former observations, for as the oscillation period of C approaches that of A A', the intensity of the current in the former increases, but a difference of phase arises between it and the exciting E.M.F. When the two are in unison the current in C attains its maximum, and, as in other cases of resonance, the difference of phase gives rise to a slightly damped oscillation, having a period of about a quarter that of the original one, which makes any interference between the oscillations excited in the circle B by A A' and C respectively impossible. These conditions clearly correspond to the stage at which the sparking distances at b and b' were equal. When the oscillation period of C becomes decidedly greater than that of A A', the amplitude of the oscillation in the former will again diminish, so that the difference in phase between it and the exciting E.M.F. will approach half of the original period. The current in C will therefore always be in the same direction as that in A A', so that interference between the two oscillations excited in B will again become possible, and the effect of C will then be opposite to its original effect. When the conductor C was made to approach A A' the sparks in B became much smaller, which is explained by the fact that its effect will be to increase the oscillation period of A A', and therefore to throw it out of unison with B.

Effects of the Approach of Dielectrics.—A very rough estimate shows that when a dielectric of large mass is brought near to the apparatus, the quantities of electricity set in motion by dielectric polarisation are at least as large as in metallic wires or thin rods. If, therefore, the action of the apparatus were unaffected by the approach of such masses it would show that, in contradiction to the theories of Faraday and Maxwell, no electro-dynamic actions are called into play by means of dielectric polarisation, or, as Maxwell calls it, electric displacement. The experiments, however, showed an effect similar to that which would be produced if the dielectric were replaced by a conductor with a very small oscillation period. In the first experiment made, the mass of dielectric consisted of a pile of books, 1·5 metre long, 0·5 metre broad, and 1 metre high, placed under the plates A A'. Its effect was to displace the null points through about 10° towards the pile. A block of asphalt (D, in Fig. 10), weighing 800 kilogrammes, and measuring 1·4 metre in length, 0·4 metre in breadth, and 0·6 metre in height, was then used in place of the books, the plates being allowed to rest upon it.

The following results were then obtained :—

(1.) The spark at the highest point of the circle was now decidedly stronger than that at the lowest point, which was nearer to the asphalt.

(2.) The null points were displaced through about 23° downwards—that is, in the direction of the block—and at the same time were transformed into mere points of minimum sparking, a complete disappearance being no longer obtainable.

(3.) When the plates A A' rested on the asphalt block the oscillation period of the primary was increased, as shown by the fact that the period of B had to be slightly increased in order to obtain the maximum sparking distance.

(4.) When the apparatus was moved gradually away from the block its action steadily diminished without changing its character.

(5.) The action of the block could be compensated by bringing the conductor C over the plates A A', while they rested on the block, the null points being brought back to a and a' when C was at a height of 11 centimetres above the plates. When the upper surface of the asphalt was 5 centimetres below the plates compensation was obtained when C was placed at a height of 17 centimetres above them, showing that the action of the dielectric was of the order of magnitude which had been anticipated.

The asphalte contained about 5 per cent. of aluminium and iron compounds, 40 per cent. of calcium compounds, and 17 per cent. of quartz sand. In order to make sure that the observed effects were not due to the conductivity of some of these substances, a number of further experiments were made.

In the first place the asphalte was replaced by a mass of the same dimensions of the so-called artificial pitch prepared from coal, and effects of a similar kind were observed, but slightly weaker, the greatest displacement of the null points amounting to 19°. Unfortunately this pitch contains free carbon, the amount of which it is difficult to determine, and this would have some conductivity.

The experiments were then repeated with a conductor, C, of half the linear dimensions of the former one, and smaller blocks of various substances, on account of the great cost of obtaining large blocks of pure materials. The substances used were asphalt, coal-pitch, paper, wood, sandstone, sulphur, paraffin, and also a fluid dielectric, namely petroleum. With the smaller apparatus it was not possible to obtain quantitative results of the same accuracy as before, but the effects were of an exactly similar character, and left little room for doubt of the reality of the action of the dielectric.

The results might possibly be supposed to be due to a change in the distribution of the electrostatic E.M.F. in the neighbourhood of the dielectric, but in the first place Dr. Hertz states that he has been unable to explain the details of the observations on this hypothesis, and in the second place it is disproved by the following experiment :—

The smaller apparatus was placed with the line $r\,s$ on the upper near corner of one of the large blocks, in which position the dielectric was bounded by the plane of the plates A A' and the perpendicular plane through $r\,s$, both of which are equipotential surfaces, so that if the action were electrostatic no effect should be produced by the dielectric. It was found, however, to produce the same effect as in other positions. It might also be supposed that the effects were due to a slight conductivity, but this could hardly be the case with such good insulators as sulphur and paraffin. Suppose, moreover, that the conductivity of the dielectric is sufficient to discharge the plate A in the ten-thousandth of a second, but not much more rapidly. Then, during one oscillation, the plates would lose only the ten-thousandth part of their charge, and the conduction current in the substance experimented on would not exceed the ten-thousandth part of the primary current in A A', so that the effect would be quite insensible.

(To be continued.)

REVIEWS.

Traite Elementaire de l'Accumulateur Voltaique. By EMILE REYNIER. (Paris : Baudry and Co., 1888).

Taken as a whole this book may be pronounced to be well worth the attention of all who are interested in the construction or the management of accumulators. The work is divided into four parts, dealing respectively with elementary principles, a description of various types of cells, technological data, and practical applications. In each section much useful matter is to be found, but in the author's desire to serve the *l'intérêt superieur de la vérité* by discriminating between real inventions and mere adaptations, some curious omissions result. Of course, a book written by a Frenchman for Frenchmen is necessarily French ; and it is no matter for surprise that the principal part is occupied with Gallic inventions. But, judging from the rate at which accumulators are being made both in England and Belgium, it seems strange that only a few pages should be given to the "foreign" manufacturer. We are disposed to attribute this to the patriotism of the author.

Chapter IV. contains sketches of some plates perhaps not generally known in England to the ordinary electrician, though most of them have been tried in approximately the same form by more than one manufacturer in this country. The Faure-Sellon-Volckmar type is briefly discussed, and some comparative tables are given, showing weights, outputs, &c., for lighting and traction cells. The use of oxygenated water with the electrolyte, according to the author, gives an increased rate of discharge, a higher voltage, and a greater capacity. Non-oxidisable sulphates are also mentioned as possessing the same virtue. But, unfortunately, we are told that this increase of activity results in damage to the plate, as ordinarily made.

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This matter is now being treated experimentally by M. C. Philippart.

Chapter VI. briefly discusses the best known couples, and will be found very instructive from the historical point of view. A careful study of this chapter may save a good deal of useless experimenting.

M. Reynier has himself invented a plate which seems to have some novelty of design. The plate consists of a fluted sheet of lead, with the active material laid in the grooves, and held tight by the subsequent expansion of the plate. The whole is surrounded by a strong casting of lead, which makes metallic connection with the conducting part of the plate proper. This framing is sufficiently strong to resist to some extent the tendency to lateral expansion, and the active material is said to make close contact with the conducting part, and thus give a larger useful effect. This may be so; but we should like to know whether buckling is also prevented.

The application of accumulators to tractive purposes is fairly discussed, and the difficulties of weight, &c., are by no means glossed over. The losses to be expected in batteries, motor, and gearing are fairly estimated, and agree well with figures obtained in this country.

The difference between applying accumulators to traction purposes on land and to the propulsion of boats is very clearly put, much to the advantage of the former.

We extract the following tabular summary :—

Comparison of Electric Traction with Electric Navigation.

Electric Tramcar.	Electric Launch.
Torque is independent of speed.	Torque is proportional *to square of speed.*
The power exerted is proportional to speed.	The power exerted is proportional *to cube of speed.*
For a given distance run work done is theoretically independent of speed.	For a given distance run work done is proportional *to square of speed.*

The use of accumulators for electric lighting, telegraphy, &c., is also briefly touched. As we anticipated, the secondary battery is mentioned as a regulator for lighting circuits. In this country we rely on more efficient and less expensive types of regulators. The author claims, however, to have designed for this purpose a cheap cell, having a high rate of discharge with small capacity. He installed in March, 1877, at the Hotel de Ville, Paris, eleven tons of lead and 4,500 litres of electrolyte for this purpose. This enormous battery is of the Planté type, and is capable of working at the rate of 100 horse-power. This is probably the largest battery in daily use yet brought into existence.

Electric Lighting; its Present Position and Future Prospects. By Hammond and Co. (London: Whitehead, Morris and Lowe).

This little pamphlet contains, within less than 100 pages, concise explanation of practically everything which those who are interested in electric lighting from a consumer's point of view are likely to wish to understand. It is well written and well printed, and we have no doubt that its circulation will tend to the promotion of an intelligent interest in the electric light. We may add that although the authors are well-known exponents of a particular system of electrical distribution, yet they have taken evident pains to present a fair and impartial account of all the practicable methods of central station distribution now in use.

BOOKS, &c., RECEIVED.

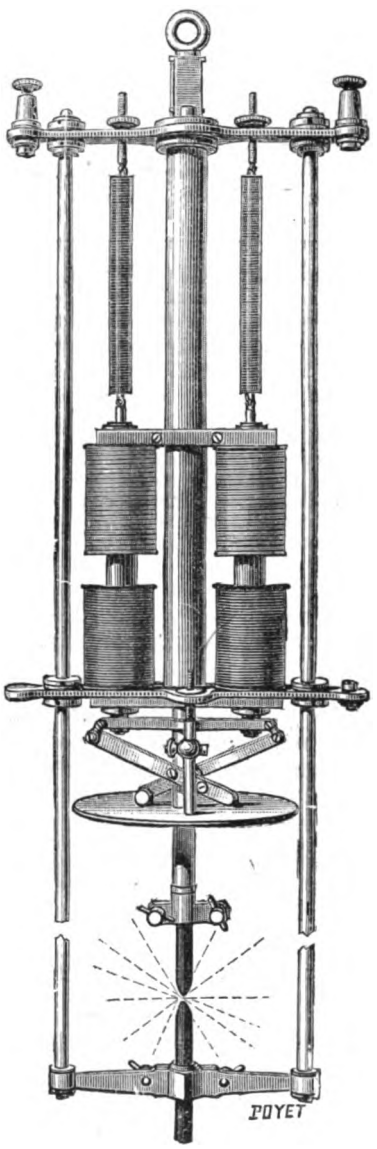
"Catalogue of the Parts of Steam Engines in Various Stages of Manufacture." (Birmingham: Tangyes, Limited.)

"The *Journal* of the Franklin Institute." Vol. CXXVI., No. 754. (Philadelphia.)

"The Van Depoele System of Electric Railways and Transmission of Power." (Chicago: Van Depoele Electric Manufacturing Company.)

THE GERARD ARC LAMP.*

We illustrate below one of the latest forms of arc lamps devised by M. Anatole Gérard. The most striking part of the mechanism is the brake, which consists of two arms crossed in the shape of an X, and carrying two steel gudgeons, which press against the upper carbon-holder. These arms are connected by two small cranks to a cross piece placed underneath a double solenoid, joined in parallel with the main circuit. The soft-iron cores of the solenoids rest on this cross piece, their other ends being attached to two strong springs. When the circuit is closed the carbons are apart, and the whole of the current passes through the shunt; the solenoids attract the armatures, lowering the X shaped brake, which presses its arms upon the plate beneath, and unlocks the upper carbon-holder;



The Gerard Arc Lamp.

the latter consequently descends and brings the two rods into contact. But at this moment the current in the shunt decreases, the springs act upon the cores, lifting them up, and causing the brake to clutch the upper carbon-holder, and lift it also; the carbons are thus separated, and the arc is struck. When the consumption of the carbons causes the arc to lengthen unduly, the current in the shunt again predominates, and allows the upper carbon to feed down slightly. The central tube is an air-tight cylinder, the piston of which forms part of the upper carbon-holder. When the carbon-holder descends a partial vacuum is formed in the cylinder, and prevents irregular feeding. An external screw allows the admission of air into the cylinder to be regulated to a nicety.

* Translated from M. Hippolyte Fontaine's "Éclairage à l'Électricité," by kind permission of the Author.

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ANSWER TO CORRESPONDENT.

A. T.—*In answer to your inquiry as to "what clubs there are in London of which the members are chiefly persons interested in electrical engineering and engineering generally," it must be confessed that the only club which at all answers to this description is the "Whitehall Club," in Parliament-street, but the number of electrical members is not great. The "Dynamicables" are only a dining club, meeting at somewhat irregular intervals. Mr. F. H. Webb, jun., 4, The Sanctuary, Westminster, is the Secretary. The formation of an electrical club has frequently been the subject of discussion, but the difficulties in the way are of a serious character.*

THE AUSTRALASIAN CABLES.

There is generally something of interest to be heard at a meeting of shareholders presided over by Sir JOHN PENDER; and the meeting of the Eastern Extension, Australasia and China Telegraph Company (Limited), of which a full report appeared in our columns last week, was no exception to the rule. That the Company's receipts should show an increase during the half-year of over £20,000, while affording matter for gratification to the shareholders, is interesting to the general public as indicating an improvement in trade generally, of the state of which the telegraph is admitted to be a reliable barometer. Some degree of influence must, perhaps, be allowed to the fact that an important exhibition is now open at Melbourne; but, on the other hand, it may be confidently believed that, as a result of the exhibition, some permanent extension of commerce will ensue.

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In these days of rapid communication a considerable amount of inconvenience and loss is caused to commercial communities when they are cut off from electrical connection with the rest of the world; and a feeling of profound uneasiness seems to seize upon our distant dependencies when, by any accident, the electrical bond uniting them with the mother country is severed. The record of the Eastern Extension Company is, however, remarkably good in this respect. Since direct telegraphic communication with Australia was established in 1872, until 1880, when the duplicate cable was laid, we learn that the total interruptions averaged seven days per annum, while the average of interruption since the duplication has been less than four days a year.

An interruption occurred on 30th June last, when both the Java-Australia sections were broken simultaneously in deep water by volcanic action, of the violence of which some indication is afforded us when we are told that on picking up the cables roots of trees and other things not usually found at the bottom of the ocean were attached to them. As the effect of this rupture was to isolate the Australasian Colonies telegraphically, the company, recognising that this method of communication should, above everything, be reliable, and in order to have three strings to their bow, promptly gave orders for a new cable to be manufactured and laid from Java to Western Australia, thus not only avoiding the volcanic region which proved fatal to the other cables, but also affording an alternate land system to the existing South Australian overland line. This cable, which we are told will shortly be laid, besides giving satisfaction to the telegraphing public, has, it appears, checkmated the opposition, which threatened to lay a line from India to Western Australia.

Communication having been restored by the repair of the interrupted lines, it was further interrupted between Banjoewangie and the Lombok Strait, where extensive renewals were being carried out by the company's ss. "Sherard Osborn," on the very day that the shareholders' meeting took place, again depriving Australia of the use of the submarine telegraph. Naturally enough these interruptions have from time to time provoked a good deal of discussion in the Colonies, and occasioned some rather wild talking as to the security to be afforded by a cable from San Francisco to Australia and the advantage to be derived from a competition in the rates.

It is frequently the case that those least entitled to complain make the loudest outcry, and this seems to apply to Governments as well as to individuals. Most of the Australasian Colonies contribute a proportion of the subsidy which is paid to the telegraph company for laying the duplicate cable. Queensland, we understand, is the principal exception, and this Colony is at the same time the strongest advocate of a competing line. It is, of course, quite easy to understand how the idea of completing the girdle of the earth and of uniting Australia eastward with Canada should exercise at first sight a certain fascination over many minds; but the question is not, however, in the last resort one of sentiment, but of simple hard matter-of-fact commercial speculation.

Now it has several times been authoritatively pointed out that a Pacific cable, consisting, as it would, of "long stretches of single cable across enormous and unsurveyed depths, terminating in coral reefs," would be of slight value as an alternative route; its existence would always be of a precarious character, and the expense of keeping a sufficiently large repairing fleet in the Pacific Ocean would be enormous, while, again, the large amount of capital required, and the war of rates which could not fail to follow, would make it difficult for either company to maintain their lines efficiently. The inevitable result in the end would be either that one company would buy up the other, or that an arrangement would be come to. In either case the capital, upon which a dividend would have to be paid, being largely increased, high rates would consequently have to be maintained.

If the Colonies wish for low rates the proposition of the Eastern Extension Company seems to us to be fair and reasonable. In effect they say to the Colonies: "You tell us you require low telegraphic rates to develop your resources and your business, and that our traffic would largely increase if the tariffs were reduced. As, however, we are not getting more than a fair return upon our outlay, and the low rates will be for your benefit, the greater part of the risk should also be yours. If you, the Australian Colonies, jointly guarantee us three-fourths of our present revenue, you may reduce the tariff to 4s. per word, or even lower if you please. You would in this way, at a minimum of risk, secure the undoubted advantage of cheap rates."

Up to the present, however, this evidently reasonable proposal has met with no acceptance in the Colonies concerned, where there appears to be a section which considers it preferable to advocate an opposition line which will cost it nothing, in the hope that those who have sunk their money at the bottom of the sea, in order to provide Australia with the magnificent system of submarine telegraphy which she enjoys, should have their profits reduced or altogether destroyed. The spirit of the closing words of the Chairman's address to the Company's shareholders ought to meet with a more generous response in Australasia, and one which we believe would better serve the interests of our Antipodean friends than a costly and uncertain alternate communication *vid* the Pacific. "Occupying the position we do," said Sir JOHN PENDER, on the occasion referred to, "we must not assume the position of monopolists, but must conduct our business on such broad and liberal principles as will satisfy you with the dividends and the general telegraphing public with a cheap, efficient, secure and expeditious system of telegraphy."

OBITUARY.

G. CABANELLAS.

We regret to learn that M. Cabanellas, whose labours in connection with dynamo-electric machinery have brought his name a good deal before the scientific world, died a few days since from inflammation of the lungs. M. Cabanellas began life in the French navy, and rose to the rank of captain. In the war of 1870-71 he greatly distinguished himself while acting as aide-de-camp to Admiral Saisset. On his retirement from the service M. Cabanellas devoted himself entirely to scientific research, and especially to electricity. His works on the theory of the dynamo and on transmission of power, although somewhat abstruse and of comparatively little practical value, yet show considerable penetration and knowledge of detail. Many ideas which are now common property were ten years ago only to be found in M. Cabanellas's works. The name of M. Cabanellas will also be associated with the electric transmission of power to a distance, in which matter he came somewhat into conflict with M. Marcel Deprez—not altogether to the advantage of the latter. For the last few months he appears to have given up his favourite studies and retired to Dieppe, where he held a post under the Government. M. Cabanellas was an officer of the Legion of Honour and a member of the *Institut.*

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ON THE TRANSFERENCE OF ELECTRICITY WITHIN A HOMOGENEOUS SOLID CONDUCTOR.*

BY SIR WILLIAM THOMSON.

Adopting the notation and formulæ of my previous Paper, and taking ρ to denote 4π times the electric density at time t, and place (x, y, z), we have

$$\rho = \nabla^2 \psi = -\text{“}v\text{”}^2 \int \left(\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} \right) dt \quad . \quad (17)$$

and, eliminating u, v, w, ψ by this and (16) from (10), we find, on the assumption of κ constant,

$$\kappa \frac{d}{dt} \nabla^2 \rho = \frac{d^2\rho}{dt^2} - \text{“}v\text{”}^2 \nabla^2 \rho \quad . \quad . \quad . \quad . \quad (18)$$

The settlement of boundary conditions, when a finite piece of solid conductor, involves consideration of u, v, w, and for it, therefore, equations (17) and (12) must be taken into account; but when the subject is an infinite homogeneous solid, which, for simplicity, we now suppose it to be, (18) suffices. It is interesting and helpful to remark that this agrees with the equation for the density of a viscous elastic fluid, found from Stokes's equations for sound in air with viscosity taken into account; and that the values of u, v, w, given by (17) and (10), when ρ has been determined, agree with the velocity components of the elastic fluid if the simple and natural-enough supposition be made that viscous resistance acts only against change of shape, and not against change of volume without change of shape.

For a type-solution assume

$$\rho = A E^{-qt} \cos \frac{2\pi x}{a} \cos \frac{2\pi y}{b} \cos \frac{2\pi z}{c} \quad . \quad (19)$$

and we find, by substitution in (18)

$$q^2 - \frac{\kappa}{L^2} q + \frac{\text{“}v\text{”}^2}{L^2} = 0. \quad . \quad . \quad . \quad . \quad (20)$$

where

$$L^2 = 1 \Big| 4\pi^2 \left(\frac{1}{a^2} + \frac{1}{b^2} + \frac{1}{c^2} \right) \quad . \quad . \quad (21)$$

Hence, by solution of the quadratic (20) for q

$$q = \tfrac{1}{2} \frac{\kappa}{L^2} \left\{ 1 \pm \sqrt{\left(1 - \frac{4 \text{“}v\text{”}^2 L^2}{\kappa^2} \right)} \right\} \quad . \quad . \quad (22)$$

[In the communication to the section numerical illustrations of non-oscillatory and of oscillatory discharge were given.]

MULTIPOLAR MACHINES AND THE DESROZIERS DYNAMO.†

BY M. E. DESROZIERS.

In the present state of our knowledge, Faraday's disc is the prototype of the ideal dynamo. A thin armature without iron, A B (Fig. 1), revolving round an axis O O, between the poles of the magnets C D. One can see at a glance that a machine of this kind possesses several important advantages: 1st. The reaction of the armature is small. 2nd. The armature being light and well balanced, high speeds are permissible. 3rd. The ventilation of the armature is excellent. 4th. Foucault currents are done away with. Numerous attempts have naturally been made to realise all these manifest advantages in actual practice, and it was whilst studying this question that I designed the dynamo which I am about to describe.

It is easy to see that a machine of the Faraday disc type lends itself preferably to multipolar construction. There are two forms of winding suitable to multipolar dynamos: first, that of the Gramme pattern, and, secondly, that in which the coils follow the sides of a star-shaped polygon. The simple regular polygon winding presents several inconveniences in the case of multipolar machines, not least of which is the constructive complexity. From a geometrical point of view, for a given machine and a given uniformity of current, the number of non-synchronous, non-identical coils is practically given *a priori*. The number of collector bars is also in some degree a fixed quantity. But with the simple regular polygon winding it is necessary that there should be at any moment as many groups of coils symmetrically situated and acting synchronously as there are magnetic fields. Consequently, the number of coils is proportional, not only, as in the case of two-pole machines, to the number of commutator sections which are necessary to secure a current of a certain degree of steadiness, but to the product of this number multipled by the number of magnetic fields. This fact introduces, therefore, a grievous complication. Another defect of the simple regular polygon winding is the necessity for placing the different synchronous coils in parallel. In a two-pole machine, owing to the continuity of the magnetic field and the approximate symmetry obtained by the placing of so many coils in series, the equilibrium of the two halves of the armature is an easy matter. But in multipolar machines, especially in those of the Faraday disc type, these conditions no longer hold to the same degree. Owing to the inevitable structural differences, the magnetic fields will be neither symmetrical nor equal, even for identical exciting power; the air-gaps will not be identical; the magnetic circuits will not be identical. Hence the various groups of coils will not be in equilibrium, and as the self-induction of this type of machine is but small, important disturbances will result. True, we can connect identical coils in series in lieu of placing them in parallel, but that does not mend matters much.

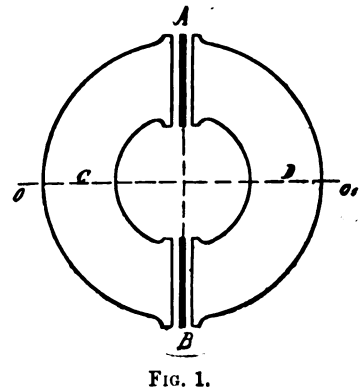

FIG. 1.

The star-shaped polygon winding, on the other hand, assures the independence of each successive group of coils, which need no longer be arranged symmetrically around the circumference. If we follow the winding shown in Fig. 2, we see that the apexes of each triangle advance one division in each similar magnetic field. Hence the coils corresponding to these apexes do not cut the same number of lines of force and will therefore produce different E.M.F's. We are, therefore, no longer obliged to have equal, symmetrical, and synchronously-acting coils. Secondly, as these coils are naturally connected up in series, the magnetic fields need not be symmetrical or identical. These obvious advantages of the star-shaped polygon winding attracted my attention. On studying Fig. 2, however, one is struck by the complex nature of the arrangement, a complexity which practical necessities would add to. This complexity is, fortunately, more apparent than real, and I shall show that it can be avoided by using a certain class of star-shaped polygon, by winding the coils in involutes and radial prejections, and by the rational grouping of the coils in two equal and distinct series.

Let us now consider the class of star-shaped polygon, the number of whose sides is given by the formula $n\,P \pm 1$; where n = number of magnetic fields and P = a certain parameter, which will evidently always be prime with regard to $n\,P \pm 1$. For instance, let $n = 3$ and let $P = 11$; then $n\,P - 1 = 32$. If we join 1 to 12 to 23, and so on, as below,

2	—	13	—	24
3	—	14	—	25
.	.	.	.	.
10	—	21	—	32
11	—	22	—	1

* Paper read before the British Association meeting (Section A) at Bath, September, 1888.

† Abstracted from a Paper read by M. E. Desroziers, before the Société Internationale des Electriciens.

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we get the arrangement shown in Fig. 4. The chords 1 – 12, &c., are however broken up (Fig. 3) into the zigzags R*c d h t*, &c., one such zigzag representing a complete element or section of the armature, and in the case of six-pole machines (to which what follows more especially refers) three of these sections complete the circumference. These three sections make one loop, and it is easy to see that in a certain position they embrace the three positions where the number of positive lines is a maximum; while at a distance of 60° from this they embrace the maximum number of negative lines. Commutation must naturally take place at these points, the neutral lines in disc machines corresponding to the polar lines. However, as the three sections are never exactly symmetrically situated with respect to the poles, being each one division ahead of one another, simultaneous commutation is, as we shall presently see, avoided. In performing the winding of one of these sections, we cross the circle twice —that is to say, the number of radial lines will be either 2 (n P ± 1) or 4 ($n p \pm 1$), according to the number of poles, p and P being arbitrary. It is, however, easy to multiply these radial lines by multiplying the sections. For instance, on reaching *t* (12), instead of going on to 18 we can effect a certain number of backward turns, as shown in Fig. 4, where the sections are trebled. If m denote this multiplying factor, the number of radial lines will be 2 m (n P ± 1) or 4 m ($n p \pm 1$). With a given speed and strength of field, by varying m and p, we possess every facility for obtaining any required E.M.F., whilst satisfying the condition of having a sufficient number of separate sections.

As there are two layers of conductors, they must necessarily cut one another; it is easy to see, however, that they can be arranged in two different planes, it being only necessary that the number of sections in each should be equal. In fact, if we look at Fig. 3, we see that the windings, which begin at an odd number, as 1—7—12, follow on quite naturally, so that they can all be arranged on a single disc. This disc is pierced by holes through which the wires are passed. The same applies to the sections, starting from even numbers, which are wound on a second and identical disc. Then these discs are placed side by side, the ends of the sections are soldered together, and the armature is complete. The two centre portions of the discs are cut away for the sake of lightness, and to give sufficient mechanical strength the two discs are bolted together at the rims and keyed to a German-silver hub with six projecting arms.

This winding, which characterises the Desroziers dynamo, is shown in Figs. 4 and 5 arranged for an armature divided into 52 divisions. By this arrangement the space between the poles is fully utilised; each section has a well-defined position, and an armature so constructed affords every facility for repairs and for inspection whilst at work.

Let us now consider the collector, which forms one of the most distinctive features of the machine. If the ends of each coil were joined to a collector bar, we should have 32 bars, and in a complete revolution there would take place under each brush 32 short circuits of each triple coil. We should therefore have $\frac{2 \times 3}{n p \pm 1}$ of the armature short-circuited each time, so that to obtain continuity of E.M.F. it would be necessary to increase either p or the number of coils. By a modification of the collector and its connections, I have avoided an increase in the number of coils. I connect each triple coil, not to a single bar, but to three, 120° apart in the case of a six-pole machine. The brushes, in lieu of uniting the ends of a triple coil, only unite the ends of a single coil, and each single coil is short-circuited n ($n p \pm 1$) times under each brush at every revolution. This method of connecting up will be understood on examining Fig. 6, where 14 coils are shown connected up. In this figure I have distinguished the two discs which together form the complete armature; the wires of the upper half are shown in full; and dotted as they would appear with the centre of the disc taken away; those of the lower half are shown by disconnected dashes. The method of joining up to the collector bars is clearly shown. The single arrows indicate the path which the current would take in a short-circuited coil if the number of bars on the

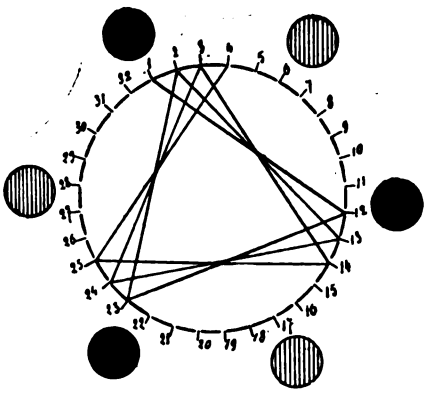

FIG. 2.

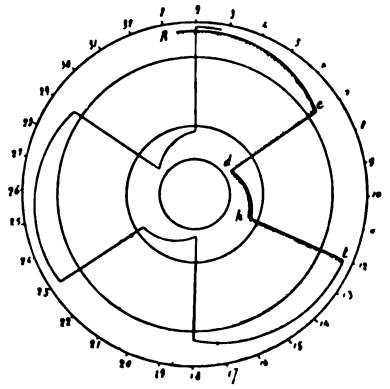

Fig. 3.

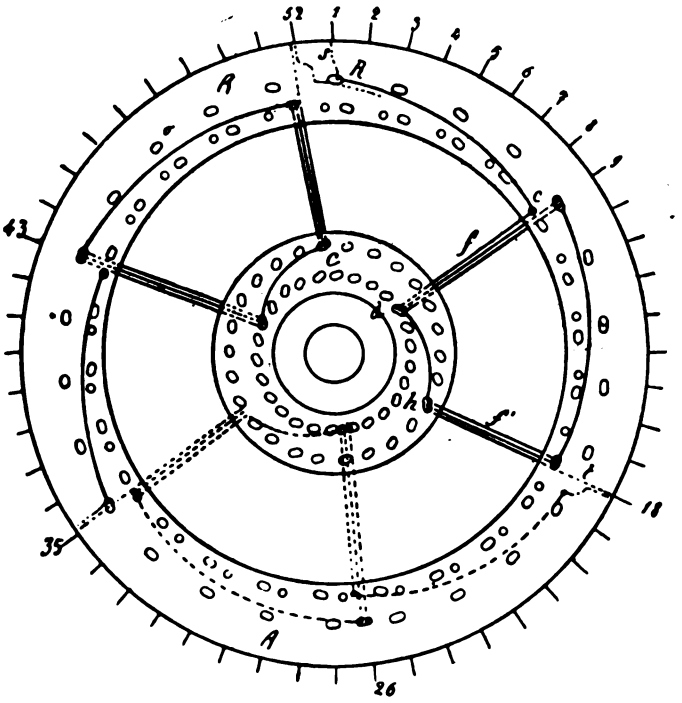

FIG. 4.

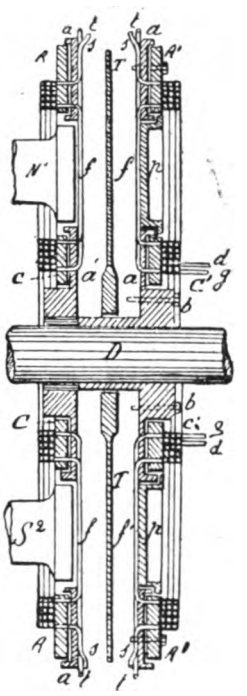

FIG. 5.

In Fig. 5 N' S² = pole-pieces, D = shaft, T T = German silver arms. The letters *f f*, *s s*, *d d*, &c., refer to the parts which are similarly lettered in Fig. 4.

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collector were not increased; the double arrows show the path taken when each coil is connected to three bars. The connections would be inextricable if I had not made use of the

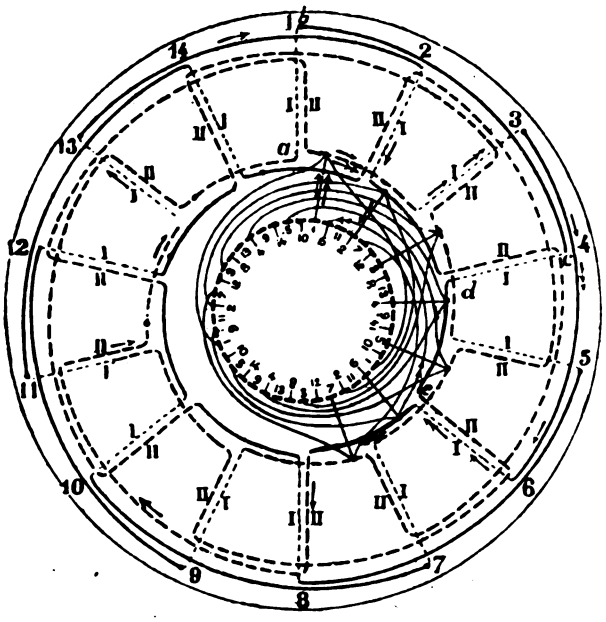

Fig. 6.

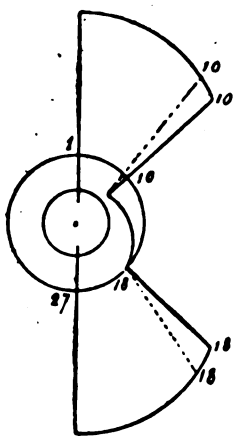

Fig. 7.

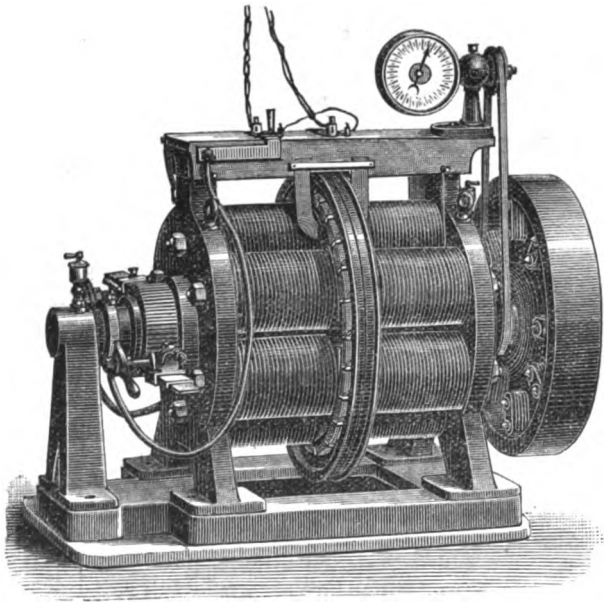

Fig. 8.

properties of the involute. The wires are, therefore, all united to a special piece of apparatus, which I call the analyser, and which is placed between the disc and the collector. The three wires of each coil come from the centre of the armature to an insulated disc; wire 1 passes on straight to the collector bar; wire 1′ is wound in involute on one side of the disc and runs thence to bar 1′; wire 1″ passes through the disc, is wound backwards through 120° and terminates at bar 1″. In this way all the wires are arranged side by side on either face of the analyser, and no mistakes are to be feared. It is not necessary to enlarge further upon the practical advantages of these arrangements, allowing as they do very satisfactory working of the collector. It would be impossible otherwise to stop sparking without increasing the number of coils or increasing the distance between the successive poles. I have, moreover, slightly modified my armature winding in the manner shown in Fig. 7, with a view to still further decrease the number of lines of force cut by the short-circuited coil.

Four Desrozier's machines (Fig. 8) have already been built by the firm of Bréguet, and placed on board the "Formidable" at Lorient. These machines weigh 1,200 klgs. each, run at 350 revolutions, and have an output of 175 amperes at 70 volts; their electrical efficiency is 82 per cent., and their commercial efficiency is 79 per cent., and varies very little with the work. "It is very probable," says the author, in conclusion, "that the efficiency of the Desroziers dynamo would be considerably higher if constructed to meet ordinary commercial requirements."

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

Section II.—Electro-Magnetic Fields.

(Continued from page 735.)

132. *Sir William Thomson's Graded Galvanometer.*—This instrument (represented in elevation at G, Fig. 112, and in plan in Fig. 113) has a wide range of sensitiveness, effected by varying the distance between the coil and needle. The coil, shown at B, is fixed in position and wound with six turns of copper strip 1·2 centimetre wide and 1·5 millimetre thick, each turn being insulated from its neighbour by winding on, side by side

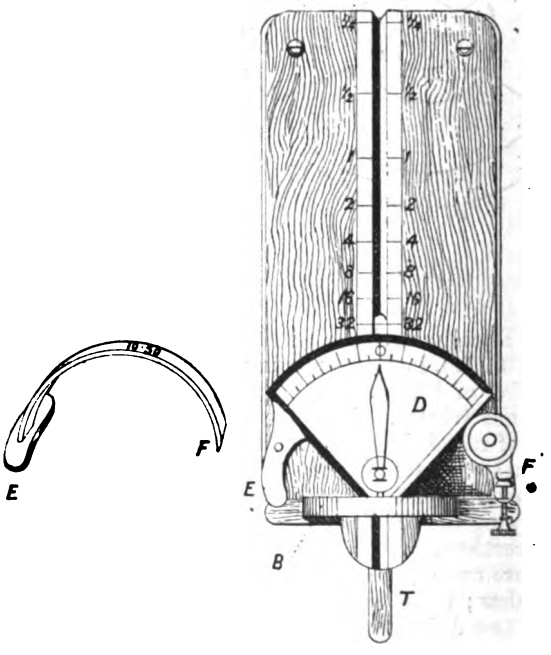

Fig. 113.

with the copper strip, a ribbon of asbestos paper. The two ends of the copper strip are brought out at T, side by side, being kept apart by a wood strip about ¼in. thick, gradually

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tapered down towards the end, to admit of sliding on the connecting clip A, from which two twisted leading wires connect the coil to the rest of the circuit. The advantage of this mode of connection is that the instrument may be introduced into or withdrawn from a circuit without causing any temporary interruption. The quadrant-shaped box D, with glass cover, contains the pivoted system of needles and pointer, and is fitted with a mirror and tangentially divided scale. The instrument being tangential, the deflections on the scale are proportional to the currents. There are four little magnets, two of which are seen in the figure; the other two are beneath these, and the whole are fixed in an aluminum frame which is prolonged to form a looped pointer. The needle-box may be moved to any position, the V groove cut in the platform guiding it so that the needle is always in a line with the centre of the coil. The two ends E and F of the controlling magnet can be fitted into the side arms E and F of the needle-box, so producing an additional controlling field on the needle in the direction of the meridian, the value of which and the date when measured are usually painted on the magnet. This value cannot, however, be depended on in practice, unless the greatest care is taken to keep the magnet from getting knocked or being placed within range of the influence of foreign magnetic fields, and it is therefore advisable to measure it before or after use. A pin on the underside of the magnet at E fits into a hole in the arm E, and the point of the magnet at F fits in the grooved wheel carried by the adjustable screw at the end of the arm F, by means of which screw the magnet may be accurately adjusted to the plane of the meridian. The arm F also carries a spirit level. Fixed to the outside of the quadrant, opposite the zero point of the scale, is a little prolongation with a horizontal cut in it, the use of which is to enable the observer to bring the needle-box exactly into a given position of sensitiveness by observing that the cut and the given mark on the platform coincide. In the figure this is placed at position 32. At position 1, without the controlling magnet, the needle is at such a distance from the coil that the current producing one division deflection is exactly equal numerically to the intensity of the earth's horizontal field H at the place where the instrument is used, which, in London, is ·18 C.-G.-S. units—that is,

$$\text{Current} = \cdot 18 \text{ ampere per division.}$$

Hence, for D divisions,

$$\text{Current} = \text{D} \cdot 18 \text{ amperes.}$$

Now, at positions 2, 4, 8, 16 and 32 the sensitiveness of the instrument is increased twice, four, eight, sixteen and thirty-two times respectively; that is, a current deflecting the needle say 10 divisions at position 1 will deflect it 20 divisions at position 2, 40 divisions at position 4, and so on. Or if we put currents through the instrument, to cause equal deflections when the needle-box is at positions 1, 2, and 4, these currents would be in the proportion of 4, 2 and 1 respectively. Hence the currents vary inversely as the position P of the needle-box on the platform for a constant deflection, and we may write—

$$\text{Current} = \cdot 18 \frac{\text{D}}{\text{P}} \text{ amperes.}$$

The field F produced at the centre of the needles by the controlling magnet, when this is used, must be added to that of the earth H, as the two fields are in the same direction. To find this field it is necessary to pass a current through the instrument, and note first the deflection without the magnet, then notice how many times the deflection is reduced, say n times, by adding the magnet. This is best done by having the needle-box much nearer the coil when the magnet is on; for example, a constant current is kept on, and at position ½, without the magnet, the needle is deflected, say, 22·5 divisions; the current is then

$$\cdot 18 \frac{22 \cdot 5}{\cdot 5} \text{ amperes.}$$

Now, at position 32, with the magnet on, the needle is deflected, say, 30 divisions, the current is then

$$\cdot 18 \frac{30 n}{32} \text{ amperes,}$$

where n is the number of times the sensitiveness is reduced by adding the magnet. The current being the same the above two expressions are equal, and

$$\frac{22 \cdot 5}{\cdot 5} = \frac{30 n}{32}, \text{ whence } n = 48.$$

The value of the resultant controlling field is then 48 or n times H, and we have seen above that it is also equal to H + F, where F is the field due to the magnet; therefore

$$\text{H} + \text{F} = n \text{ H}$$
$$\text{F} = \text{H} (n - 1)$$
$$= \cdot 18 \times 47 = 8 \cdot 46 \text{ C.-G.-S. units.}$$

It is the value of F thus measured which is usually painted on the magnet, together with the date when measured.

Now, it will be seen in the figure that the needle is not within the coil at position 32; there is still a position of higher sensitiveness, which does not usually fall in the same geometrical series as the previous grades. Its value in some instruments is over 40. If we take it as 45, and suppose the needle-box placed there, without the controlling magnet, we should have

$$\frac{\cdot 18}{45} = \frac{1}{250} \text{ of an ampere per division.}$$

And, using the above magnet with the needle-box at position ¼, we should have

$$\frac{(\cdot 18 + 8 \cdot 46)}{\cdot 25} = 34 \cdot 5 \text{ amperes per division.}$$

This shows the very wide range of sensitiveness obtained.

133. *The Demagnetising Force set up by a Magnetised Rod.*—A bar or rod which has been magnetised sets up by the action of its own poles a reverse magnetising force—that is, it tends to demagnetise itself. To study this phenomenon we must consider the quantity of lines of force issuing from a pole of

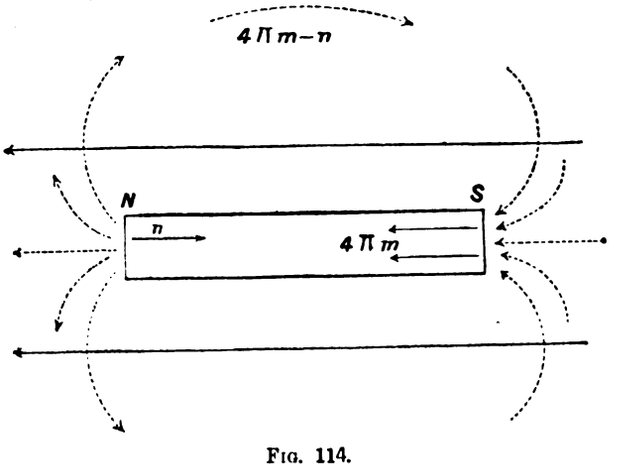

Fig. 114.

strength m (the action of the complementary pole being considered negligible). At a distance of r centimetres from the given pole in *all directions* the magnetic field is equal to

$$\frac{m}{r^2} \text{ C.-G.-S. units}$$

(*see* paras. 108, 109, and 113)—that is to say, the above number of lines of force pierce every square centimetre of surface of a sphere of radius r centimetres whose centre is the pole m. But on the surface of such a sphere there are $4 \pi r^2$ square centimetres area, through each of which, as we have seen, pass the above number of lines of force. Therefore, the total number of lines issuing from the pole m is equal to

$$4 \pi r^2 \times \frac{m}{r^2} = 4 \pi m \text{ lines.}$$

(The Greek letter π (*pi*) is always used as the ratio of the circumference of a circle to its diameter, which is 3·14159.)

Now take an iron bar (Fig. 114) to which is applied a certain magnetising force, the *direction* of which is indicated by the straight arrows on each side of the bar. Suppose that the iron acquires m C.-G.-S. units strength of pole.

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Lines of force will issue from the N pole and pass in curves through the air to the S pole (para. 104); but these are not all the lines issuing from the pole. They issue radially in all directions, and therefore some pass through the metal to the S pole. It is precisely these lines within the metal which tend to demagnetise the bar. Say there are n demagnetising lines running from N to S through the metal; we shall then have $4\pi m - n$ lines issuing from the N pole into the air, $4\pi m$ being the total number. Both the lines through the air and the demagnetising lines through the metal form closed circuits, and therefore at the S pole the two return circuits of lines are in the same direction and run back through the metal from S to N. These are respectively $4\pi m - n$ and n. Adding them together, because they are in the same direction, we have $4\pi m$ as the number of lines through the metal in the same direction as the magnetising force applied to the bar. This phenomenon is all-important in magnetisation experiments. We wrap a bar of iron round with a certain number of turns of insulated wire, pass a known current through the wire, and from these data can calculate exactly what number of magnetising lines of force are produced by the coil, viz.—

$$\frac{4\pi C n}{l} \text{ lines per square centimetre}$$

(*see* para. 130). But as soon as the iron becomes magnetised, the action of its own poles causes n *demagnetising* lines to pass through the metal and weaken the above magnetising field. Now if the sectional area of the bar is a square centimetres, the demagnetising lines are

$$\frac{n}{a} \text{ lines per square centimetre,}$$

and therefore the resultant, or actual magnetising force **H**, acting on the bar is equal to

$$\frac{4\pi C n}{l} - \frac{n}{a} \text{ lines per square centimetre.}$$

The demagnetising field is greater in proportion as the poles are stronger and nearer to each other. In the case of bars we can only, with strict theoretical exactness, get rid of the effect by using rods of infinite length. Practically, however, by using rods whose length is many times their diameter, the demagnetising effect may be neglected. Prof. J. A. Ewing, of University College, Dundee, who is a high authority on the electro-magnetisation of iron, says in his Paper, entitled "Researches in Magnetism" (*Phil. Trans.*, 1885):—"My own observations show that it is only when the length of the rod (if of iron) is about 300 or 400 times its diameter that the effect of length becomes insensible."

The same authority also states that the demagnetising force due to the ends is unequal along the bar, being much greater at the ends. The demagnetising effect is entirely got rid of if the iron is employed in the form of a ring, since, in this form, there is a complete magnetic circuit, and therefore no poles. The intensity of magnetisation can be found indirectly this way from the value of the magnetic induction **B**, and the magnetising force **H**; but what we are considering now is the *direct* measurement of the magnetisation by the action of the poles on the magnetometer. We shall select two instances from a number of experiments to illustrate the difference between these conditions, and shall take first a short, thick iron rod, in which there is considerable demagnetising effect. When the demagnetising action of the poles is got rid of by employing either very thin iron wires or iron rings, the condition is technically spoken of as that of "endlessness."

(*To be continued.*)

Tempering Steel by Electricity.—Electricity, says *Engineering*, is used in a most successful manner for tempering watch springs and other forms of spring steel, whether in the form of ribbon or wire. The steel is wound upon a spool, from whence it passes down through a bath of oil. The wire is made a conductor in an electric circuit, carrying sufficient current to maintain the wire at a proper degree of redness to answer the desired requirements of temper.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October 6th*, 1888.

A very interesting Paper was presented a few weeks ago by Prof. J. P. Barnett, of Chicago, before the National Association of Fire Engineers. Much of the Paper was in the form of an explanation as to the method and systems of electric lighting, but the valuable part so far as his hearers were concerned in practical work was that which contained his suggestions as to the manner of dealing with electrical conductors of all kinds. Prof. Barnett has charge of the electrical department of the City of Chicago, and is well-known for his energetic advocacy of electric lighting for city purposes, and his remarks appear to have been accepted with favour. This is a good sign, for there have been only too many endeavours in certain quarters to cultivate a spirit of enmity and opposition on the part of firemen against electric wires of all kinds. Prof. Barnett reminded his hearers of the fact, however, that electric light and power wires were already to be found everywhere, and that the number would certainly not decrease, but largely increase, and that the proper thing to do was to meet the new condition of things, and to acquire as much experience and information as possible in regard to such developments of modern science. He made a good point in recommending the fire department to co-operate with the insurance people in this matter, and said: "While insurance rates are less in some portions of New England, where electric lighting has displaced gas, these lower rates cannot be obtained except on the certificate of an inspector, and I am satisfied that this view of the subject is spreading amongst the sensible insurance people." This is practical, as is also the following passage: "You will all do well to keep your eyes on wires which are cotton-covered and then painted with common paint. The electric lightman will tell you it is underwriters' wire, and therefore good. Tell him you have heard it called undertakers' wire. He will tell you it is asbestos painted; contradict him, make him prove it. He will tell you it is waterproof. Tell him Barnett says it is not, and make him put up a decent wire out of doors, something that with the first rain will not water-soak and endanger the life of everybody who stumbles over it or the property it happens to swing against." Such talks as these are in every way useful.

The subject of the electrical utilisation of water-power is assuming more and more importance, and is attracting considerable attention in circles other than electrical. Some of the new plants which have been installed by the motor companies are of no mean magnitude, while the results obtained have been extremely encouraging. I do not refer to the numerous cases in which electric-light plants, already run by water-power, have been utilised to furnish current for motors during the day, but to installations where the first and only object has been to transmit water-power long distances to drive motors. One instance of this is a plant you have already noted, that of the Sprague Company in the Feather River, Cal., where 14 motors are distributed along a circuit 18 miles in length, for pumping, hoisting, and other operations, utilising the water-power of the river itself, conveyed by tunnel and canal to a point where a fall of 300 feet is obtained. Another instance to which attention has just been directed is the installation prepared by the Brush Company for the famous Sutro tunnel. In this instance there are six Brush dynamos, each to be driven by a 40-inch Pelton wheel. This plant will be set up at the Sutro tunnel level of the Chollar mine, and water brought down the side of Mount Davidson in a wrought iron pipe will be delivered at the wheels, it is said, at a perpendicular pressure of 1,630 feet, the stream acting upon each wheel coming from a nozzle somewhat less than half an inch in diameter. Each wheel is intended to develop about 125 horse-power, or 750 horse-power in all. The current thus generated will be transmitted to drive stamping-mills. The first shipment of machinery for this remarkable plant has already been made, and we shall soon know what results are obtained. It may perhaps be worth

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mentioning here, as indicative of the size of this field, that the water-power of the country is estimated to average about 200,000,000 horse-power, of which only one and a half million horse-power is utilised. A large proportion of the whole probably will never be utilisable. Of Niagara, with its six million horse-power, for example, only about 5,000 horse-power is utilised to-day, and there are many instances where the waste, if we may give it such a name, is inevitable, and must continue. But even after all deductions have been made it will be seen that in working up water-power for general distribution and consumption electricity has much to do in our country.

An interesting electrical railway patent has just been issued to Messrs. J. D. Nicholson, T. J. M'Tighe and W. J. M'Elroy, the last of whom has Westinghouse affiliations, for an ingenious form of electric railway, not unlike in its main idea that which was brought out by Pollak and Binswanger some little while ago in Europe. There is an insulated underground main conductor connecting with a series of boxes, each of which contains a pivoted magnet, over which is a metallic cap to be operated inductively. As the car passes over the conductor and boxes it becomes energised through a contact bar with a magnet, which is capable of spanning and touching two of the metallic caps at once, so that the current passes from the line through the magnets to the motor, and out to line again. The object and recommendation of the system is the avoidance of exposed conductors or conduits, as such a road would be, so far as its outward signs are concerned, an ordinary street railway, with a number of metallic knobs showing at regular distances apart between the tracks.

You have probably seen accounts in the English daily papers of the extent to which Jacksonville, one of our favourite southern resorts, has been visited by yellow fever. Of course, whenever an epidemic of this kind occurs there is always endless discussion as to the best means of preventing or stopping the spread of the disease, and various odd remedies are sure to be proposed. In the present instance Mr. Edison is given credit for one original preventive. Accepting the theory that yellow fever is a parasitic disease, he asserts, from experiments made, that rhigoline or gasoline and caustic soda combined, distributed over the soil, so as to soak in for some little distance, will effectually eradicate the germs, or at least would arrest their spread. It seems to be admitted that gasoline, wherever it comes in contact with the germs would certainly destroy them, but the idea is not new, it is said; but it happens that a genuine electric cure has also been proposed and introduced. It is described as follows:—"It is a small cylindrical nickel box, containing several steel rods, and connected by 6ft. of wire to an arrangement resembling a garter, or a bracelet. This garter is placed around the wrist of the patient, and the nickel box immersed in a vessel containing hot water. Immediately the microbes begin to perish, and in a few hours the patient sinks into a calm refreshing slumber, and all symptoms of fever disappear." The description is deliciously vague, and I have still to learn that this method of cure is successful, or is looked upon favourably by any person of the medical profession. Times of plague and pestilence always produce their charlatans and nostrums, and in days when electricity is supposed to be able to do everything, I suppose some people are ready to believe that it will cure yellow fever.

I have occasionally commented on the progress made in the agitation for improvements in our patent system. The movement started by the National Electrical Light Association two or three years ago has been steadily maintained, and now the Bill proposing to establish a court of patent appeals has been favourably reported to the National House of Representatives by its judiciary committee. The report of the committee states that the expenses of the court will not exceed $30,000 per annum, and that, moreover, there is a balance in the treasury to the credit of the patent fund of over $3,000,000. Besides, the small sum of money required to carry on the court is absurdly insignificant compared to the amount which would be saved by the speedy adjudication of patent cases. There is another point for consideration, and that is the saving of the time of the Supreme Court, a body which is at present sadly over-loaded with work. At the last term of the Supreme Court, before which all such cases now go, on appeal, 325 various cases were disposed of on oral arguments or submitted on printed briefs. But the docket of the court at the beginning of the term included considerably more than 1,000 cases, so that all the judges worked as many days as possible, and one of them practically killed himself under the pressure, 700 cases went over till the next term; and thus the work accumulates. Evidently the establishment of this court of patent appeals is a desirable reform, and it appears to meet the approval not only of the judges, patentees, and patent attorneys, but of all laymen who have given the subject the slightest attention.

The dispute between the Board of Electrical Control and the local United States Company reached another crisis last week in a somewhat unexpected way. The *employés* of the Board began removing poles on 6th Avenue here, from which the wires of the telephone company had been stripped, and in the course of the work it became necessary to cut the wires of the United States Company. The result was that some 40 or 50 lights were extinguished, and there is a big row, as the United States Company has not been allowed to re-establish its connections. Just what the Company will do in the premises is not easy to say, as the wires were cut by an order of the Board, and cannot be restored in any way without a breach of the law. Meantime the disgusted customers have been deprived of their light, and the company of their revenue. Relations between the Board and the other companies seem to be more pleasant. The East River Company, for instance, have recently completed their new circuit, which runs up and down town a distance of some five or six miles, carrying already about 100 lights; but this is on the east route, where subways have not been provided. An amusing instance of the lessons taught by all this public discussion as to the danger and safety of electric light wires has just been given here in the political campaign. A big banner was hoisted on Broadway by the partisans of General Fisk, the temperance candidate for the Presidency. It was complained of as a nuisance, and threats were made to remove it. The persons in charge, however, have taken measures to secure their banner from disturbance by passing live electric light wires all round the pole which carries it. The result is that it has since been very respectfully let alone.

The Centennial Exposition, which is now being held at Cincinnati, Ohio, is noteworthy as embracing a remarkably fine electrical display. Not only is the electric light used with considerable effect for general purposes of illumination and decoration, but electric motors are also shown doing a variety of work. One of the most remarkable exhibits is that made by the Edison Lamp Company, which has built up over 15,000 Edison lamps into a mammoth pedestal, socket and lamp. The large lamp represents an ordinary sixteen candle-power lamp, magnified over twenty thousand times, with a capacity of 100,000 candle-power. Across the front slope of the pedestal is the name of Edison spelt in lamps, which can be flashed letter by letter all together. This unique piece of work as well as some other novel effects has been carried out by Mr. W. J. Hammer.

In closing a series of articles in *The Electrical World* on telegraphy with superposed pulsatory and undulatory currents, Mr. William Maver, jun., takes occasion to mention the fact that over 13,000 miles of wire in Europe are used for the Van Rysselberghe system of simultaneous telegraphy and telephony, while there are no such wires in Great Britain or in this country. He then proceeds to look for the reason of such a state of affairs. In England as he points out, the Wheatstone automatic system is extensively used, almost to the practical exclusion of the quadruplex; and the insertion of a "graduator" in circuits assigned to rapid automatic work is, of course, out of the question. In this country the quadruplex is undoubtedly a main reliance of the telegraph companies, and the introduction of the "graduators," even when radically modified, would reduce the efficiency of that system. As to the 13,000 miles on the Continent of Europe, Mr. Maver appears to think that there is some question as to the success-

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ful work obtained there. The reports from Belgium are favourable, but those from other quarters not so optimistic.

An important application has been made through the Inter-State Commerce Commission by the Postal Telegraph Company, for proceedings against the Pacific Railroads, compelling those comporations to perform the obligations imposed upon them by law in respect of telegraph service. Over these railroads up to the present, the Western Union Company has had exclusive rights, but now the Postal Telegraph Company desires to use the railway wire facilities as a means of reaching numerous points now rapidly growing up between the Missouri River and the Pacific, to which it desires to extend the advantages of competition. It already has connections over the Canadian Pacific, but these are not sufficient for its purpose. The company states in its request that it does not ask for any special concession or for anything it will not pay for, but "we insist," says the appeal, "that they shall carry out their obligations to the Government and its citizens by maintaining and operating their telegraph lines, and by accepting from us both through and local business at rates which shall be no greater than those of the Western Union Company, and to which they shall be entitled to their share *pro rata* in proportion." It will be remembered that Mr. Robt. Garrett began this agitation on behalf of the Baltimore and Ohio Company, and that it has now gone on for some time without results, the alliance between the Western Union and the railroads having proved too strong to be broken. It is thought probable however, that the Commission will use its power on behalf of the Postal Company. By the way, having mentioned Mr. Garrett's name, I am sorry to have to say that that gentleman is seriously ill, and has to be constantly watched.

Mr. Henry E. Abbey, our great impressario, mentioned this week to one of the papers an interesting illustration of the facility for rapid transaction of business afforded by cables. He was in Germany while Mr. Grau, one of his associates, was in Buenos Ayres, and Mr. Schoeffel, another, was in England. One Monday Mr. Grau transmitted by cable a very large sum of money, the profits of South American business, *viâ* Europe to New York. On Tuesday, at Hamburg, Mr. Abbey received a telegram from a leading artist in London, with whom he was negotiating, asking him to send $12,000 to an agent in Paris to close the contract. While waiting to obtain this gentleman's address by telegraph Mr. Abbey received a telegram from Mr. Schoeffel in New York telling him that the Buenos Ayres remittance was to his credit in this city. The address of the Paris gentleman reached Hamburg on Tuesday night, and on Wednesday morning the $12,000 of the Buenos Ayres remittance to New York was paid in Paris, and the receipt was sent to Mr. Abbey in Hamburg. The question arises, how long would this business have taken to transact under the old conditions of mail service? Six months would not have sufficed, and the business would have been transacted in some other slower and much less satisfactory way. Speaking of this reminds me, too, that during the present week a copy was received in this city from Europe of the German publication, containing the sensational extracts from the Emperor Frederick's diary. The matter was at once put on the wires—over 22,000 words—and sent to the leading German paper in Milwaukee, where it appeared verbatim next morning. This I believe to be the largest telegram sent in German to this city, and it is unquestionably a very fine piece of journalistic enterprise.

NOTES FROM VIENNA.

(FROM OUR OWN CORRESPONDENT.)

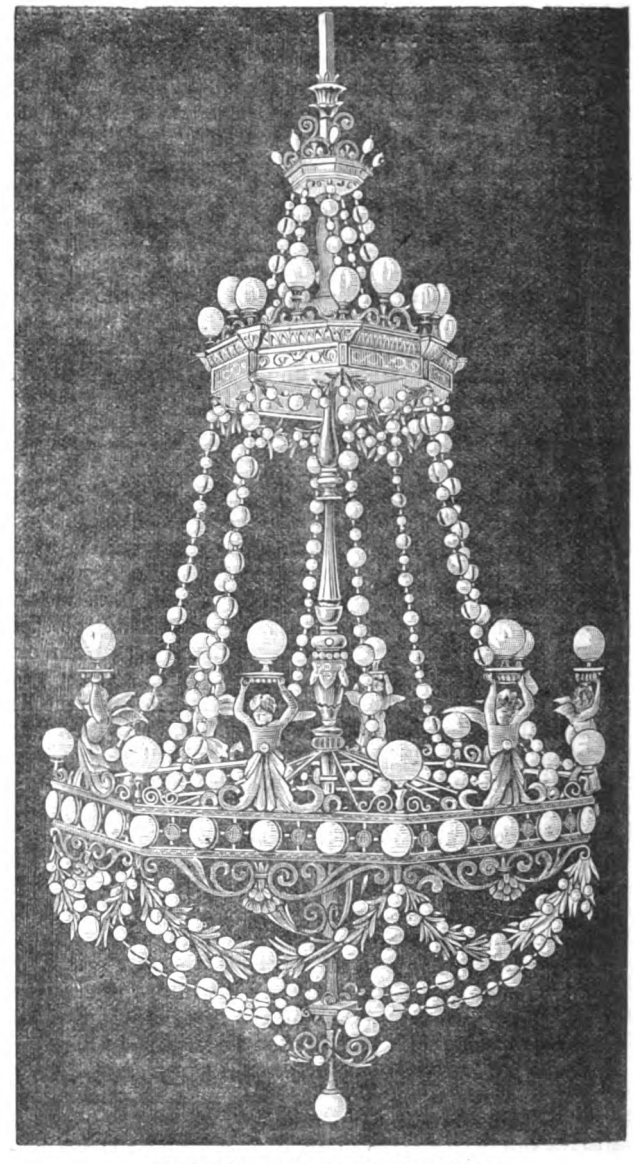
VIENNA, *Oct. 15th.*

THE LIGHTING OF THE NEW COURT THEATRE.

The old Court Theatre was closed last week with great ceremony, and the new magnificent building, which has cost over two millions sterling, was opened with much pomp on Sunday last, the Emperor and many members of the Royal Family being present, also the Prince of Wales.

The contrast between the two buildings can hardly be imagined, considering that the old building was built in 1742, and renovated in 1776. The oldest playbill existing dates from April 8, 1776; since that time more than 30,000 have been issued. Full descriptions of the new building itself, its decorations and splendid paintings have appeared in the daily papers, and this report is, therefore, confined to the electric light installation, as being of special interest to the readers of *The Electrician*.

The installation is, without doubt, the most perfect and substantial that has ever been carried out. It has been made by the Imperial Continental Gas Association, and the current is supplied from their Central Station in the Schenkenstrasse, a description of which appeared in *The Electrician* of September 14th, p. 610. As mentioned then, the company's resident engineer, Mr. T. W. W. Melhuish, A.M.I.C.E., deserves very great credit for his work in connection with the theatre and the Central Station.



Central Electrolier at the Burg Theatre.

The system adopted has been that of accumulators, which are charged during the day from the Central Station. Three batteries of accumulators containing altogether 540 cells of a very large type are placed in the cellars of the theatre. Each cell weighs complete nearly 300 kilos. Two of these batteries are used for lighting the house generally on the three-wire system, and the third is entirely reserved for the stage lighting. The current passes from the accumulators to the regulating room, where charging and discharging regulating switches, having the very extensive range of fourteen cells, are provided for each battery, and from these switches the current goes through wattmeters of Dr. Aron's latest type to the distributing room, thence 94 leads go off to different parts of the house, each circuit being provided with a switch and double safety fuse; the connections are so arranged that any circuit can be put on either battery, thus ensuring equal demands on the latter. Most of the cables in use are made on the Berthoud-Borel principle, and by this means, although the house is damp in many places, and is likely to remain so, an unusually high insulation has been secured.

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The total length of the cables reaches 110 kilometres, or about 62 miles.

The fittings, such as lustres, standards, brackets, &c., are mostly very fine specimens of this class of workmanship; the engraving of the magnificent lustre in the auditorium carrying 373 lamps will give some idea of these. To such fittings, together with the very tasteful arrangement of lamps, is to a great extent due the magnificent and brilliant effect produced when the house is fully illuminated. It is surprising to see how the effect has been improved by such small means as adopting a suitable shape of lamp, *i.e.*, long pear-shaped globes or rounder ones, and by a judicious mixture of ground, opal, and clear glass lamps. On the stage the coloured effects are most efficiently produced by means of coloured lamps and the different degrees of brilliancy. Darkness is effected by means of a very complete regulating apparatus, designed and manufactured for this theatre; the space occupied by this apparatus is very small. The form of the overhead battens was only determined after a number of experiments had been carried out with a view of determining the most efficient shape; as now made they give every satisfaction. The total number of incandescent lamps installed is 5,300, varying from 10 to 40 candle-power. In addition to these, several arc lamps will be used for stage effects, and for lighting the exterior of the building.

The auditorium is lighted by 720 lamps, including the great lustre; the *foyer*, staircase, corridors, &c., by 1,800; the cloak rooms, stores, cellars, &c., by 800; and the stage by 1,970 lamps; these latter develop a light equal to 50,000 candles.

THE OPERA HOUSE INSTALLATION.

After 15 months lighting of the Opera House (during which time no disturbances whatever due to electrical causes have taken place) the I.C.G.A. have no doubt as to the success of this new installation, and certainly the absolute steadiness of the light, which is so agreeable to the eye, the impossibility of sudden darkness, and consequent panic which might be caused by stopping of machinery, are very strong points in favour of the system which has been adopted. The work in the theatre has been carried out under the personal superintendence of Mr. E. Sechcharge, who has gained golden opinions for his work. To his ability and great industry the success of the work is in no small measure due.

He is now leaving for London to undertake the electric light installation in the new Lyric Theatre, Shaftesbury Avenue, and some other large buildings. It will certainly not be his fault if the lighting of this theatre is not a decided advance on anything that has as yet been seen in a London theatre, and I hear that the enterprising management of the Lyric intend to afford every facility for making their installation a first-rate one.

THE SIEMENS AND HALSKE CENTRAL STATION.

As reported some time ago, this firm had made all arrangements for a large central station in the Neubadgasse. At the time *The Electrician* expressed a doubt as to the hopes of commencing lighting by December being realised, owing to the inevitable interference of the Vienna Town Council, who are known to dearly love a "dog in the manger" policy. This prophecy has now come true. Messrs. Siemens and Halske have stopped the work, owing to the difficulties made by the Town Council and the neighbours, and it is quite uncertain when the work will be recommenced, if ever it will be.

NOTES FROM PARIS.

(FROM OUR OWN CORRESPONDENT.)

PARIS, *Oct. 19th.*

It is probable, and certainly very desirable, that the present stagnation in electric light circles will soon come to an end. The contract for the Municipal Electric Station will be considered on the 22nd of this month, and already no less than 20 tenders have been handed in. These tenders relate to steam boilers for about 800 horse-power, engines for the same power, and electrical plant for 160 arc lights and about 5,000 16 candle-power incandescent lamps. The station will be entirely worked by the Municipality. The light will be used for lighting the Halles Centrales, and will also be distributed to private consumers in the neighbourhood. The Conseil Municipal will meet on the 22nd, and the special committees will have to examine the tenders at once.

It is hoped that the inauguration of this installation will take place by the time of the opening of the Exhibition in May next. At the same time the Conseil Municipal will have to consider the demands for concessions which have been made up to this time for the distribution of electric current to the public in other parts of Paris. The example given by the Municipality has borne fruit, for I am told that the city authorities have received demands for concessions covering a good third of the city.

The Lyons Central Station was opened last week and seems to give the greatest satisfaction. The Théâtre des Célestins, the Café Maderni, the Scala, and many other establishments, are lighted from the station, which is equal to 8,000 sixteen candle-power incandescent lights. All the material, electrical and mechanical, has been manufactured by the Société de Constructions Mécaniques, of Belfort, which has also done the wiring and general fittings. The mains are are all underground, the cables resting on the ground without any tubes or protecting pipes.

I see you have already announced in your columns that a scheme is on foot for lighting Versailles by electricity from a central station at Marly, 10 kilometres off, so that a few details as to the water-power available may prove of interest. The hydraulic station at Marly is situated on a stone bridge spanning the left arm of the Seine at the De la Loge. By a combination of locks and sluices an average fall of 3 metres is always ensured. The plant comprises six enormous water wheels, more than 8 metres in diameter, driving a series of pumps which furnish the town of Versailles with a constant supply of water. Two wheels working day and night suffice for this, so that there are always four out of the six lying idle, representing an annual waste of 650,000fr. As each wheel is capable of working up to 150 horse-power we have no less than 600 horse-power available for electric lighting purposes. It is not astonishing, then, that this scheme has been mooted. No doubt it would have been better to have had the station nearer Versailles; but with a 3-metre fall already available at Marly a station elsewhere is not to be thought of.

THE LONDON CHAMBER OF COMMERCE.

ELECTRICAL AND ALLIED TRADES SECTION.

The following circular has been issued by the Secretary of the London Chamber of Commerce to the members of the Electrical and Allied Trades Section:—

SIR: Your attendance is specially requested at a meeting which will be held at Botolph House, 12, Eastcheap, on Monday, Oct. 22, at 3 p.m., for the purpose of completing the organisation of an Electrical Trade Section of the London Chamber of Commerce on the lines of my circular letter of the 24th of July last. The appended agenda of business will be transacted, and your attention is specially called to the list of members of the section, which, for purposes of ascertaining the representation to which they will be entitled on the general committee, has been divided into sub-sections. The working committee, as a whole, will consist of 33 members, and you are requested to fill up the enclosed voting paper according to the directions given thereon, and return the same to me as early as possible before the meeting takes place, whether you are able to attend or not. To facilitate the scrutiny it has been agreed that no voting papers will be received later than five minutes after the opening of the proceedings.

I am, sir, yours faithfully,

KENRIC B. MURRAY, Secretary.

AGENDA.

1. To receive and adopt the report from the organising committee with reference to the future working of the section.
2. To consider the subjects to be dealt with by the section.
3. Election of the working committee of the section (result of the voting to be announced).
4. Other matters.

REPORT OF THE ORGANISING COMMITTEE.

The committee appointed at the general meeting held on the 27th of July last, "with a view to organising an Electrical Trades Section under the auspices of the London Chamber of Commerce," beg to report that in the interval which has elapsed they have held two meetings to carry out the terms of their reference, irrespective of what has been done by a special sub-committee formed to consider certain details.

The committee recommend that a working or executive committee (elected annually by the general body of the trade in accordance with the bye-laws of the chamber) be charged with the ordinary business of the section, and that in the first instance it consist of 33 members, this number to be increased to 48 at the first annual meeting of the section, if the membership then obtained should warrant a larger representation.

It is proposed that the working committee should meet whenever occasion requires, and that meetings of the whole or part of the section, in addition to the usual annual meeting, should also be called from time to time.

With a view to an equitable representation on the working committee of the various branches of the electrical trade, the organising committee, after preparing a classified list of members,

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recommend that the committee be divided into the following sub-sections, viz. :—

1. Telegraph companies	5	members.
2. Telephone companies	3	,,
3. Electrical supply companies	6	,,
4. Electrical manufacturers and contractors	13	,,
5. Consulting electrical engineers	4	,,
6. General	2	,,
Total	33	,,

The committee recommend that members of the working committee be elected by ballot, and they have accordingly approved the issue of a voting paper with the circular convening the present meeting. They suggest that the election of the chairman and two deputy chairmen of the section should rest with the working committee.

Having regard to the bye-laws and regulations of the chamber, the committee do not advise the adoption of special rules to govern the section and its committee, as they are of opinion that for the present it will suffice to follow the procedure of other trade sections. As regards applications for admission into the section it is suggested that the working committee should be allowed an opportunity of scrutinising these before presentation to the council of the chamber for election.

The committee further recommend that the questions first dealt with by the section and its working committee should include the most pressing of the matters set forth in the circular letter of the 24th of July last, and that the admission of reporters to all future meetings be determined by the vote of members present.

SIR JOHN PENDER ON SUBMARINE TELEGRAPHY.

On Tuesday last Sir John Pender was presented with the freedom of the Burgh of Dingwall in recognition of his eminent services to the county in connection with the extension of submarine telegraphy throughout the world.

Provost Ross presided, and there was a large attendance. In presenting the freedom of the burgh to Sir John,

Provost ROSS alluded to the distinguished position which he occupied in the work of submarine telegraphy all over the world. During his Parliamentary career Sir John Pender had always evinced a deep interest in the welfare of the northern burghs, and the freedom of the burgh was now conferred upon him, not only on account of his being a prominent and distinguished man, but also as a mark of the people's gratitude for many acts of kindness.

Sir JOHN PENDER, who was received with loud applause, said his audience could well understand the difficulty he had in acknowledging in suitable terms the very eloquent and most kind and generous words which had been put before them by the Provost—words which would touch the heart of any man—words which he had no power or language to thank him sufficiently for (applause). It was indeed a very great honour to receive such a recognition at the hands of old friends, more particularly in a burgh with which he had been associated for so many years. During that time he dared say they had found out the bad parts in his character, and they also had been generous enough to appreciate some of the good parts (applause). He did not accept that honour entirely as a personal honour, but he accepted it in recognition of probably the greatest work that had been done during the greatest and most beneficent reign of any monarch who had reigned in the world ; and the work had been done so silently that even men of distinction could scarcely believe that such a work had been accomplished (applause). There had been a few honest, hard-working men engaged in that work, and one of those distinguished men was kind enough to say to him (Sir J. Pender) that he would like to go to Dingwall, and tell a little of the part that he (Sir J. Pender) played in it. That generosity was displayed on the part of his friend Sir George Elliot, who was now on the platform (applause), and who was, he might tell them, associated with submarine telegraphy before he (Sir John) took any active part in it. He not only made telegraphs, but laid them (applause). He thought he was bound to say a few words to them in justification of the honour they had conferred upon him. In April of this year the jubilee of telegraphy was celebrated. Fifty years ago there were only 2,000 miles of line, whereas the system now extended to 680,000 miles. The income then was *nil*, the income now amounted to many millions sterling (applause). At that time submarine telegraphy was practically unknown. It had been taken up, as he had told them, by himself and his friend Sir George Elliot and others. They had taken a firm grip of it, as they found that science had given them something that would be of universal advantage to the world, and they pushed it on so steadily that at the present moment there were 120,000 miles laid at the bottom of the sea (applause). That 120,000 miles of cable had cost £40,000,000, and still nobody knew where the money had been found, but everyone knew and recognised the enormous advantage it conferred upon humanity (applause). What had telegraphy done? He would enumerate some of the things it had done. That country of theirs was now in touch with all their colonies, it had brought them into touch with their great Indian Empire, with every part of the world where British ships could enter or the British flag could fly (applause). It had done more than that, it had brought about that federation of sentiment, that federation of interest—that which so many statesmen had endeavoured to do by talking, they had done with one great practical act (applause). They had done more in twenty years than Parliament had done during that time with all its talk (laughter and applause). They had done more for the benefit of the world by that one act than Parliament had done during the past twenty years (applause). He asked them not to suppose that he was egotistical in his remarks. He was speaking of a great system which was of vast importance to the world (applause). He would ask them to listen to what other people said on that great subject. At the Jubilee Panquet the following telegram was read from Australia :—"Submarine telegraphy, this offspring of science, has, in the direction of peace, revolutionised the whole world, brought the most distant portions of the British Empire within speaking distance, and rendered federation not only possible, but easy of accomplishment" (applause). America telegraphed : "All rejoice in an anniversary which finds New York as near to London as Camden Town was to Euston-square fifty years ago, and which sees the great name of Wheatstone honoured the world over in connection with inventions that have made nations neighbours, that have broken down prejudice, and provided knowledge, friendship, and peace to the whole universe. God bless Old England!" (applause). He said that he was anxious to read to them those extracts, because it took from him a certain responsibility. It showed them that other nations appreciated these benefits as well as their own. Their policy was not to confine their work to England, they went to the whole world (applause). Another telegram from America, read at the same meeting, said : "While the railroads have been the means of quicker transportation, the telegraph has been, if I may so call it, the nervous intelligence which has informed their movements, enlarged their facilities, and enriched their results. In a few months by these means, towns have sprung up in the virgin forests or on the desolate plains, and in a few years they have, by the same means, developed into opulent cities, giving prosperity and contentment to thousands. Add to this the achievement of submarine telegraphy, and are we not identified with, and, in fact, part and parcel of, one of the greatest powers for good, not only of this marvellous nineteenth century, but of all time? The kinship of nations has been strengthened by the telegraph, and most of all between England and America. The incessant stream of messages across the Atlantic bear silent witness to the bonds of affection, sympathy, and interest which bind the two peoples together" (applause). Could they, he asked, have in words more positive an expression of appreciation of this great work, for which they had done honour to the humble person who was now addressing them (applause)? What said a Minister of the Crown—one who, from his position as Postmaster-General, was entitled to know more than any other person of the benefits conferred on the world by the great work in which he had been engaged? He said, "I make bold to predict for this great science another and much ampler jubilee whenever the next half century enables it to take stock of the marvellous labours which it achieved for the human race, for the development of human enlightenment, and for the propagation of universal peace" (applause). Those were very strong and very emphatic words, and they came from a man whose knowledge of the question was beyond all doubt (applause). Now, he thought he had mentioned to them something of the extent of the work, but when he told them that it had to be carried on from day to day, and from hour to hour, and that the extent of the investment had been on the part of the companies about 90 per cent., and the Governments only 9 per cent., it would give them some idea of what British enterprise was (applause). They had thirty-eight ships that carried a tonnage of 60,000 tons, and it cost £300,000 a-year to maintain the system. When they thought on all that they would have some idea of the work that had been done. Submarine telegraphy had averted wars, and was likely to avert wars in the future. It had promoted social enterprise ; it had sweetened emigration by bringing to those who left the country and went to a country where they could find elbow room, facilities whereby they could converse with their friends, or tell them regarding their surroundings (applause). With regard to emigration, he believed in it very much. He could not see why people would choose to remain in a place where they had no room to turn themselves in ; why should they not go to a country where there is plenty of room and greater opportunities to become prosperous? (applause). Although they were far removed, they were in communication, by the aid of the press, with the home country (applause). The press was the organ which brought that about, but they were the means of giving the press the facilities. A statesman of to-day could not be happy in his position if it were not for the communications he received daily by telegraph. Merchants engaged in enormous export and import traffic, involving thousands of millions sterling, were aided in the most marked way by the telegraph. Prices were daily marked in London from the Indian, China, and other foreign markets of the world, so that merchants at home knew exactly what they were doing. There was scarcely a transaction of any importance in London, Liverpool, or Glasgow that was not either begun or closed by telegram. When the Melbourne Exhibition was opened the other day, he had been asked whether it would be possible to have a communication sent in answer to a message received from Melbourne in a very limited time. The message received from Melbourne to the Queen contained 117 words, and it took only 38 minutes to reach London (applause). The reply contained 13 words from Her Majesty, and it reached Melbourne in 16 minutes (applause). It showed the little time that had been lost when he told them that the distance travelled was 14,000 miles (applause). Indeed, if they took the time as the sun indicated, the message was back before the event took place in Melbourne at all (laughter and applause). He thought that he had said sufficient to satisfy them of the importance of the great work which had been done during the last 22 years. It had only passed its majority, but when it attained to riper years, they would find that it would continue to go on by leaps and bounds ; for if he had one wish more than another, it was that God would spare him for a few years more to see the advantage derived by humanity, and to see the great

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system arrive at a state of perfection (applause). All that was done had been accomplished in a very short period—in one half of the reign of the Queen, and he thought that every British subject could not help being proud of Britain when he felt his ability in a short space of time to have his thoughts transmitted to any other part of the world (applause). He hoped that he had justified the Provost, Bailies, and Councillors for the honour they had conferred upon him as a representative of the great telegraph system, an honour he could not have accepted simply for the work he had done while he was their member in Parliament. But in those days he had many pleasant associations with these burghs (applause). He might tell them that some of the young men who went from those burghs—those whom, he might say, he had taken by the hand—were part of the organisation of the great telegraph system (applause). He hoped that there were still many coming who were looking forward to take part in it. There was a great field before them, and he would counsel them to look carefully to their education, work hard, incessantly, and earnestly, and their satisfaction in the end would be much the same as he had that day in receiving such a high honour (applause). They had entered his name on the record of an ancient and Royal Burgh, which dated back to a period when such work as he had been representing to them was little known (laughter), but their burgh had held together in a wonderful degree during these long years, and he thought he could associate that with the management of the able men who had filled the positions which were entrusted to them by their townsmen. When his record was written, he desired that he should be remembered as one of the band of earnest workers who had made the nations of the world more united, more in harmony, and more progressive than they found them, and who also desired that peace and goodwill might be promoted by the great agency of submarine telegraphy, which it had been the object of his life to establish and develop (loud applause).

LINES TO THE ELECTRIC LIGHT AT THE GREAT WESTERN RAILWAY TERMINUS.

(By a Misanthropic Gas-holder.)

Twinkle, twinkle, little Arc,
Sickly, blue, uncertain spark;
Up above my head you swing,
Ugly, strange, expensive thing!

Now the flaring gas is gone
From the realms of Paddington,
You must show your quivering light,
Twinkle, blinkle, left and right.

When across the foggy air
Streams the lightning's purple glare,
Does the traveller in the dark
Bless your radiance, little Arc?

When you fade with modest blush,
Scarce more bright than farthing rush,
Would he know which way to go
If you always twinkled so?

Cold, unlovely, blinding star,
I've no notion what you are,
How your wondrous "system" works,
Who controls its jumps and jerks.

Your's a lustre like the day!
Ghastly, green, inconstant ray!
No; where'er they worship you,
All the world is black or blue.

Though your light perchance surpass
Homely oil or vulgar gas,
Still (I close with this remark)
I detest you, little Arc!

—*St. James's Gazette.*

LEGAL INTELLIGENCE.

King, Brown and Co. v. The Anglo American Brush Electric Light Corporation.

In the Edinburgh Court on the 16th inst., before Lord Trayner, his lordship closed the record and ordered proof in an action at the instance of King, Brown and Co., Rosebank Electric Works, Broughton-road, Edinburgh, against the Anglo-American Brush Electric Light Corporation (Limited), 6, York-place, Edinburgh, for the reduction of letters patents obtained by the defenders in October, 1878, and other papers, for "improvements in apparatus for the generation and application of electricity for lighting, plating, and other purposes," material parts of the alleged invention not being new or original. The defenders have threatened the pursuers with legal preceedings and liability in respect of manufacture, use or sale of the alleged invention said to be covered by the letters patent, and in particular of compound-wound dynamo machines. This, the pursuers state, has very seriously affected their business. The defenders admit having threatened the pursuers with legal proceedings, and that the proceedings threatened were carried out against the Orient Steam Navigation Company, who were using machines made by the pursuers. An action against the Orient Company is pending in the High Court of Justice, England, and, it is stated, the same questions are raised there as in the present action. The defenders therefore plead that the case ought to be sisted until the issue of the English action is known.

CORRESPONDENCE.

ELECTRIC TRACTION IN CANADA.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Thinking it might be interesting to your readers, I send the following short account of the St. Catherine's, Merritton, and Thorold Electrical Street Railway, including (by permission of the president, E. A. Smyth, Esq.) some figures as to the cost of working.

The plant consists of one 100 horse-power generator, seven motor cars, and two cars without motors.

The main line is about five miles and a-quarter, and a branch half a mile.

Working expenses, at per diem.

Power Station.		Road.	
Power	$0 83	Oil and waste	$1 00
Oil and waste	0 20	Brushes	0 30
Labour	3 00	Travellers	0 30
Depreciation on generator, at 3 per cent.	1 00	Labour	2 00
Depreciation on turbine, at 10 per cent.	2 70	Material for repairs of cars and line	1 70
		Depreciation on cars, at 15 per cent.	6 30
		Depreciation on line, at 10 per cent.	2 00
	$7 73		$13 60

Power station	$7 73
Road	13 60
	$21 33, equal to about £4. 7s. 6d.

Seven cars at 72 miles per car gives $3.06 (12s. 3d.) per car, or $0.0424 per car-mile (equal to about 2·08d.)

As these figures were made out for comparison with the cost of horse-power the wages of conductors and drivers were not reckoned. These would average about 3 dols. per car, bringing up the total cost per car-mile to about 4d. The motive power is obtained from Lock 12 of the Old Welland Canal, where there are 300 horse-power on a 12ft. 6in. fall. The rent paid to the Government for this is 300 dols. per annum, and as the turbine is only 125 horse-power, a balance of 175 horse-power remains. This is expected to be in use at no distant period, thus bringing the cost down very considerably. The generator is 100 horse-power separately excited; E.M.F. 500 volts, and is situated within a few yards of the middle of the main line. There are seven motor cars, four closed 10ft. long, which have the motor at the front, and three open 16ft. with the motor in the middle. The motors are all 15 horse-power. Besides these there are two without motors, which are towed by the closed cars whenever there is any increase of traffic, as on market days, &c. When full the closed cars weigh six tons and the open seven tons (2,000lb. to the ton).

The road on which the main line runs is a remarkably bad one for such a purpose. For about three-quarters of a mile from the St. Catherine's Terminus it is level enough, although not straight for more than 300 yards at any one part. It then takes a sudden turn to the right and follows the line of the Old Welland Canal until Thorold is reached, over a succession of hills.

To give an idea of what the cars have to overcome, it will suffice to mention that the end of the track at Thorold is 287ft. higher than at a point four miles distant, and that in this four miles there are several dips that bring up the total height to be mounted to about 370ft. Some of the grades are very bad, the steepest, although not the worst, being 1 in 15. The worst are two of about 1 in 20, these occurring on curves. Many of the curves are very severe, there being eight with radii between 35 and 66ft. in addition to numerous easier. For the greatest part of the distance the line runs on the top of a steep embankment, at the bottom of which is the canal, rendering slow speeds an absolute necessity for safety.

The conductors are two hard-drawn copper wires $\frac{3}{10}$in. diameter, supported on poles where the track is on the side of

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the road and on cross wires made fast to the houses where it is in the middle. They are about 19ft. from the rails in most parts, although in one or two places they come down to 14ft. to pass beneath bridges. On each wire runs a simple brass or iron wheel, which is connected to the car by a flexible cable to conduct the current. The figures given above are those for the first nine months, namely, from October, 1887, to July, 1888, and looked at in this light, together with the fact that the machinery had at the start to tackle a Canadian winter, they may be considered remarkably good.

Until last October the road was run by horses, and the work was so hard that a pair was required to take a car (10ft. long) to Thorold and back. They made one trip, and had six hours' rest before making a second. It was very seldom that a horse went over the road three times in one day. Even then the conductor used to invite his patrons to walk up the steep hills Since those days, however, matters have altered. Firstly, there is a direct saving of 3 dols. 50 cents. per car per day; secondly, three cars used to be ample for the traffic, and during winter it was a good month when receipts covered working expenses, the last car getting in at 8:40 p.m. Last winter the increased traffic required four cars every day after 12 o'clock, the last one getting home at midnight. Seeing this unexpected increase of business the company had three large open cars built for summer traffic, and since the beginning of June have had to put six on the road as a regular thing. Another advantage is that before it was impossible to take all the passengers that frequently wanted to ride, as the horses could not draw them; now as many as can get a foothold anywhere get on. It may be as well to mention that on this continent they do not trouble about carrying only a certain number in a public vehicle, but let everyone who likes crowd in. On the 1st of July last (a public holiday) a crowd took it into their heads to come from Thorold to St. Catherine's to see a lacrosse match, and piled on to a car to the number of 125, making with conductor and driver 127. As none would get off, and all paid their fares, the conductor had to bring them. The great weight broke the car's back, but it got there all the same. On the 10th August I was riding on a car that was being towed. On the towing car I counted 50, and on the other 61, or 111 all told, plus about a dozen babies. This shows what a thoroughly good motor will do on an emergency. The people who use these cars would not go back to horses for anything. During spring the canal was emptied for a week, and the cars had to be run on the old plan, which resulted in much grumbling, and served as a good guide to public opinion.

A very important item is the matter of repairs to machinery. This has been very satisfactory, the only part that has required much attention being the brakes and the chains that run from the motor to the axle. The electrical part has stood the hard work well, and apart from the trouble that always occurs with new machinery everything has done better than the most sanguine hoped for. Altogether, the proprietors are satisfied that they have made a good investment.

In addition to the main line, which runs from St. Catherine's through Merritton to Thorold, there is a branch wholly in St. Catherine's, about half a mile to the Grand Trunk Railway, Welland Division Station, to which cars run to connect the trains. Another branch, about two miles, will be commenced shortly. This will run to the cemetery.

If any of your readers may happen to be travelling to or from Niagara Falls by the Grand Trunk Railway they will see this road, and pass within a few yards of the power station at Merritton. It will repay them to stay over for a few hours and examine it.—Yours, &c., H. E. DOLAN.

14, King-street West, Toronto, Ontario.
October 1st, 1888.

PRACTICE *VERSUS* THEORY.—ELECTRO-MAGNETIC WAVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The remarkable leader in your issue of the 12th inst. states very lucidly some of the ways in which theory and practice seem to become antagonistic. There is, however, one point which does not, I think, receive the attention it deserves, which is, that it is the duty of the theorist to try to keep the engineer who has to make the practical applications straight, if the engineer should plainly show that he is behind the age, and has got shunted on to a siding. The engineer should be amenable to criticism.

Another point is this. It might appear from the concluding paragraph of the article to which I have referred that the points at issue between Mr. Preece's views and my own were mere matters of complicated corrections, not affecting the main argument much. But the case is far different. A complete change of type is involved.

Now, I shall have great pleasure, when opportunity offers, in endeavouring to demonstrate that such is the case, and that the despised self-induction is the great moving agent; that although Mr. Preece, in the presence of some distinguished mathematicians, recently boasted that *he* made mathematics his *slave*, yet it is not wholly improbable that he is a very striking and remarkable example of the opposite procedure; that although Mr. Preece, who, as a practical engineer, knows all about electro-magnetic inertia and throttling, does not see the use of inductance, impedance, and all that sort of thing, yet there is not wanting evidence to make it not wholly unbelievable that Mr. Preece is not quite fully acquainted with the subject as generally understood; that, for example, his co-efficient of self-induction is of very different size, and has very different properties, from the theoretical one; and that Mr. Preece's knowledge of the manner of transmission of signals, though it may not be "extensive," is certainly "peculiar."

I may take the opportunity of adding that on account of a certain peculiar concurrence and concatenation of circumstances last year rendering it impossible for me to communicate the practical applications of my theory (based upon Maxwell's views, so far as the higher developments are concerned), either *viâ* the S. T.-E. and E. or four other channels, the resultant effect of which was to screen Mr. Preece from criticism, combined with the fact that Mr. Preece, in his Papers to the Royal Society, British Association, and S. T.-E. and E. has taken his stand upon Sir W. Thomson's celebrated theory of the submarine cable, I have been forced, with great reluctance, to assume what may have appeared to be, superficially, an apparently unnecessarily aggressive attitude towards the said theory. But those who are acquainted with the subject will know that there is no antagonism whatever between the electrostatic theory and the wider theory; and those, further, who may be acquainted with the peculiar concurrence I have mentioned will understand the meaning of the apparent aggressiveness.

In addition, it seems to me to be almost mathematically certain that Sir W. Thomson would emphatically repudiate the very notion of applying his theory of the diffusion of potential to cases to which it does not apply, and to which it was never meant to apply; and I cannot find any evidence in his writings that he ever would have made such a misapplication.—Yours, &c., OLIVER HEAVISIDE.

P.S. Is self-induction played out? I think not. What is played out is what we may call (uniting the expressions of Ayrton, Preece, Thomson and Lodge) the British engineer's self-induction, which stands still, and won't go. But the other self-induction, in spite of strenuous efforts to stop it, goes on moving; nay, more, it is accumulating momentum rapidly, and will, I imagine, never be stopped again. It is, as Sir W. Thomson is reported to have remarked, with a happy union of epigrammatic force and scientific precision, "in the air." Then there are the electro-magnetic waves. Not so long ago they were nowhere; now they are everywhere, even in the Post Office. Mr. Preece has been advising Prof. Lodge to read Prof. Poynting's Paper on the transfer of energy. This is progress, indeed! Now these waves are also in the air, and it is the great "bug" self-induction that keeps them going.

On this question of waves I take the opportunity of referring to a point mentioned at the Bath meeting by Prof. Fitzgerald. That physicist, in directing attention to Hertz's recent experiments, considered that they demonstrated the truth of

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the propagation of waves in time through the ether; but that, on the other hand, the waves sent along a circuit did not do so, because they might be explained by action at a distance.

It seems to me, however, that the more closely we look at the matter the less distinction there is between the two cases, and that to an unbiassed mind the experiments of Prof. Lodge, sending waves of short length into a miniature telegraph circuit, with consequent "resonance" effects, are equally conclusive to those of Hertz on the point named; in one respect, perhaps, more so, because their theory is simpler, and can be more closely followed.

But, after all, has it been demonstrated that we cannot explain the propagation of electromagnetic waves in time by action at a distance, pure and simple? I suggest the following as evidence to the contrary. Take the case of Maxwell's non-conducting dielectric. Let the electric current element *cause* magnetic force at a distance according to Ampère's law, and let the magnetic current element *cause* electric force at a distance according to the same law with sign reversed. Then

$$\text{curl } \mathbf{H} = \epsilon \dot{\mathbf{E}}, \text{ and } -\text{curl } \mathbf{E} = \mu \dot{\mathbf{H}}$$

follow, and propagation of waves in time follows. That is, by mutual action at a distance between electric current elements, and also between magnetic current elements, we get propagation in time. Of course the currents may be oppositely moving electric or magnetic fluids or particles.

Whether there is any flaw here or not, it is scarcely necessary for me to remark that I do not believe in action at a distance. Not even gravitational.

DUPLEX WORKING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In *The Electrician* of October 5th, paragraph 5 of the Notes, you remark with regard to an improvement in duplex working by Mr. Melhuish, of the Indian Telegraph Department (quoting, I presume, from the *Indian Engineer*), that "in the ordinary methods of working duplex, the capacity of the wire is only increased so long as no correction is required by either of the receiving clerks; but directly a word misses fire the remaining pair of signallers are reduced to enforced idleness whilst the correction is being made . . . . . Mr. Melhuish's invention is intended to obviate this difficulty, and to enable either pair of clerks to send or receive at will."

En passant, the term "carrying capacity" is preferable to "capacity" in the above paragraph, for obvious reasons.

I am unacquainted with the methods of working duplex employed on the Indian Government lines; but if, because a repetition (or, as it is termed in submarine telegraphy, an "R Q") is required, two of the four clerks are reduced to enforced idleness, it is certainly a good thing for the Indian Government that Mr. Melhuish has come forward with an improvement.

These "R Q's" undoubtedly diminish the "paying-carrying capacity" of the wire or cable, in that they occupy the line for a certain percentage of the time which would otherwise be devoted to paying messages; but this applies also to simplex working, although perhaps in a lesser degree. In our duplex working on submarine cables a constant stream of messages, interpolated with the necessary "R Q's," passes both ways, and there is never any "enforced idleness" on the part of the operators.

If the receiver at station A requires a repetition in a certain message, he writes down the number of the message and the "R Q" required on a slip of paper, and hands it to his sender, who in turn passes it on to station B. The receiver at station B in his turn notes the "R Q" on a slip, and passes it to his sender, who then gives the receiver at A the required information. Thus there is no "enforced idleness," as I have remarked, and also either pair of clerks can and *do* send and receive at will.

In conclusion, if Mr. Melhuish's invention will enable us to weed out these "R Q's," and drop them harmlessly through another instrument without interfering with the paying traffic, then indeed it will be of considerable value; but, as you remark, "an additional instrument or two, and a rearrangement of batteries" is rather vague data to go upon.—Yours, &c.,

F. ALEX. TAYLOR,
Assistant Superintendent and Electrician,
Eastern Telegraph Company.

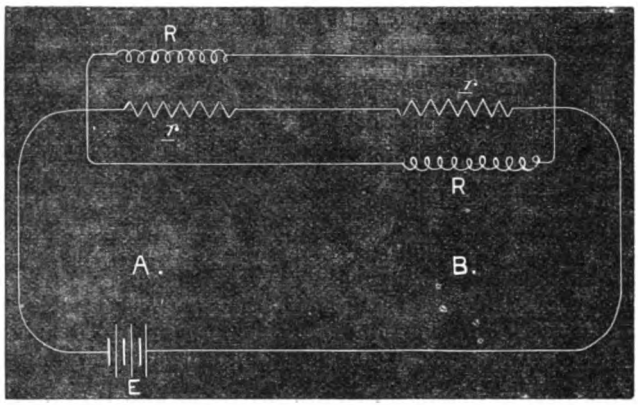
Gibraltar, Oct. 12, 1888.

ELECTRO-CALORIMETRY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you allow me to point out that the arrangement employed by Profs. Stroud and Haldane Gee for heating the baths (*Electrician*, p. 705) is electrically in unstable equilibrium, since any difference of temperature between the baths causes less power to be spent in the cooler one, thus tending to increase the difference. With the coils in parallel less power would be spent in the hotter bath, but the method would still be imperfect from the want of equality of heating at different temperatures.

Coils may, however, be so arranged as to completely overcome these defects in an otherwise very simple and convenient



apparatus. In the figure let A and B represent the two baths and the coils therein, each bath being heated partly by a series coil of r ω, partly by a parallel coil of R ω. All four coils should be made of the same metal.

The necessary relation between R and r to secure equal heating may be found by writing

$$\frac{d \text{ watts in A}}{d\theta} = \frac{d \text{ watts in B}}{\theta d},$$

where θ is the difference of temperature between the baths. When worked out this gives $R = 4r$, a result which is obviously true provided the coils have a small temperature coefficient.—Yours, &c.,

SYDNEY EVERSHED.

Westminster, Oct. 17, 1888.

DR. LODGE'S EXPERIMENTS ON LIGHTNING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the phenomena observed by Dr. Lodge in the discharge of Leyden jars, recently described in your journal, perhaps some light would be thrown on their cause if the direction of the secondary discharge were ascertained.

I think it will be found that the induced discharge set up on the passage of the Leyden jar discharge passes through the comparatively good conducting medium afforded by the spark itself and takes the alternative circuit.

In everyday experience I find that induced discharges of no great strength from electro-magnets will pass through a voltaic arc in the opposite direction to the current flowing in the latter; therefore I do not think it impossible that a similar discharge from a curved wire should pass through a conductor which affords it a passage in the manner found by Dr. Lodge.

It does not appear to me that there is in the experiments sufficient resemblance between the circumstances of condenser or Leyden jar discharges and lightning. In the case of the

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latter we may suppose that the upward movement of masses or layers of moist air oppositely electrified to the surface of the earth, creates with the increase of distance an increasing potential, in the manner of an electrophorus, the air in this case taking the place of the dielectric, and the earth that of the cover.

The discharge occurs when, by the separation of the electrified air or cloud and the earth, the potential is sufficiently increased, and is probably aided and its course determined by the condensed moisture which would be formed by the warm air ascending into upper and colder regions.

The ramifications of a lightning flash show that a number of small streams unite usually into one or more larger discharges, as would occur by removing the cover of an electrophorus to a short distance from the dielectric, and then tilting it slightly to concentrate the charge in the most proximate parts. Whether lightning be formed in this manner or not, it will not have a continuous conducting condenser surface, like that of a Leyden jar, to receive the induced discharge from a conductor, and therefore the induced effects of lightning in a rod will differ from those produced in a conductor by a Leyden jar discharge, and will sooner disappear.

To provide an electrostatic reservoir for the induced discharge, such as the Leyden jar used in the experiments, might cause oscillations similar to those which usually prevent magnetisation being properly carried out by means of condenser discharges.

It is well known that Leyden jar discharges cannot be depended upon, without certain precautions, to magnetise uniformly in one direction, and the reason is to be found in the reception of the induced discharge by the jar until the fall of potential in the conductor allows it to redischarge itself through the helix, when it will demagnetise or even reverse the direction of the magnetism caused by the original discharge.

It can be easily seen that when once a spark has established a conducting path, the induced sparks can pass and repass in a series of oscillations until they are too feeble to overcome the air resistance.

Perhaps another set of experiments with a large electrophorus, and in which the direction of the abnormal discharge, if present, is ascertained, might lead to the elucidation of the apparently paradoxical results obtained.—Yours, &c.,

17, Cornhill, E.C., October 16th, 1888. F. HIGGINS.

LIGHTNING PHOTOGRAPHS.

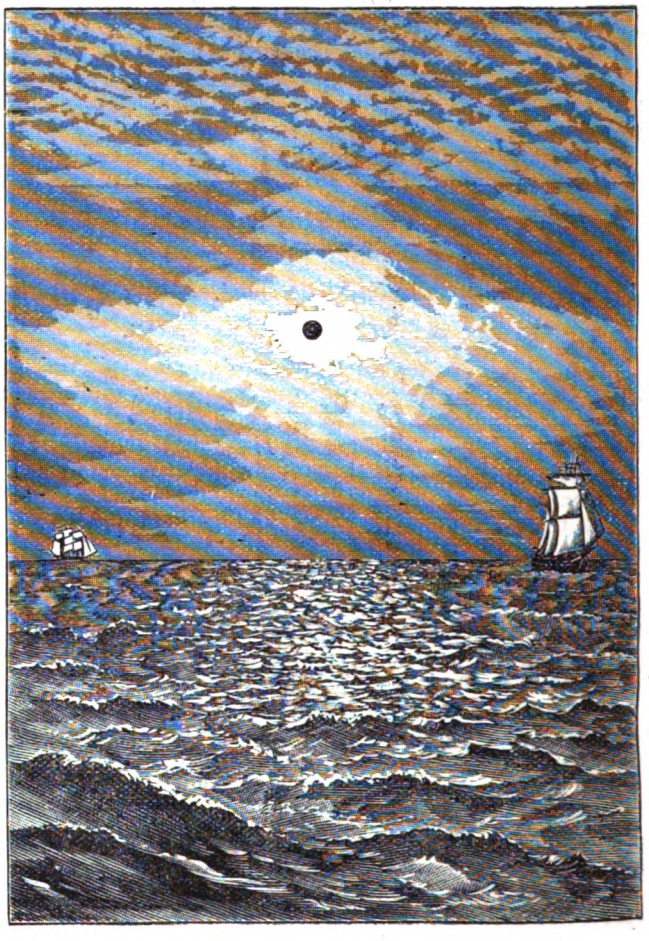
TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have seen with much interest the three engravings in *The Electrician* of the 5th instant. In Fig. 2 is shown what is called a "*dark*" flash. Now, this term, whatever it is intended to signify, is hardly correct, for it is really the result of a very *bright* flash. It is a well-known fact to most photographers that if a dry plate is ever exposed in any way a reversed action takes place when the plate is placed in the developer, and instead of a dense negative being the result, it is found to be thin and flat. If the plate has been very much over-exposed the reversed action is so great that little or no silver is deposited in developing. It is manifest that if only a portion of the plate is thus over-exposed the reversed action takes place on that part alone, while the rest of the plate may be correctly exposed, or even under-exposed.

I enclose two photographs, illustrating this effect; the view has been taken with the sun included, to obtain a moonlight effect, the image of the sun being overpoweringly brilliant, as compared with the light on the rest of the plate. The reversed action necessarily takes place on that part, and in the print the sun comes out black, as in photograph No. 1. No. 2 is a print from the same negative after the sun has been painted out with black. Applying this principle to the photograph in question, the "*dark*" flash would be produced by a very intense flash of light, causing the reversed action on the plate, and, of course, it will come out black in the print. I have not had the opportunity of seeing a negative with a "dark" flash; but should I be correct in my explanation the "*dark*" flash should have "fogged" the plate to some little distance round its course.

With reference to Fig. 3, the ribboned appearance at the edges, spoken of, but not visible on the engraving, is doubtless due to the lens not "covering" the plate, the duplication being caused by astigmatism. Again, you mention that this flash has a tendency to form bright spots at places; this is easily accounted for. If a flash of the meandering type could be taken in two positions at right angles to each other it would be found that these bright spots are produced by the flash striking in a direction perpendicular to the camera, and thus giving a little longer exposure to those parts.

Last year you illustrated a flash of the meandering type, which is strangely similar to a flash I obtained on the same night; it has formed several loops, and several little balls of light at the sudden bends. On examining my negative I came to the conclusion that the loops are caused by the flash striking in a direction perpendicular to the camera, and in doing so forming a turn in a spiral, while the little globes of light are due to the same cause, only the spiral is too small for the convolutions to appear separate.



Engraved from Mr. Adams's Photograph "No. 1."

In the photographic exhibition at Pall Mall last year were a series of lightning photographs taken during the great storm (August 17th, 1887). I think there were at least six taken at short intervals. Amongst these was one which caused me some wonder, as I had not then heard of the oscillatory theory; it was a solid flash, not a meandering one, which was repeated again and again, if I remember right more than six times, each repetition following exactly the same course, and each succeeding one becoming fainter. This photograph, I am inclined to think, is of the utmost importance, as evidence in support of the oscillatory theory, for the flashes were close to each other—in fact, were partly superimposed—and had the camera been moving while the flash was striking, each succeeding flash would be registered by the side of the others, as was the case.

Some mention of a similar flash has been made in the discussion at the B.A., and I believe the cause has been ascribed

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to reflection from the back of the plate. I hardly think this is possible, as the film is opaque and the light behind the plate is diffused, and what reflection there is will only produce "halation;" also reflection is reduced to a minimum by a dead black backing. Again, why should duplication by reflection take place only in certain cases? I have never seen it in photographs of ordinary subjects, and we have numbers of lightning photographs without a sign of it.

I feel inclined to believe with Prof. Lodge that some flashes are oscillatory and some are not. Those that meander through the air, striking at nothing in particular and vanishing into space, should, I think, be classed as non-oscillatory, while, those which strike direct from the clouds to the earth—thick heavy flashes—probably oscillate until the potential between the points is equalised.

While on this subject I should like to learn if the following phenemena can be accounted for:—One evening last year, after sunset, I was watching a dark black cloud, with clearly defined outline, high above the horizon, when from the top flashes of lightning shot upwards into quite clear atmosphere. There was nothing visible for it to strike at. I understand from a gentleman who has spent some years in India that it is not uncommon for flashes to strike across the clear blue sky in which there is no sign of a cloud.

In conclusion, I should recommend all those who are interested in the study of lightning flashes to refer to negatives or glass positives for their information, as there is much interesting detail lost in silver prints.—Yours, &c.,

W. P. ADAMS, A.K.C., A.S.T.E.

Springwell, Barnes, October 8, 1888.

[Our correspondent's explanation of the "dark flash" is one which is likely to occur to every photographer, and in the discussion on Lightning in Section A at the recent meeting of the British Association it was carefully considered (see *The Electrician*, September 28th, p. 674). But if our correspondent will refer again to the engraving on p. 699 he will notice that a "white" flash lies across the dark one in three several places; and no one has yet shown how this is to be reconciled with the over-exposure theory.—ED. *E.*]

THE LIGHTING OF BARNET.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Since we have obtained the contract and have carried out the lighting at Barnet (the first town in the United Kingdom whose streets are entirely lighted by the electric light) we have been subjected to all manner of abuse from interested opponents in the local papers and elsewhere, chiefly in the shape of anonymous letters (the most contemptible form of criticism), the merest perusal of which is sufficient to show their origin.

The report of a visit to see the electric light at Barnet was published in a Blyth paper as coming from a Blyth man; this report, it is believed, was written by an unfriendly gas shareholder, a resident in Barnet. Of course, it was copied in the *Barnet Press*, and extracts, we regret to say, in some of the electrical papers. The malicious and yet ludicrous nature of that report will be apparent when it is known that the writer states that electric light lamps (of 50 candle-power) gave much less light than an ordinary gas lamp (of about 14 candle-power). The absurdity of this statement is evident by a glance at the two lamps. The writer of the report makes other misleading and erroneous statements.

The editor of the *Luton Times* was, we are so informed, invited to Barnet to write down the electric light, and after spending "a very happy evening" (*vide* report), proceeds to do so in a very amusing, but, of course, totally erroneous and misleading manner.* Many other equally stupid and misleading letters and criticisms have appeared, and perhaps a few facts as a corrective may not be out of place.

Now as to the light. This is the first installation of town lighting by incandescent lamps in series, and we had enormous difficulties in obtaining the novel fittings in the short time at our disposal. Our contract was not signed until July 6th, we did not obtain the official plan showing the position and number of the lamps until some time after, and we found that we had to fit up 71 street lamps, posts, five miles overhead wire, nearly one mile of underground wire, dynamo, engines, &c., in about five weeks. We asked the Local Board for six months in which to do the work permanently. This they were unable to grant, as the gas company's contract expired at the end of August, and we had to light up on the 1st September. Under such circumstances we were compelled to use temporary appliances, which we are now replacing by permanent plant, and we expect shortly to have our duplicate sets of engines, dynamos, &c., in proper working order.

Our contract is for 71 thirty-two candle-power lamps. We have substituted many 50 candle-power lamps in the High-street, &c., in order to make a good display, and the opinion of competent and unbiassed persons is that the light is a success, and we are much gratified at the orders we have received for private lighting and the general good feeling shown towards us by the townspeople of Barnet. The Barnet lighting is, no doubt, the stepping-stone to an immense business in town lighting. We have already had numerous applications from other towns, and we consider the unfair criticism we have received is due to the envy of our opponents, and we take it as a tribute and measure of the success we have already achieved.

* We have deleted a sentence here which possesses no interest of a technical character.—ED. *E.*

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When we are fixed up permanently, of which we will give you notice, we shall be glad to see you, and explain the whole system, and invite your personal criticism.—Yours, &c.,

HENRY F. JOEL AND CO.

City Electric Light Works, 31, Wilson-street, Finsbury, London, E.C., Oct. 17, 1888.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

14,110. T. N. VAIL, Massachusetts, and J. A. SEELY. United States. Improvements in telephone central-station apparatus. October 1, 1888 [Date applied for under Section 103 of the Patents, &c. Act, 1883. March 1, 1888.]

14,111. T. N. VAIL, Massachusetts, and J. A. SEELY. United States. Improvements in telephone-exchange signalling apparatus October 1, 1888. [Date applied for under Section 103 of the Patents, &c., Act, 1883, March 1, 1883.]

14,129. H. H. LAKE. London. Improvements in and relating to dynamo-electric machines (E. Thomson, United States). October 2, 1888.

14,332. S. MILLER. London. An improved galvanic cell or battery for electric lighting or for other purposes. October 5, 1888.

14,323. S. MILLER. London. An improved electrolyte or depolarising solution for galvanic batteries. October 5, 1888.

14,383. J. HAUSER. London. An improved electric switch. October 6, 1888.

14,426. C. S. SNELL. Saltash. Improved electrical connection. October 8, 1888.

14,472. W. GRIFFIN. Liverpool. A galvanic action or current for the cure of toothache. October 9, 1888.

14,489. E. R. VON NOLLENDORF. London. Improvements in electric lighting. October 9, 1888.

14,492. J. B SUTHERLAND. London. Improvements in electrical signalling, indicating or registering apparatus for railway purposes. October 9, 1888.

14,522. D, HUMPHREYS. London. Improvements in galvanic batteries. October 9, 1888.

14,542. R. W. H. NEWINGTON. London. Improvements in electric and other bells. October 10, 1888.

14,600. G. H. BASSANO. Derby. Improvements in the cores and armatures of electric bells, relays for electric bells, railway signalling bells, and electrical indicators. October 11, 1888.

14,611. J. MONTEITH. Glasgow. Improvements in or relating to apparatus for driving electric railway or tramway cars. October 11, 1888.

14,622. E. G. CRAVEN. London. Variable adjustable resistance for electrical currents. October 11, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

October 13, 1888.

14,632. I. A. TIMMIS. London. Improvements in electrically lighting railway trains. October 27, 1887.

15,161. P. EVERITT. London. A coin-freed electrical-current-producing apparatus. November 7, 1887.

15,735. W. R. LAKE. London. Improvements in electrical indicating or signalling apparatus (C. Grivolas, France). November 16, 1887.

16,324. F. T. SCHMIDT. Keighley. Improvements in electro-mechanical striking gongs. November 28, 1887.

16,870. R. TATHAM. Liverpool. Improvements in electro-dynamic generators and motors. December 8, 1887.

17,031. W. LAHMEYER. London. Improvements in or relating to the regulation of electric currents and in apparatus therefor. December 10, 1887.

17,409. C. A. MCEVOY. London. Improvements in electrical primers or fuses. December 17, 1887.

729. D. URQUHART. London. Improvements in electric batteries and elements therefor. January 17, 1888.

12,396. W. P. THOMPSON. Liverpool. Improvements in electric motors for self-winding clocks (D. W. Edgecomb, United States) August 28, 1888.

12,437. W. A. CONNER and J. W. MARSH. London. Improvements in electrical conductors or cables. August 29, 1888.

13,128. J IRWIN. London. Improvements in electric railway signalling systems. September 11, 1888.

13,193. E. M. H. ANDREOLI. London. Bleaching paper pulp by electrolysis. September 12, 1883.

PATENTS SEALED.

October 12, 1888.

10,663. A. J. BOULT. London. Improvements in or relating to electrical type-writers and printing telegraphs (J. F. McLaughlin, United States). August 2, 1887.

10,785. J. G. LORRAIN. London. Improvements in clocks and in apparatus for winding the same by electricity. August 5, 1887.

10,836. C. A. MCEVOY. London. Improvements in electrical firing mechanism for ordnance. August 6, 1887.

4,659. F. T. SCHMIDT. Bradford. Improvements in apparatus for making and breaking electrical circuits in connection with call or alarm boxes and recording the same automatically on dials. March 27, 1888.

7,848. W. P. THOMPSON. Liverpool. Improvements in or relating to indicators for alternating electric currents (G. Westinghouse, jun., United States). May 29, 1888.

7,849. W. P. THOMPSON. Liverpool. Improvements in or relating to apparatus for detecting and locating faults in alternate current electric circuits (G. Westinghouse, jun., United States). May 29, 1888.

UNITED ELECTRICAL ENGINEERING CO., Ltd., 36, ALBERT EMBANKMENT, LAMBETH, S.E.

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13,709. R. S. Bozon. London. India-rubber compensators for telegraph, signal, and other wires. October 10, 1887.

7,998. F. Holman. United States. Improvements in and relating to shades and reflectors for incandescent electric lamps. May 31, 1888.

9,206. C. Lütcke and P. George. Berlin, Germany. Improvements in galvanic elements or batteries. June 23, 1888.

9,660. A. J. Boult. London. Improvements in electric motors and dynamo machines (O. Lugo, United States). July 3, 1888.

9,661. A. J. Boult. London. Improvements in telephone transmitters (J. Emmuer, jun., United States). July 3, 1888.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

10,099, 1887. Wright, G. H. Electric railway signals. (Price 11d.)

13,080, 1887. Fritsche, W. Dynamo electric machines. (Price 1s. 1d.)

15,385, 1887. Hermite, E., and others. Disinfecting impure liquids by electrolytic action. (Price 8d.)

15,532, 1887. Joyce, S. Electricity. (Price 8d.)

15,555, 1887. Mordey, W. M. Electric motors. (Price 8d.)

15,583, 1887. Mills, B. J. B. (Edison). Electric tramways and railways. (Price 8d.)

15,660, 1887. Thomas, A. J. Electric clocks. (Price 8d.)

15.801, 1887. Beck, W. H. (Michel). Incandescence electric lamps. (Price 11d.)

16,458, 1887. Campbell-Swinton, A. A. Electric telephones. (Price 8d.)

3,979, 1888. Johnson, W. G. Plates for medico-electric purposes. (Price 8d.)

6,075, 1888. Ries, E. E. Utilising electricity for heating, &c., buildings, &c. (Price 1s. 1d.)

9,662, 1888. Boult, A. J. (McLaughlin). Electrical type writers. (Price 8d.)

11,108, 1888. Justice, P. M. (Acheson). Electric conductors. (Price 8d.)

11,411, 1888. Meston, A. W. Dynamo-electric machines. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

Australian Electric Company.

An adjourned special general meeting of the shareholders of the Australian Electric Company (Limited) was held in Melbourne, on Thursday, August 23rd, for the purpose of confirming resolutions passed at a meeting on the 31st of July, winding up the Company, and authorising liquidators to transfer its business to a new company having extended powers. Mr. Levien, M.L.A., occupied the chair.

Mr. S. J. WALKER said that he must object to the winding up of the Company, as it appeared from the last report which had been brought up that its business was in a flourishing condition. The buildings had been enlarged and the plant increased, so that there was no need to merge the Company into a new one.

The CHAIRMAN explained that the reason why the Company was being wound up was not because there was any scarcity of funds, but because the present Articles of Association did not allow of such an expansion of operations as was desirable.

The resolutions of the former meeting, that the Company should be wound up voluntarily, and that liquidators should be appointed to transfer its business, property, and goodwill to a company registered under the Company's Statute 1864, were confirmed.

It was also resolved that Messrs. Levien, M.L.A., H. Fink, and Captain Rowan should be the liquidators of the Company, the fee of each being fixed at 50 guineas.

The Western and Brazilian Telegraph Company (Limited).

Report of the Directors to be presented at the sixteenth ordinary general meeting of the Company, held at Winchester House, 50, Old Broad-street, on Thursday, the 25th October, at 12 o'clock :—

2. The total earnings amount to £86,874. 7s. 11d., as against £81,419. 13s. 1d., an increase of £5,454. 14s. 10d. compared with the half-year to 30th June, 1887.

3. The working expenses, exclusive of renewals of cable, amount to £32,813. 7s. 10d., as against £33,412. 17s. 11d., a decrease of £599. 10s. 1d.

4. Including the amount brought forward from 1887 (£3,464. 8s. 7d.) the balance to the credit of the revenue account is £57,526 8s. 8l., from which has to be deducted £13,500 for debenture interest, leaving £44,025. 8s. 8d., of which £7,500 has been placed to the renewal fund, and £6,000 to the debenture redemption fund. This leaves £30,525. 8s. 8l. The Directors recommend the payment of a dividend on the Ordinary Shares for the half-year of 2 per cent., or at the rate of 4 per cent. per annum, carrying forward £3,293. 16s. 8d. At the corresponding period last year the dividend was at the rate of 2½ per cent. per annum.

5. In the case of shares which have been divided into Preferred and deferred, the whole of the dividend now recommended will be payable to the Preferred shareholders, who are entitled to the payment in each year of 5 per cent. "in priority to any payments to the holders of Deferred Ordinary Shares." This matter will, of course, adjust itself at the end of the year.

6. The agreement between this Company and the London Platino-Brazilian Telegraph Company, referred to in the last report and since ratified by the shareholders, has been carried out, and up to date 34,770 shares have been transferred by shareholders in exchange for 20,862 shares of this Company, and numerous further exchanges are in progress.

7. In the accounts now submitted no credit has been taken for moneys due on account of the half-year from the Platino Company, that company's accounts having hitherto been made up in November and May, owing to their later arrival in this country.

8. The lines of the Company are in good working order, and reference to the figures will show an increasee in the revenue with a slightly diminished expenditure.

9. The dividend will be paid on the 1st November.

CITY NOTES, &c.

ANGLO-AMERICAN TELEGRAPH COMPANY.—At a meeting of the Board of Directors of this company, held on Friday last, it was resolved to declare an interim dividend for the quarter ended September 30th, 1888, of 7s. 6d. per cent. on the Ordinary stock, and 15s. per cent. on the Preferred stock, less income-tax, payable on the 1st November to the stockholders registered in the books of the company on the 9th October.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended October 12th, 1888, amounted to £5,061.

DIRECT UNITED STATES CABLE COMPANY.—The Board of Directors of this company have resolved upon the payment of an interim dividend of 2s. per share, free of income-tax, being at the rate of 2 per cent. per annum, for the quarter ended September 30th, 1888, such dividend to be payable on and after the 24th inst.

EASTERN TELEGRAPH COMPANY.—This company announces the payment by interest warrants, on the 1st November prox., of interest for the half-year ened October 31st, on their Four per Cent. Mortgage Debenture Stock. The books will be closed from October 27th to November 1st, both days inclusive.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended October 12th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £4,215.

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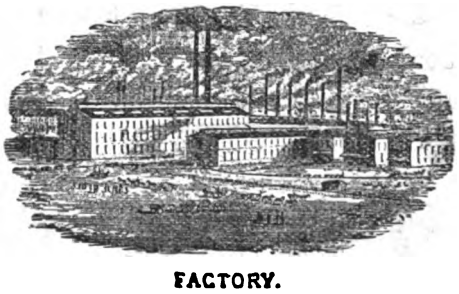
It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.



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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Oct. 17, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Oct. 17, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	47½ 48½	2 16 8	Jan., Apr., July, Oct.	48½	47⅞
2,614,820	Stock	10/0	Do. Preferred	80 81	3 7 11	,, ,,	81½	79½
2,614,820	Stock	nil.	Do. Deferred	16½ 16⅞	...	February	17	16⅞
130,000	£10	3/0	Brazilian Submarine	13⅜ 13⅝	5 1 0	Mar., June, Oct., Dec.	13 9/16	13⅜
16,000	10	9/0	Cuba Submarine	13¼ 14¼	5 19 9	February and August	14	13⅞
6,000	10	10/0	Do. Preference	18 19	5 5 3	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid) xd	3¾ 4¼	3 15 4	March & September	4⅛	...
6,000	5	5/0	Do. Preference xd	9 10	5 0 0	April and October	...	...
60,710	20	2/0	Direct United States	10¼ 10⅜	3 17 6	Jan., Apr., July, Oct.	10 7/16	10
380,000	10	4/6	Eastern xd	12⅜ 12⅝	4 15 1	,, ,,	12⅝	12 7/16
70,000	10	3/0	Do. 6 per Cent. Preference xd	14¾ 15¼	3 19 0	,, ,,	15⅜	14⅞
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	3 18 0	February & August	...	...
250,000	10	2/6	Eastern Extension xd	12⅞ 13⅛	4 19 1	Jan., Apr., July, Oct.	13¼	13
22,050	10	8/3	German Union Telegraph and Trust	9 9½	7 7 4	January and March	...	...
179,177	10	3/0	Globe Telegraph and Trust xd	7⅛ 7⅜	4 15 0	Jan., Apr., July, Oct.	7⅜	7⅛
178,992	10	3/0	Do. 6 per Cent. Preference xd	14½ 14⅝	4 3 6	,, ,,	14½	14¼
150,000	10	5/0	Great Northern	13¾ 14¼	5 5 3	Jan., July, and April	14½	14 1/16
17,000	25	37/6	Indo-European	38 40	6 5 0	April and October	...	...
32,348	10	3/0	London Platino Brazilian	6 6½	...	May and November	...	...
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	...	...
338,225	Stock	13½%	Submarine xd	135 145	10 0 0	February & August	...	...
30,000	10	6/0	West Coast of America	7¾ 8¼	6 1 3	January and July	7⅞	7⅝
150,000	Stock	8%	Do. Debentures	117 121	6 12 3	June and December	...	...
88,321	10	nil.	West India and Panama	1½ 1⅝	...	...	1⅝	1½
34,563	10	*10/0	Do. 1st Preference	12 12½	7 12 0	April and October	12½	...
45,181	15	9/0	Western Brazilian	12¾ 13	...	March & September	12 1/16	12 1/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 6	March & September	...	...
			TELEPHONES.					
224,350	14/0	£5 7s.% '87	Consolidated Telephone and Maintenance	0 1/16 1 1/16	5 10 0	Yearly	...	...
220,000	£1	2½% '87	Oriental (11s. paid)	0 1/16 1/16	3 9 0	...	...	...
80,000	5	10/0	United	13½ 13⅝	5 9 1	June and December	13⅝	13⅜
275,000	5	4/6	United River Plate	5⅜ 5⅝	...	July and January	...	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	4 4½	...	...	4 7/16	3 15/16
23,692	5	nil.	Do. (fully paid)	5 5⅛	...	February & August	5 1/16	4 15/16
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2⅜	...	...	2¼	...
312,000	½	5% '86	Maxim-Weston	1/16 2/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	39 40	6 3 10	March and July	39⅝	39⅜
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 3	February & August	17 1/16	17½

* On account of arrears of dividend.

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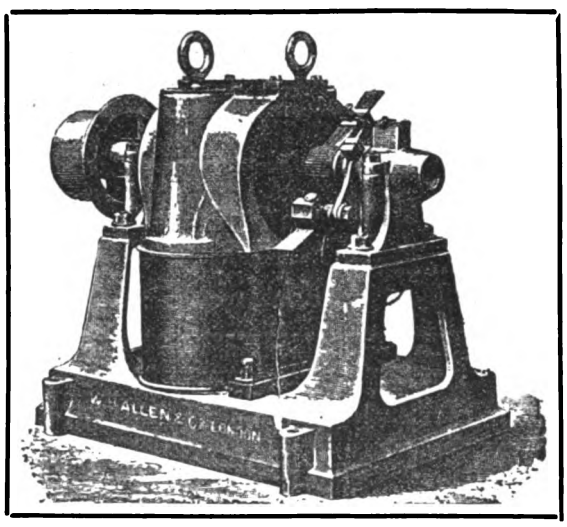

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THE ELECTRICIAN:

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NOTES.

By the courtesy of Dr. Oliver Lodge we are enabled this week to publish an interesting letter from Dr. Hertz on lightning conductors. This will be found in our correspondence columns.

The members of the technical press who were invited to visit the works of the London Electric Supply Corporation at Deptford on Wednesday last came away with a vivid impression, not only of the magnitude of the undertaking, but also of the sheer audacity—there is no other word for it—of the promoters. We need not repeat here the details which we give in a later column, but we venture to assert that in the whole range of engineering enterprise there is nothing which has demanded more skill, ingenuity and daring than the project, now well under weigh, for the lighting of central London from the Deptford station. The remarkable character of the enterprise is not lessened by the fact that the entire credit of the designs, from the beginning to the end, is due to Mr. S. Z. de Ferranti, and to him alone. Later on we shall of course go at full length into a technical description and discussion of the arrangements. At this moment the only approach to criticism which we think it necessary to make is this: that the plan of relying upon a single engine and dynamo—however perfect—is one which must depend for its justification upon the actual success which it achieves in practice.

Our readers will generally be aware that the "London Electric Supply Corporation" is the lineal descendant of the Sir Coutts Lindsay Electric Light Company, of Grosvenor Gallery fame. The following account of the origin of the latter company, with which we have been supplied, will therefore be read with interest:—

"It is now some four years ago that Sir Coutts Lindsay made up his mind to light the Grosvenor Gallery by electricity, and made arrangements to that effect. On mentioning the fact to a neighbour, that gentleman at once said, 'Put down twice the necessary machinery and produce twice the current you require, and let me have what you can spare.' Very soon other neighbours joined in this request, and Sir Coutts Lindsay began a moderate installation; but, long before it could be completed, the demand became larger and larger, and additions were made to the original intention. At length Sir Coutts Lindsay associated a few gentlemen with himself, among them the Earl of Crawford and Lord Wantage, and a small private company was formed with the title of 'Sir Coutts Lindsay and Co. (Limited),' but, owing to its origin, familiarly known as the Grosvenor Gallery Company. However, although thus enlarged to a company, the demand for electric supply increased so steadily and rapidly that the originators of the undertaking soon found that they must enter into a wider field, and the development resulted in the formation of the London Electric Supply Corporation. The corporation, while constructing their great central station at Deptford, have carried on and developed the original undertaking, until at the present time they are supplying from their Grosvenor Station some 33,000 lamps."

The formation of the Electrical and Allied Trades Section of the London Chamber of Commerce is now an accomplished fact, and in another column will be found the names of the thirty-three members of the permanent committee whose election took place on Monday last. We think that it will be generally admitted that the organising committee—whose most important duty was the determination of the number of members to be apportioned to the representation of each class of trade—discharged their labours in a satisfactory manner. It was undoubtedly a wise arrangement to defer the election of the fifteen members which are required to bring up the committee to the full total of forty-eight, until the numerical strength of the section shall have further increased. We also think that the list of names already chosen is such as will command a general feeling of confidence.

Turning to the proceedings of the meeting on Monday last, it must be confessed that the differences of opinion which were disclosed—or, rather, were emphasised, for their existence was already well known—are of a serious character. We have never hesitated in our conviction that any attempt to control prices would be a mistake, and would, moreover, be foredoomed, sooner or later, to failure. No individual manufacturer, whether a member of the Section or not, could be bound by any resolutions of this character, and the attempt would not conduce to that harmony of feeling which it is one of the objects of the movement to promote, and which is so especially desirable in the *quasi*-scientific industries. With regard to the regulation of wages, although our views are less pronounced, yet we are inclined to think that similar considerations may be applied. We are confident that the Section will find abundance of useful and necessary work lying ready to its hand, and we trust that—at any rate, so long as this is the case—no attempt will be made to force on the consideration of questions whose discussion is repugnant to so many of the members, and which can well await further developments.

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THE following is a copy of a circular with which the house holders in the Camden Town district have recently been inundated :—

"THE SUBURBAN ELECTRIC SUPPLY COMPANY.

"Temporary Offices—96, Camden Road, N.W.

"The above Company is prepared to receive applications for Electric Current to be supplied at a Yearly Rental per Lamp, payable quarterly, the first payment being due three months after installation. Three months' notice in writing to be given for a discontinuance of the supply. The current will be available from one hour before sundown to 1 a.m. in the first instance, and on a sufficient number of subscribers being obtained the current will be continuous. No less number than 20 lamps of 10 candle-power will be installed, or one arc lamp of 1,000 candle-power. For further information apply to the manager as above."

The tariff is fixed as follows :—£1 per 10 candle-power lamp, £2 per 20 candle-power lamp, £3 per 32 candle-power lamp; arc lamps, £18 per 1000 candle-power. With this is enclosed a "wiring estimate," which reads as follows :—

"WIRING ESTIMATE.

"To supplying and fixing all the necessary cable, flexible cords, switches, cut-outs, holders, lamps, shades, casing, ceiling-roses. The lights to be so arranged as to meet the requirements of each individual consumer, and in accordance with the Phœnix Fire Office Rules. The whole to be carried out in the most workmanlike manner, including all labour and supervision, for the sum of Twenty-two Shillings and Sixpence per light.

"*Terms:* Cash when the light is turned on."

At first sight it strikes one as rather singular that in a document ostensibly emanating from a public company (although it will be observed that the word "Limited" is not employed) no information is given as to the technical, financial or commercial position of the concern, nor is any signature attached or any other guarantee of genuineness vouchsafed. We have therefore deemed it desirable to institute inquiries into the position and prospects of the "Suburban Electric Supply Company," with a view of discovering the whereabouts of their central station, the system adopted, the extent of their financial resources, and the names of the promoters, directors, engineers, &c.

As a result of these inquiries we are now in a position to publish a complete and exhaustive history of the whole undertaking. At the present moment, however, we confine ourselves to the following remarks :—(1) The Suburban Electric Supply Company is a private venture, and has not, up to the present, been placed upon the Register of Public Companies. (2) Our representative was, unfortunately, unable to find the manager himself, but he is able to state, on the authority of the office boy, that the central station is nearly complete and will be ready to start in November—the boy could not recollect its whereabouts. (3) This state of things reflects the highest possible credit upon the contractors whoever they may be for we have the best possible reasons for asserting that less than one month ago the contract had not been signed, nor had the system of operation been determined on. (4) Notwithstanding the forward state of the preparations, the managerial, clerical and technical staff are at the present moment concentrated in one individual, whose name we need not for the present disclose.

THE long and the short of the business is, we believe, simply this. A gentleman having some spare time on his hands, and taking a benevolent interest in electric lighting, conceives the idea of working up a connection in one of the inner suburbs, with the intention of disposing of the business so formed to any electric lighting contractors or others whom he can interest in it. Very well—we have no legal ground for complaint, only we think it a most unfortunate proceeding in respect of the true interests of electric lighting, and we consider it our duty to state the facts as far as we know them.

ONE of the finest specimens of mill lighting which we have come across has recently been carried out by the Schmidt-Douglas Electric Lighting Co., of Bradford, for Messrs. HOLLINGRAKE and CLEGG, worsted spinners, of Halifax. On the occasion of a recent visit we found 500 incandescent lamps and 60 arcs, all of which are run from a single Schuckert dynamo at 110 volts, with a steadiness which leaves nothing to be desired. The dynamo is driven from the mill engine, which is a magnificent machine, capable of developing over 1,000 horse-power. This mill is almost entirely devoted to the spinning of coloured yarns, and the advantage of the light in enabling colours to be dealt with is fully appreciated in the woollen trade, and we have no doubt that a considerable extension of mill lighting in the West Riding may be confidently looked for in the near future. It is, however, an unfortunate fact that a good deal of bad work has been done in the district, and this has had the inevitable effect of retarding progress. In this very mill the present installation is the third which has been put in.

AT Birmingham this week we witnessed a trial run of an electric tramcar which has been built by Elwell-Parker (Limited) for the Birmingham Central Tramways Company. The car is intended for use as a locomotive, to draw a detached train behind it, and since it has not yet wholly emerged from the experimental stage we do not propose at the present moment to describe the arrangements in detail. We may, however, say that the Tramway Company has been well satisfied with the results hitherto obtained, and that, as regards the design of the motor, gearing and equipment, the details are worked out in a manner well calculated to sustain the reputation of the Wolverhampton firm. Although this car is little more than half the size and weight of the steam locomotives in use at Birmingham, yet the dynamometer tests showed that it was able to exert a tractive force 66 per cent. greater. The Birmingham Central Tramways Company are looking into the question of electric traction with perfectly serious intentions. Their experience of steam locomotives - of which they possess no less than 76 - is not of a wholly favourable character. The wear and tear is something enormous. A tyre of 4 inches in thickness is only good for 27,000 miles—that is, about nine months' use—by which time it has been reduced in thickness to 1½ inch, and this is in addition to an equally excessive wear of the axles. What this means in the way of expense and trouble for continual adjustment in case of so complex a machine some of our readers will be able to appreciate. With electric traction the greater part of this trouble will be

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avoided. The company also find that the public prejudice against the steam cars—"Juggernauts," as they are called in Birmingham—increases rather than diminishes with lapse of time. With regard to cable haulage, which is in use on one part of this company's lines, their experience seems to be only moderately satisfactory. We gather that they do not propose to extend the system beyond the limits at first contracted for, some portion of which has yet to be laid down. Elsewhere we give some detailed figures as to the cost of working per car mile which this company incurs for horse, cable and steam traction respectively. This will be useful for purposes of comparison.

A CORRESPONDENT sends the following, "with best wishes for the learned editor's speedy recovery from temporary insanity, caused by reading 'fairy tales of science'":—

"Etheric force" has found a formidable rival in "carbodium." According to a long extract in the *Globe* from an American source, an inventive mechanic of Cleveland City has been spending a lifetime in solving the profound problem of "generating heat from electricity." The solution of all his difficulties is "carbodium," a composition which "looks like a lump of coke." When connected to two wires this mysterious substance yields a heat, "not dry like a furnace, nor yet damp, but that pleasant warmth felt on a spring day." We much fear, however, all this must be taken *cum grano salis*, for we learn further that this historic interview took place in the inventor's little shop back, "where one feels the very influence of the subtle fluid on the body, and even on the brain," and therefore the narrator can scarcely be held responsible for his actions. The whole conception is too startlingly original, daring and profound for immediate acceptance.

Alpignano.—The central lighting station of Alpignano (Italy) started running on the 23rd September. Cruto lamps are employed.

Personal.—Messrs. Sir W. J. Armstrong, Mitchell and Co., of Elswick, have appointed Mr. A. A. Campbell Swinton their permanent consulting electrical engineer.

Telegraphy and Telephony in Austria-Hungary.—The Hungarian Budget for 1889 contains an item of 60,000fl. to be appropriated to the development of the Telegraph system, and for the construction of a Telephone between Vienna and Pesth.

The Institution of Civil Engineers.—There are now on the books of this society 1,614 members, 2,499 associate members, 458 associates, 19 honorary members, and 939 students, together 5,529, being an increase at the rate of 3¾ per cent. during the past twelve months.

The Electric Light in Mexico.—The last mail from Mexico states that the public electric light service in that capital has been augmented by 300 additional lights, contracted for by the City Council. The city of Tehuacan is shortly to be illuminated with the electric light.

The Electric Light at Suakim.—The Eastern Company's ship "Electra" arrived at Suakim on Tuesday last, and her electrical and engineering staff has been placed at the disposal of the Government for the repairing of the electric light on the Shata Gate, which operation is expected to take about a week.

India Rubber, Gutta Percha and Telegraph Works Company (Limited).—The Portuguese *Diario do Governo* contains a decree from the Minister of Marine conceding to this company a prolongation of the period originally fixed for the laying of the submarine telegraph cable between Loanda on the West Coast of Africa and Cape Town.

Interruption of the Australasian Cables.—The Eastern Extension, Australasia and China Telegraph Company announce that telegraphic communication is again interrupted with Australia and New Zealand, owing, it is believed, to the accidental breakage by the company's repairing ship of the duplicate cable whilst renewing a portion of the original cable off the Lombok Straits. The ship is on the spot, and it is hoped that communication will be restored very shortly.

Leeds.—The Leeds Corporation have recently received a number of applications from electric lighting agents and syndicates with a view to the installation of the electric light in certain districts of the borough, and it is probable that the whole subject will shortly be brought before the Town Council. In the meantime the Electric Lighting Committee has instructed the Borough Surveyor to prepare a scheme for lighting a sectional area of the borough, starting with Briggate, Boar-lane, and Commercial-street, with the view of supplying the light to the public. The work is to proceed without delay.

Fleetwood.—A town's meeting was on Monday night held in the Fielden Public Hall, Fleetwood, to hear the report of the deputation appointed several weeks ago to inquire into the cost and methods of lighting in other towns. One conclusion the committee had arrived at was that in a town like Fleetwood, where the cost of gas is over 4s. per thousand cubic feet, the introduction of the electric light would insure a considerable saving. The meeting resolved—"That the Improvement Commissioners be requested to take into consideration the recommendations made in the report, with a view to the introduction of the electric light or other light into Fleetwood."

Palermo.—The following information relating to the present position of electric lighting at Palermo may prove of interest. The principal streets and squares are lit by 100 Thomson-Houston arc lamps. The Bellini Theatre, the Hotel de Ville, and several other buildings are lit by 16 and 32 candle-power Edison incandescent lamps, run off Zipernowski-Déri transformers. The central station is 3 kilometres outside the town, and the insulated copper conductors are all run overhead. The consumers are charged by meter or by contract. The Aubert meter is used for arc lamps and the Cauderay meter for incandescent lamps. The prices charged are 50c. per arc lamp per hour, and 10c. per incandescent lamp per hour.

New Electrolytic Treatment of Copper Solutions.—It is reported that the mining engineer who is at the head of the Official Department of Mining in Spain has invented a new process connected with that employed at Rio Tinto and similar mines, to obtain the metal from weak solutions of sulphate of copper. The object of the process is to obtain the copper in the pure state as electrolytic copper, instead of in the form of precipitates. Laboratory experiments have been made with solutions brought from the Rio Tinto and the Lagunazo mines. These proved successful, the process being exceedingly simple. It is stated that of the copper contained in the solution 78 per cent. is obtained as pure electrolytic copper, and the remainder only has to be refined. The Lagunazo mines are said to be about to employ the process on a large scale.

Liverpool.—The Watch Committee of the Liverpool City Council, at their last meeting, had a letter before them from the Liverpool Electric Supply Company (Limited), applying for the consent of the Corporation to the company making

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application to the Board of Trade for a provisional order under the Electric Lighting Act, 1888. The committee, after considering the matter, passed a resolution that as the company are only just beginning to work under the Liverpool Electric Lighting License, 1888, which has been granted by the Board of Trade, they be informed that until sufficient time has elapsed to enable the Council to see how they have carried out the provisions of the license, the committee cannot recommend the Council, as the local authority under the Electric Lighting Act, 1888, to consent to the company making an application for a provisional order.

Electrolytic Formation of Aluminium Alloys.—M. Jules Dreyfus has recently devised an apparatus for obtaining aluminium and other metals in the form of alloys. The apparatus consists of a carbon crucible, having a hole at the bottom plugged with carbon. The top of the crucible is closed by the positive electrode, while the bottom is in connection with the negative pole. The process is commenced by placing some copper in the crucible, and passing a current through it. As soon as sufficient copper is deposited to form the negative electrode, aluminium is placed in the crucible. The aluminium dissolves, and is carried to the copper, producing bronze, while the oxygen combines with the carbon. Care must be taken to constantly add copper and aluminium. The carbon crucible consists of thick plates, which can be replaced as they are eaten away.

The Strand District Board of Works.—At a meeting of the Board held on Wednesday, 17th inst., letters were read from the Electric Supply Corporation (Limited) and Messrs. Deacon, Gibson and Co. (the company's solicitors), the former asking for a license to supply the electric light to the district, and the latter urging that the application made by the company be acceded to. The company's letter was accompanied by several memorials, signed by inhabitants of the district, in favour of their application.—Mr. Biggs pointed out that the Board had already passed a resolution in favour of another company, and unless that was rescinded it was impossible to grant the application.—Dr. Sandwell moved that the matter be referred to the Lighting Committee for consideration and report, but, after discussion, the motion was allowed to stand over till the next meeting of the Board, a special meeting to be held during the interim for the purpose of rescinding the previous resolution.

Birmingham.—The annual meeting of the Town Council on the 9th of November will, after the election of the Mayor, be made special to consider the notice given by Messrs. Barlow, Smith and Pinsent, solicitors, on behalf of their clients, Messrs. Arthur Chamberlain and George Hookham, of New Bartholomew-street, Birmingham, electrical engineers, of the intention of the said Arthur Chamberlain and George Hookham to make application to the Board of Trade in pursuance of the Electric Lighting Acts, 1882 and 1888, for a Provisional Order, to be confirmed by Parliament in the next ensuing Session, empowering them to supply electricity for public and private purposes within the area within the jurisdiction of the Council; to determine whether the Council shall consent to or oppose the grant of such Provisional Order; and to authorise the General Purposes Committee to take measures for carrying out the decision of the Council.

Vegetation on Telegraph Wires.—A telegraph wire, says the New York *Electrical Review*, is the last thing one would expect to support vegetation of any kind; yet a traveller in Brazil writes to a German horticultural journal describing a crop of mistletoe which he found clothing the wires not far from Rio Janeiro. At a distance, he says, the wires appeared fringed with what he supposed were the leavings of a recent flood. But a perception of their height soon removed this idea, and upon examination the fringe proved to be composed of thousands of little mistletoes, firmly fixed to the wires from which they depended. Many species of this family flourish in Brazil, and some of them, called "bird-weeds" by the people, thickly infest fruit trees and other cultivated plants and bear large berries, which are greedily devoured by birds. These seeds are deposited on the telegraph wires in the birds' droppings, and quickly take root, and although the plants perish, naturally, before very long, they are succeeded by others, and the curious mistletoe fringe is perpetuated.

Light Batteries for Ballooning.—In the experiments made by Commander Renard and Captain Krebs to propel and steer balloons, the source of energy was a single-fluid battery excited by a liquid composed of chromic acid dissolved in dilute hydrochloric acid. The negative element was platinised silver foil; this foil was shaped into a tube, in the centre of which was placed a pencil of amalgamated zinc. On account of this disposition the current density on the surface of the zinc was 25 to 40 amperes per square decimetre. The elements and liquid were contained in tubes of ebonite or glass, the height being ten times the diameter. A battery of 16 cells, 40 millimetres in diameter, and each composed of six tubes joined in parallel, gave a current of 120 amperes, with a useful potential of 1·2 volt, and fed twenty Gérard 45-watt glow lamps. A battery of 36 tubes, 30 millimetres in diameter, was joined in series, and maintained a Gramme arc lamp of 30 carcels for over two hours. The total weight of the battery was 15 kilogrammes, and the energy expended 200 to 250 watts.

Baudot's Isochronous Regulator.—M. Baudot has devised a new isochronous regulator for his multiple printing telegraph apparatus. The regulator consists of a movable mass of metal, capable of moving between two guide rods fixed transversely to the end of the motor shaft. Two powerful springs, which are also fixed to the motor shaft, pull this mass of metal towards the centre of rotation. When the motor is in motion the strength of the springs is so arranged that if the speed exceeds a certain amount the centrifugal pull of the mass of metal stretches the springs and pulls the shaft against the bearings, and by increasing the friction reduces the speed to its normal value. This arrangement merely constitutes a speed regulator; but it is converted by M. Baudot into an isochronous regulator by establishing a suitable relation between the centre of rotation, the centre of gravity, and the points to which the springs are fixed. The apparatus was specially constructed to maintain the uniformity of speed of the distributor employed in M. Baudot's printing telegraph under variable conditions of power and work. The additional work introduced by friction varies from 5 to 90 gramme-metres. The variations of speed arising from changes of temperature are negligible, amounting as they do to only one-tenth per cent.

Bath.—It will be remembered that some months ago the Bath Town Council passed a resolution accepting the tender of Mr. H. G. Massingham to light 50 of the principal streets of the city by electricity, on the Thomson-Houston system, at £19. 17s. 6d. per lamp per year. A committee was chosen to make arrangements for the introduction of the light, and this committee has drawn up a report which will be presented to a meeting of the urban sanitary authority, to be held on Tuesday next. This report states that the tender of Mr. Massingham stipulated that the Corporation should provide and fix the columns which are necessary; 243 of these will be needed, and the cost of providing and fixing them will be £2,500. The committee recommend that the terms of the proposed contract

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should be altered, and that £21. 17s. 6d. per lamp per annum be paid to Mr. Massingham upon his furnishing the columns, which will become his property on the expiration of the term of the contract. They also recommend that if a limited liability company, with a capital of £10,000 be formed, the contractor shall have power to assign the contract to them, and that then his and his sureties' liability shall cease. The committee state that Mr. Massingham will be prepared to supply occupiers within the area to be lighted at the rate of £2 per annum for each lamp of 10 candle-power, provided the consumer have his house properly wired and fitted with suitable lamps; or by meter at the rate of 1s. per Board of Trade unit.

The Lighting of the City.—At the meeting of the Court of Common Council, on Thursday in last week, Mr. Pannell (chairman of the Commission of Sewers), in answer to Mr. Stewart, said there were before the Commission six or seven applications from electric lighting companies who were desirous of lighting a portion or the entire area of the City. These applications had been referred to the Streets Committee, and the solicitor and engineer had been instructed, in conference with Mr. Preece, to prepare for the purposes of the committee a scheme on which could be based a form to be advertised, so that they might receive tenders not only from these companies, but from any other corporation that might desire to tender for any area of the City.—At a meeting of the Aldgate Ward Ratepayers' Association, Mr. Marriage said it was quite time that more light was provided for the City. They had recently had an example of the dangerous condition of the streets, owing to the bad lighting. At the present time the streets gave opportunities for all sorts of crimes to be perpetrated. The Chairman said the little town of Barnet put the City of London to the blush by the action it had taken with regard to electric lighting. That it should not be used by the Corporation was to him a marvel, because it must be cheaper than gas. After some further discussion on the subject, the secretary was instructed to communicate with the Streets Committee of the Commissioners of Sewers, calling their attention to the defective lighting of the district.

Filtration of Mercury.—Mercury often becomes contaminated with alloys or other impurities which can be removed by simple filtration. This may be done in glass funnels, the stems of which are drawn out to a fine capillary tube. But this often becomes clogged after a short time, and then ceases to act; besides, it acts very slowly. Prof. C. H. Bohn, of Aschaffenburg, in the *Zeitschrift für Instrumentenkunde*, recommends a method which has long been practised in Bunsen's laboratory. A filter is made of writing paper, and numerous fine holes pricked in it. Instead of making these round with a needle, it is better to use the point of a penknife, which produces narrow triangular holes. The holes should be pricked both vertically in the direction of the radius of the filter, and horizontally, at right angles with the former; some of the holes should be pricked from the outside inwards, and the others in the opposite direction. Even with this arrangement, the filtration sometimes proceeds only very slowly, but it may be accelerated by using a filter-pump. A still better way to purify mercury by filtration, according to the same author, is the following:—Select a glass tube, of about the thickness of a lead-pencil, and about a yard long. Expand one end to the shape of a funnel, and the other to a tulip-shaped bulb, or expand this end in a wave-like form, such as is customary when rubber tubing is to be stretched and tied over the end of a tube. A piece of linen or chamois is firmly tied over the latter end, and the tube then suspended. On pouring the mercury into the funnel, it will be pressed through the pores of the filtering medium with a pressure considerably exceeding that of the atmosphere.

The Wirt Rheostat.—The construction of the Wirt Rheostat is as follows:—The wire, which is covered, is first wound as closely as possible upon a paper tube, which is kept in shape on a mandrel during winding. When the tube is sufficiently covered, the whole wire and tube are well varnished. While the tube and varnish are still soft, the former is pressed flat in a heavy press. The flattened paper covered with wire is then wound round the metal cylinder which forms the body of the instrument, and is attached to it firmly by string, the whole being varnished. The cylinder is then put in a lathe, and the covering of the wires carefully bared at a suitable point for the contact of the brush, which consists of parallel hard copper wires pressed against the cylinder by their natural spring, the two ends of the brush being supported by upright pieces, one of which is connected to one terminal of the instrument. The metal cylinder is attached to one end of the convolutions of wire by solder, and is also connected to the other terminal of the instrument. The convolutions of the wire being vertical, and the brush horizontal, it follows that by the rotation of the cylinder by the handle at the top successive convolutions are cut out of circuit, and so the resistance is altered. The smallest difference of resistance, therefore, that can be made is that of a length of wire equal to the circumference of the paper tube. By means of a pointer attached to the handle, the actual resistance corresponding to any degree of rotation can be tested and marked upon a scale of a dial over which the pointer moves. The compactness of the instrument is much in its favour. The size of instrument principally in use is on a base 5¾in. square, the cylinder being 3⅓in. diameter and 3⅛in. high. The wire can be wound in this size to any resistance between 1,200 and 45 ohms.

Transmission of Power between Thorenberg and Lucerne.—The following data have reference to the transmission of power from hydraulic works at Thorenberg to a flour-mill in Lucerne. Dynamos of Brown's design are employed, the generator and motor being of the same type, but differently wound. The plant has to transmit 120 horse-power, with 1,000 volts, at a speed of 450 revolutions, and 80 amperes. The line, which is partly above and partly underground, has a total resistance of about two ohms. The above-ground portion is 3,040 metres long, and 63 square millimetres in section, and is suspended on porcelain double-bell insulators. In order to prevent the two machines from being injured by short-circuiting caused by any accidental contact of the two line wires, a special electro-magnetic accessory is joined up in the general circuit, so that immediately the current strength becomes abnormal the field-magnets of the dynamos are automatically shunted. This automatic circuit-closer consists of a straight electro-magnet, having each end of its core fixed in a mass of iron. Beneath these prolongations of the core is an armature which works on a hinge, and, in its position of rest, holds up the weighted extremity of an upright lever, the lower end of which turns on an axle held in a frame. At the lowest part of the base-board are two metal springs; as soon as the current attains a strength of about 20 per cent. more than the maximum, the armature of the circuit-closer is drawn upwards and releases the lever, which falls between the contact springs, and thereby short-circuits the field-magnets of the dynamo. A hand cut-out of special form is also used in this installation, so that, in case of necessity, the circuit of a machine in action can be opened without endangering the insulation. This cut-out is composed of a base on which are mounted a carbon rod, held at its lower end between two flat

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metallic springs that are fixed on an insulating handle, the latter being attached to a bar which can be slid up and down. In order to avoid an abrupt severance of the circuit, the handle is moved slowly downwards; directly the springs and carbon are separated, the space between them is bridged by an arc, which, with careful manipulation, can be made to attain a length of 50 centimetres before the circuit is finally broken.

Electric Lighting in Dublin.—A special meeting of the Municipal Council was held on Monday last in the City Hall, to consider, and, if deemed expedient, to adopt a resolution authorising an application by the Corporation, as Local Authority for the City of Dublin, to the Board of Trade, for a provisional order to authorise the Corporation, as such authority, to supply electricity for any public or private purposes within the area of the City of Dublin. Mr. J. L. Robinson, in moving that the Town Clerk be instructed to issue the necessary advertisements and take all proper steps to obtain a provisional order giving the Corporation power to use electricity for public and private lighting, said this question was before the Council for a considerable time, and although nothing very practicable was done so far, it did not result from any neglect on the part of the special committee to whom the matter had been referred, but from the unreasonable opposition of the Gas Company. The Corporation wished to treat the Gas Company with every consideration, but owing to the factious opposition it was time for the Corporation to see that the Gas Company had not the monopoly of electric lighting as well as the gas lighting. The Gas Company had served notice that they were going in for a provisional order in December next to enable them to use electricity for public as well as private purposes. The Corporation ought to make a determined stand in this matter, and they should remember that they had to look after the interests of the citizens. The committee were also advised that the best and most prominent electric lighting companies would be more likely to tender for the lighting of thoroughfares, and at a cheaper rate, if allowed the option of private lighting; and under those circumstances they recommended that application be made to the Board of Trade for a provisional order to enable the Corporation to supply electricity for private as well as for public purposes. The committee were also of opinion that any further steps which should be taken in the matter should be entrusted to a special committee. Mr. Healy seconded the motion. Mr. Doran was opposed to the additional expenditure that would be involved by using electricity. It was proposed to replace 318 gas lamps by 45 electric lamps, which he believed would not be at all adequate, although the change would cost the citizens £1,500 a year more. Alderman Winstanley thought it should be shown that a profit would be made by the Corporation entering on this enterprise. Mr. Mayne, M.P., denied that the Dublin Electric Light Company was a failure. The motion was put and adopted. Mr. Robinson then moved the appointment of a select committee of fifteen members to take all necessary steps to carry out the object of the resolution. Alderman Byrne seconded the motion. Mr. Doherty moved as an amendment that the appointment of the committee be postponed until the report of the committee of the whole house on the subject of electric lighting be discussed. Mr. Dennehy seconded the amendment, which was lost on a division, 12 voting for and 25 against. The original motion was then adopted.

Tempering Springs by Electricity.—Mr. Frederick Sedgwick, of Chicago, has invented a process of tempering spring wire and ribbon by the introduction of a current of electricity as an agency for raising the temperature of the metal to the required heat. While Mr. Sedgwick's work has thus far been more especially confined to the tempering of watch main springs, he has carried out the plan of putting the finest kind of fire temper into round wire, which can be used to great advantage in numerous articles of which more will be said hereafter. The process by which the inventor tempers steel for watch springs is said to be very simple and inexpensive. He tempers the steel in continuous lengths of any number of feet or yards, instead of cutting it up into the proper length for one watch spring, and treating each separately. The greatest difficulty met with in tempering a fine piece of steel, such as that for a watch spring, by any other process, is the oxidation of the surface of the metal by contact of the heated surface with the air, and also the buckling or twisting of the ribbon on being plunged into the oil-bath. Both of these troublesome points are stated to be effectually eliminated by Mr. Sedgwick's process. In the old method the surface has to be rubbed, dressed down, and polished, piece by piece, with emery, until a smooth surface and uniform gauge are obtained; and where the strip of metal is twisted it has to be straightened out by hand before the temper can be drawn. In the new method the soft steel is wound, like a long, narrow ribbon, on a large spool as it comes from the splitting rolls. The ribbon then passes through a set of very fine but powerful rolls, which give it a perfectly even gauge of the desired thickness of the finished spring. The soft steel is again spooled, and is ready for the hardening process. From the spool the ribbon passes a point of contact of an electric current from a dynamo, the ribbon itself there forming a circuit by extending to a second point of contact. Midway between the two points, and at the place where the ribbon has received the greatest heat (it being raised to a bright red), it passes into and through an oil bath. The second point of contact is in the further end of the bath, so that a greater portion of the current is taken up in the oil. There is a simple device in the bath for preventing the metal from twisting and kinking, and which also effectually eliminates all oil bubbles which would otherwise form on the surface of the steel, and thus make it rough. The ribbon passes through the apparatus continuously at the rate of several yards a minute, and when it emerges from the oil bath it possesses a perfectly uniform temper of great hardness. The fine polished surface given to the ribbon by the finishing rolls is not in the least destroyed, and all that is required is to remove the burned oil by the buffing machine, and smooth the edges by an automatic grinder. The temper is then drawn to the required degree and colour by a current of electricity, and at this point the temper is automatically gauged. It is then ready to be cut into suitable lengths, and coiled ready for market. For coil springs such as are used in the magazines of repeating firearms, and light coils of almost any other kind where a reliable spring must be had, the Bessemer electric-tempered wire can be advantageously employed, as it can be hot set. Mr. Sedgwick has a device for giving the wire its proper temper while in the coil. A spring thus made is said to have a much longer life than any other spring coiled in a cold state. Very superior crinoline wire and piano strings can also be thus made. By a slight change in the application of the principles Mr. Sedgwick has successfully case-hardened common soft iron wire. Experiments showed that with Nos. 8 and 9 wire the case-hardening extended through one-third the thickness of the wire. But the remarkable feature of this was that, while the surface becomes so hard that it can scarcely be touched with a file, the wire itself retains its pliability to a wonderful degree. This wire would enter very successfully into the manufacture of wire cable and rope of all kinds.

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NOTES ON ELECTRO-MAGNETIC INDUCTION.*

BY DR. J. A. FLEMING, M.A.

Researches of Prof. Joseph Henry.—An early worker in the field of electro-magnetic discovery opened up by Faraday was Prof. Henry, of Princetown, New Jersey, and his work was fruitful in many new and important investigations. An account of his experiments is to be found in the *Philosophical Magazine*, Vol. XVI., 3rd Ser., 1840. (See also *Transactions* of the *American Philosophical Society*, 1838, Vol. VI.) As this memoir sets before the reader in a very clear manner the chief phenomena of mutual induction, I propose in this Paper to reproduce the main portions of it.

The principal articles of apparatus used in the experiments consisted of a number of flat coils of copper riband, which were designated by the names *Coil No. 1*, *Coil No. 2*, &c., also several long bobbins of wire, and these, to distinguish them from the ribands, were called *Helix No. 1*, *Helix No. 2*, &c.

Coil No. 1 was formed of thirteen pounds of copper plate one inch and a-half wide and ninety-three feet long; it was well covered with two coatings of silk, and was generally used in the form represented in Fig. 1, which is that of a flat spiral sixteen inches in diameter. It was, however, sometimes formed into a ring of larger diameter, as is shown in Fig. 2.

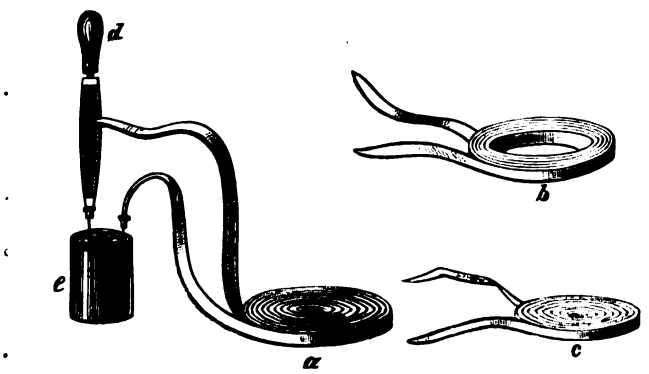

Fig. 1.

Coil No. 2 was also formed of copper plate of the same width and thickness as coil No. 1. It was, however, only sixty feet long. Its form is shown at *b* in Fig. 1. The opening at the centre was sufficient to admit helix No. 1. Coils No. 3, 4, 5, 6, were all about sixty feet long, and of copper plate of the same thickness, but of half the width of coil No. 1.

Helix No. 1 consisted of sixteen hundred and sixty yards of copper wire $\frac{1}{40}$th of an inch in diameter; No. 2 of nine hundred and ninety yards, and No. 3 of three hundred and fifty yards of the same wire. These helices were wound on bobbins of such size as to fit into each other, thus forming one long helix of three thousand yards, or, by using them separately and in different combinations, seven helices of different lengths. The wire was covered with cotton thread saturated with bees' wax, and between each stratum of spires a coating of silk was interposed.

Helix No. 4, shown at *a*, Fig. 2, was formed of five hundred and forty-six yards of wire $\frac{1}{40}$th of an inch in diameter, the several spires of which were insulated by a coating of cement.

Helix No. 5 consisted of fifteen hundred yards of silvered copper wire, $\frac{1}{125}$th of an inch in diameter, covered with cotton, and is of the form of No. 4.

In addition, a long spool of copper wire covered with cotton, $\frac{1}{16}$th of an inch in diameter and five miles long, was provided. It was wound on a small axis of iron, and formed a solid cylinder of wire eighteen inches long and thirteen in diameter.

For determining the direction of the induced currents a magnetising spiral was used, which consisted of about thirty spires of copper wire in the form of a cylinder, and so small as just to admit a sewing needle into the axis.

Also a small horseshoe is frequently referred to, which was formed of a piece of soft iron about three inches long and $\frac{2}{3}$ths of an inch thick; each leg was surrounded with about five feet of copper bell wire. This length was so small that only a current of considerable quantity could develop the magnetism of the iron. This instrument was used for indicating the existence of such a current. The battery which was used was a simple copper-zinc cylinder battery, having about $1\frac{3}{4}$ square feet of zinc surface. In some experiments a series of cells was used, but most experiments were performed with one or two cells of the above kind. The manner of interrupting the circuit of the conductor was by scraping one end of the conductor along a rasp, held in contact with the battery terminal.

Provided with this apparatus, a preliminary series of experiments was made on the self-induction of these various coils. The mode of operating was to close the battery circuit by dipping the ends of a coil or helix into two mercury cups, and then to break the circuit by lifting out one end from its mercury cup, the hands being at the same time in contact with the battery terminal and the end of the conductor which is being raised. In this way the *extra current* or electro-magnetic discharge of the coil passed through the operator's body.

When the electromotive force was small, as in the case of a thermopile or a large single cell, and the circuit is the flat riband coil No. 1, ninety-three feet long, it was found to give brilliant

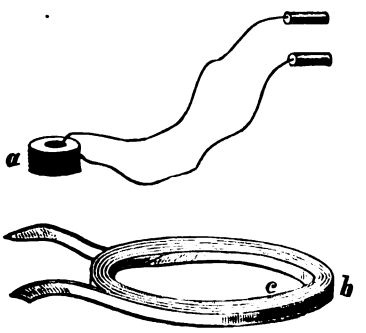

Fig. 2.

snaps at the surface of the mercury when contact was broken, but the shocks were very feeble, and could only be felt in the fingers or through the tongue. The induced current in a short coil, which thus produces deflagration, but not shocks, may, for distinction, be called one of quantity.

When the length of the coil was increased, the battery being the same, the deflagrating power decreased, while the intensity of the shock continually increased. With five riband coils making an aggregate length of three hundred feet and a small battery, the deflagration was less than with coil No. 1, but the shocks are more intense.

There appears to be, however, a limit to this increase of intensity of the shock, and this takes place when the increased resistance or diminished conduction of the lengthened coil begins to counteract the influence of the increasing length of the current. The following experiment illustrates this fact.

A coil of copper wire $\frac{1}{16}$th of an inch in diameter was increased in length by successive additions of about thirty-two feet at a time. After the first two lengths, or sixty-four feet, the brilliancy of the spark began to decline, but the shocks continually increased in intensity until a length of five hundred and seventy feet was obtained, when the shocks also began to decline. This was, then, the proper length to produce the maximum effect with a single battery and a wire of the above diameter. With a battery of sixty cells (Cruickshank's trough), having plates four inches square, scarcely any shock could be obtained when the coil formed a part of the circuit. If the length of the coil was increased, then the inductive effect became very apparent.

When the current from ten cells of the above-mentioned trough was passed through the large spool of copper wire the induced shock was too severe to be taken through the body. Again, when a small battery of twenty-five cells having plates

* These Papers may be regarded as a continuation of Prof. Fleming's articles which appeared under the title of "Notes on Alternate Currents" (see *The Electrician*, Vols. XIX. and XX.).—Ed. *E.*

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one inch square, which alone would give but a very feeble shock, was used with helix No. 1, an intense shock was received from the induction when the contact was broken. Also a slight shock in this arrangement was given when the contact is formed, but it was very feeble in comparison with the other. The spark, however, with the long wire and compound battery was not as brilliant as with the single battery and short riband coil.

When the shock is produced from a long wire as in the last experiments, the size of the plates of the battery may be very much reduced without a corresponding reduction in the intensity of the shock. A small battery was made, formed of six pieces of copper bell wire, about one inch and a-half long, and an equal number of pieces of zinc of the same size. When the current from this was passed through the five miles of wire of the spool the induced shock was given at once to twenty-six persons joining hands.

With the same spool, and the single battery used in the former experiments, no shock, or at most a very feeble one, could be obtained.

The induced current in these last experiments may be considered as one of *considerable intensity* and *small quantity*.

The energetic action of the flat riband coil in producing self-induction led Prof. Henry to conclude that it would also be the most proper means for the exhibition and study of the phenomena of mutual induction.

Mutual Induction.—Coil No. 1 (*see* Fig. 3) was arranged to receive the current from a small battery of a single cell, and coil No. 2 was placed over it with a plate of glass between to secure perfect insulation. As often as the circuit of No. 1 was interrupted a powerful secondary current was induced in No. 2. When the ends of the secondary were joined to a

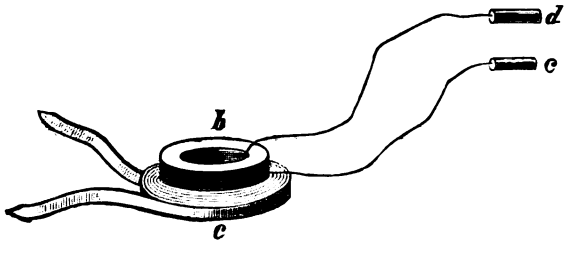

FIG. 3.

magnetising spiral the enclosed needle became strongly magnetic. Also when the ends of the second coil were attached to a small water decomposing apparatus, a stream of gas was given off at each pole, and when the secondary current was passed through the wires of the iron horse-shoe magnetism was developed. The shock, however, from the secondary coil was very feeble, and scarcely felt above the fingers. This secondary current had, therefore, the properties of one of moderate intensity but considerable quantity when developed by the current in one flat riband coil acting on another flat riband coil.

Coil No. 1 remaining as before, a longer coil, formed by uniting Nos. 3, 4, and 5, was substituted for No. 2. With this arrangement as a secondary circuit, the magnetising power of the current and the brilliancy of the spark at breaking contact was less than before, but the shocks were more powerful—in other words, the intensity of the induced current was increased, whilst its quantity was decreased.

A compound helix formed by uniting Nos. 1 and 2 helices, and therefore containing two thousand six hundred and fifty yards of wire, was next placed on coil No. 1. The weight of this helix happened to be precisely the same as that of coil No. 2, and hence the different effects of the same quantity of metal (as secondary circuit) in the two forms of a long and short conductor could be compared. With this arrangement the magnetising effects with the apparatus above-mentioned disappeared. The sparks were much smaller and the decomposition less than with the short coil, but the shock was almost too intense to be received with impunity except through the fingers of one hand. The secondary current in this case was one of small quantity but of great intensity.

The following experiment is important in establishing the fact of a limit to the increase of the intensity of the shock as well as the power of decomposition with a wire of given diameter.

Helix No. 5, consisting of a wire $\frac{1}{125}$th of an inch in diameter, was placed on coil No. 2, and its length increased to about seven hundred yards. With this extent of wire neither decomposition nor magnetism could be obtained, but shocks were given of a peculiarly pungent nature. The wire of the helix was further increased to about fifteen hundred yards; the shock was now found to be scarcely perceptible in the fingers.

As a counterpart to the last experiment coil No. 1 was formed into a ring of sufficient internal diameter to admit the great spool of wire, and with the whole length of this (five miles) the shock was found so intense as to be felt at the shoulder when passed only through the forefinger and thumb. Sparks and decomposition were also produced, and needles rendered magnetic. The wire of this spool was $\frac{1}{16}$th of an inch in diameter; and we therefore see from this experiment that by increasing the diameter of the wire its length may be also increased with increased effect.

The previous experiments were repeated, using a battery of sixty cells (Cruickshank's trough). When the current from this was passed through the riband coil No. 1, no indication, or a very feeble one, was given of a secondary current in any of the coils or helices arranged as in the preceding experiments. But when the long helix No. 1 was placed as a primary, instead of coil No. 1, a powerful inductive action was produced on each of the circuits used as before.

First, helices Nos. 2 and 3 were united into one coil and placed within helix No. 1, which still conducted the battery current. With this disposition a secondary current was produced, which gave intense shocks but feeble decomposition, and no magnetism in the soft iron horse-shoe. It was therefore one of intensity, and was produced by a battery current also of intensity. Instead of the helix used in the last experiment for receiving the induction (secondary) one of the coils, No. 3 (copper riband), was now placed on helix No. 1, the battery remaining as before. With this arrangement the induced current gave no shocks, but it magnetised the small horse-shoe, and when the ends of the coil were rubbed together produced bright sparks. It had, therefore, the properties of a current of quantity, and it was produced by the induction of a current from a battery of intensity.*

This experiment was considered of so much importance that it was varied and repeated many times, but always with the same result; and it therefore established the fact *that an intensity current can induce one of quantity*, and by the preceding experiments the converse has also been shown, *that a quantity current can induce one of intensity*.

(To be continued.)

THE CENTRAL LIGHTING STATION OF THE LONDON ELECTRIC SUPPLY CORPORATION AT DEPTFORD.

The Central Electric Lighting Station at Deptford will very shortly assume a position of absorbing interest in scientific and in engineering circles throughout the civilised world. This enterprise has been conceived, and is now in process of execution, on a scale of such colossal magnitude that our friends over the water will once for all—in their own expressive phraseology—have to take a back seat. In central station electric lighting the banks of the Thames will shortly have a display which, in the mere matter of bigness, will simply "whip creation." We have so often had to suffer under Yankee boasts of this order that we are now disposed to make the most of our opportunity for revenge, and we felicitate ourselves and

* This last experiment is very interesting, as showing that in 1838 Prof. Henry had already realised that which is sometimes called the reverse use of the induction coil. He had employed a current flowing in a fine wire of many turns and moving under a high electromotive force, to induce a current of greater strength in a secondary circuit, consisting of a lesser number of turns of copper riband, and moving under a less electromotive force. In other words, he had constructed *a step-down transformer*.

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all English electrical engineers accordingly. Regarded merely as an engineering enterprise, a building which is designed ultimately to contain engines and boilers for the production of 140,000 horse-power will become an object of the first importance. When it is added to this that the engines are to drive dynamo machines with armatures of 42ft. in diameter, giving an E.M.F. of 10,000 volts, it will be seen that the electrical and mechanical problems which have had to be solved are upon a scale of magnitude which fully justifies the employment of superlatives. Our sense of the skill and daring with which these problems have been attacked is in no way lessened by the knowledge of the fact that the whole of the arrangements, architectural, mechanical, and electrical, have been designed by Mr. S. Z. de Ferranti, the engineer to the corporation, and are being carried out under his sole superintendence.

The works were commenced in April last, and since then, by the aid of the arc light, they have been pushed forward night and day without intermission. The present stage of their progress is not, however, sufficiently advanced to justify such full and exhaustive details of the arrangements as we hope in due time to supply; in fact, the roofing is not yet commenced, though, on the other hand, some of the Babcock and Wilcox boilers are already *in situ*.

It will therefore be understood that the details which we are now to give are merely of a preliminary character, and are chiefly designed to convey a general idea of the size and character of the undertaking.

The works are situated on the riverside at Deptford, and cover an area of nearly four acres. With the exception of a wharf for unloading coal—for which service it is anticipated that a special line of steamers will be employed—the whole of this space will be covered by the engine and boiler houses. The general plan of the arrangement is as follows:—A central avenue runs from the river right through the middle of the ground up to the external gateway. A second line at right angles to this is then selected, along which a massive partition wall is built, the only opening in it being a lofty arch for the central avenue. On the river side of this the boiler houses are placed, consisting of a basement, taking the flues for the smoke and compressed air, two railways for removing the ashes, and necessary space for the forced draught apparatus. Next comes the ground floor of the boilers and firing platform, above this is a concrete ceiling, which carries a repetition of the basement, with flues, &c. Above this is another floor of boilers, and again under the roof is a sloping floor for storing some 40,000 tons of coal. The tramways for taking the coal from the ships will run at this elevation, and will discharge their coal directly into the store over several lines. The gases before passing to the chimneys go through feed water economisers. There are two chimneys, one on each side of the ground; each chimney is 26ft. on one face and 18ft. on the other, and is divided into four flues. These two chimneys are capable of taking the smoke from boilers which will indicate 40,000 horse-power. The whole of this plant will eventually be repeated three times over when the station attains its maximum capacity.

On the other side of the central partition wall comes the first engine-house, which is 66ft. wide, then a row of columns some 80ft. high, and on the other side of these columns is placed the second engine-house, which again is 66ft. wide, and is finished with another row of columns similar to the first. The floor of these engine-houses is formed of wrought-iron girders and concrete, the foundations for the machinery going through the basement, which is 12ft. deep, on to the gravel. This basement is, therefore, convenient for getting at the foundation bolts and also for placing the steam and water-pipes in.

The first engine-room, on the left-hand side of the central avenue, will contain two Corliss engines and two Ferranti high-tension dynamos of 1,500 horse-power each. These machines will be the first to be started, but will eventually be used only for the day circuits. They will be driven by rope gearing of 40 turns. The armatures are 12ft. 6in. in diameter.

The first engine-house, on the right-hand side of the central avenue, will be entirely devoted to the condensing gear, which will be sufficient for the whole station when completed. The second engine-house is being arranged to take four direct-driven Ferranti dynamos of 10,000 E.H.P. each. To give some idea of the size of these machines it may be here stated that the shafts are 36in. diameter in the centre. The armature measures about 45ft. over all, and the weight of the whole machine, exclusive of the engine, is some 500 tons. They will run at 60 revolutions, with an E.M.F. of 10,000 volts.

The E.M.F. of 10,000 volts may cause some surprise to the electrical world, but the electricians of the corporation, after a number of careful experiments, have arrived at the conclusion that 10,000 volts is no more difficult to manage than 2,400 (the figure at present employed at the Grosvenor Gallery) if suitable precautions are taken.

The first two Ferranti dynamos, of 1,500 horse-power each, are nearly completed, and will shortly be erected. The two dynamos of 10,000 horse-power will probably be completed in about five months.

There are many special features in these machines which will be described later. We may, however, mention here that the insulation of the armature coils is effected by means of sulphur, which yields excellent results mechanically as well as electrically. The machines are being built by Messrs. Hick, Hargreaves, and Co., of Bolton.

Amongst the precautions which are taken in dealing with the high voltage we may refer to the fact that the brushes are completely enclosed in an iron box which is *magnetically locked* by the current of the exciting circuit.

Next to the machinery itself the greatest interest attaches to the method of distribution. This is briefly as follows:—The potential of 10,000 volts will undergo two transformations before the consumers' lamps are reached. A considerable number of secondary transforming stations will be established in different parts of London, whose function will be to reduce the potential from 10,000 to 2,400 volts, and distribution will be effected from these sub-stations on exactly the same lines as are now in use at the Grosvenor Gallery. The current in the consumers' lamps will therefore be of the tertiary order. One of the most far-seeing and admirable arrangements which the company has made is the manner in which they have practically solved the problem of conducting the high-potential mains to their destination.

Agreements have been made with the Chatham and Dover, Brighton and South Coast, and South-Eastern Railways for the use of their lines as main arteries.

From Deptford the primary conductor will be carried along these lines to the London Bridge, Cannon-street, Ludgate Hill, Charing Cross, and Victoria Railway Stations, and it will also enter at several of these points upon the Metropolitan and District lines of railway. From these points of vantage no difficulty will be experienced in reaching the secondary transforming stations in any part of central London. It is, moreover, intended that the network of secondary wires from which the consumers' transformers will obtain current shall always be supplied from at least two separate and independent sub-stations. The primary conductors will consist of two concentric copper tubes, and the method of insulation between these tubes is the subject of one of the most important patents of Mr. Ferranti. The cable will be $2\frac{3}{8}$in. external diameter, the outer tubular conductor being $\frac{3}{16}$in. and the inner $\frac{3}{32}$in. in thickness, leaving a space of $\frac{3}{16}$in. in the centre. It will be uninsulated upon its exterior; in fact, this return conductor will be placed to earth. The current density will be extremely low, not exceeding 170 amperes per square inch, and at 130 alternations per second it will be found that the thickness of the conductor is within the theoretical limit recently indicated by Sir William Thomson.

The Heisler Electric Light Company.—The *St. Louis Globe Democrat* says that the Heisler Electric Light Company has secured patents in Belgium, England, and Italy for its system of lighting, and is expecting the same favour to be accorded it in Germany and Austria at an early date, when it will begin at once to work the foreign field. It has been carrying on an active correspondence for several months with a view of arranging its plans abroad

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HERTZ'S RESEARCHES ON ELECTRICAL OSCILLATIONS.

BY G. W. DE TUNZELMANN, B.SC.

(*Continued from page 758.*)

It was shown in the experiments described in my last Paper that when variable electrical forces act in the interior of dielectrics of specific inductive capacity not equal to unity, the corresponding electric displacements produce electro-dynamic effects. In a paper "On the Velocity of Propagation of Electro-Dynamic Actions," in Wiedemann's *Annalen*, Vol. XXXIV., p. 551, Dr. Hertz shows that similar actions take place in the air, which proves, as was previously pointed out, that electro-dynamic action must be propagated with a finite velocity.

The method of investigation was to excite electrical oscillations in a rectilinear conductor in the same manner as in former experiments, and then to produce effects in a secondary conductor by exciting electrical oscillations in it by means of those in the rectilinear conductor, and at the same time by the primary conductor acting through the intervening space. This distance was gradually increased, when it was found that the phase of the vibrations at a distance from the primary lagged behind those in its immediate neighbourhood, showing that the action is propagated with a finite velocity, which was found to be greater than the velocity of propagation of electrical waves in wires in the ratio of about 45 to 28, so that the former is of the same order as the velocity of light. Dr. Hertz was unable to obtain any evidence with respect to the velocity of propagation of electrostatic actions.

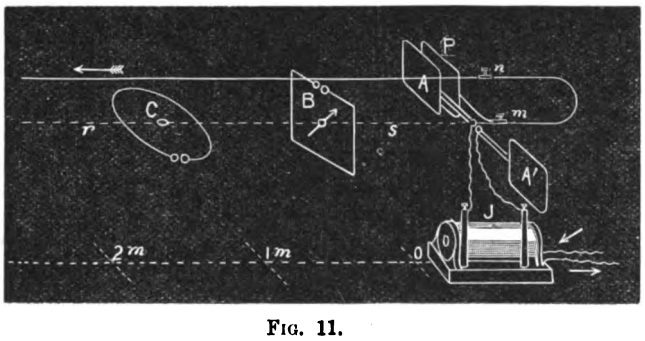

FIG. 11.

The primary conductor A A′ (Fig. 11) consisted of a pair of square brass plates with sides 40 centimetres in length, connected by a copper wire 60 centimetres in length, at the middle point of which was an air space, across which sparks were made to pass by means of powerful discharges from the induction coil J. The conductor was fixed at a height of 1·5 metre above the base-plate of the coil, with its plates vertical, and the connecting wire horizontal. A straight line, *r s*, drawn horizontally through the air space of the primary and perpendicular to the direction of the primary oscillation will be called the base line, and a point in this situated at a distance of 45 centimetres from the air space will be referred to as the null point.

The experiments were made in a large lecture room, with nothing near the base line for a distance of 12 metres from the primary conductor. The room was darkened during the experiments.

The secondary conductor consisted either of a circular wire, C, of 35 centimetres radius, or of a square of wire, B, with sides 60 centimetres long. The primary and secondary air spaces were both capable of adjustment by means of micrometer screws. Both the secondary conductors were in unison with the primary, the (half) vibration period of each being 1·4 hundred-millionth of a second, as calculated from the capacity and coefficient of self-induction. It is doubtful whether the ordinary theory of electrical oscillations would lead to accurate results under the conditions of these experiments, but as it gives correct numerical results in the case of Leyden jar discharges, it may be expected to be correct as far as the order of the results is concerned. When the centre of the secondary lies in the base line, and its plane coincides with the vertical plane through the base line, no sparks are observed in the secondary, the E.M.F. being everywhere perpendicular to the direction of the secondary. This will be referred to as "the first principal position" of the secondary. When the plane of the secondary is vertical and perpendicular to the base line, the centre still lying in the base line, the secondary will be said to be in its "second principal position." Sparking then occurs in the secondary when its air space is either above or below the horizontal plane through the base line, but not when it is in this plane. As the distance from the primary was increased the sparking distance was observed to decrease, rapidly at first, but ultimately very slowly. Sparks were observed throughout the whole distance of 12 metres available for the experiments. The sparking in this position is due essentially to the E.M.F. produced in the portion of the secondary remote from the air space. The total E.M.F. is partly electrostatic and partly electro-dynamic, and the experiments show beyond the possibility of doubt that the former is greater, and therefore determines the direction of the total E.M.F. close to the primary, while at greater distances it is the electro-dynamic E.M.F. which is the greater.

The plane of the secondary was then turned into the horizontal, its centre still lying in the base line. This may be called "the third principal position." When the centre of the circular secondary conductor was kept fixed at the null point, and the air space was made to travel round the circle, vigorous sparking was observed in all positions. The sparking distance attained its maximum length of about six millimetres when its air space was nearest to that of the primary, and its minimum length of about three millimetres when the distance between the two air spaces was greatest. If the secondary had been influenced by the electrostatic force, sparking would only be expected when the air space was close to the base line, and a cessation of sparks in the intermediate positions. The direction of the oscillation would, moreover, be determined by the direction of the E.M.F. in the portion of the secondary furthest from the air space. There is, however, superposed upon the electrostatically excited oscillation a second oscillation due to the E.M.F. of induction, which produces a considerable effect since its integral round the circle (considered as a closed circuit) does not vanish; and the direction of this integral E.M.F. is independent of the position of the air space, opposing the electrostatic E.M.F. in the portion of the secondary next to A A′, and assisting it in the portion furthest from A A′, as explained in a previous Paper.

The electrostatic and electro-dynamic E.M.F.s therefore act in the same direction when the air space is turned towards the primary conductors, and in opposite directions when the air space is turned away from the primary. In the latter position it is the E.M.F. of induction which is the more powerful, as is shown by the fact that there is no disappearance of sparking in any position of the air space, for when this is 90 degrees to the right or left of the base line it coincides with a node with respect to the electrostatic E.M.F. In these positions the inductive action in the neighbourhood of the primary can be observed, independently of the electrostatic action.

Waves in Rectilinear Wires.—In order to produce in a wire by means of the primary oscillations a series of advancing waves of the character required for these experiments, the following arrangements were made:—Behind the plate A was placed a plate, P, of equal size. A copper wire one millimetre in diameter connected P to the point M of the base line. From M the wire was continued in a curve about a metre in length to the point N, situated about 30 centimetres above the air space, and was then further continued in a straight line parallel to the base line for such a distance as to obviate all danger of disturbance from reflected waves. In the present series of experiments the wire passed through a window, and after being carried to a distance of about 60 metres was put to earth, and a special series of experiments showed that this length was sufficient. When a wire, bent so as to form a nearly closed circuit with a small air space, was brought near to this straight wire, a series of fine sparks was seen to accompany the discharges of the induction coil. Their intensity could be varied by varying the distance between the plates P

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and A. The waves in the rectilinear wire were of the same period as that of the primary oscillations, as was proved by their being shown to be in unison with each of the two secondary conductors previously described. The existence of stationary waves showed that the waves in the rectilinear wire were of a steady character in space as well as in time. The nodal points were determined in the following manner:—The further end of the wire was left free, and the secondary conductor was brought near to it, in such a position that the wire lay in its plane, and had the air space turned towards it. As the secondary was moved along the wire, points of no sparking were observed to recur periodically. The distance from the point n to the first of these was measured, and the length of the wire made equal to a multiple of this distance. The experiments were then repeated, and it was found that the nodal points occurred at approximately equal intervals along the wire.

The nodes could also be distinguished from the loops in other ways. The secondary conductor was brought near to the wire, with its plane perpendicular to it, and with its air space neither directed completely towards the wire nor completely away from it, but in an intermediate position, so as to produce E.M.F.s perpendicular to the wire. Sparks were then observed at the nodes, while they disappeared at the loops. When sparks were taken from the rectilinear wire by means of an insulated conductor, they were found to be stronger at the nodes than at the loops; the difference, however, was small, and was, indeed, scarcely distinguishable unless the position of the nodes and loops was previously known. The reason that this and other similar methods do not give a well-defined result lies in the fact that irregular oscillations are superposed upon the waves considered; the regular waves, however, can be picked out by means of the secondary, just as definite notes are picked out by means of a Helmholtz resonator. If the wire is severed at a node, no effect is produced upon the waves in the portion of wire next to the origin; but if the severed portion of wire is left in its place, the waves continue to be propagated through it, though with somewhat diminished strength.

The possibility of measuring the wave-lengths leads to various applications. If the copper wire hitherto used is replaced by one of different diameter, or by a wire of some other metal, the nodal points retain their position unchanged. It follows from this that the velocity of propagation in a wire has a definite value independent of its dimensions and material. Even iron wires offer no exception to this, showing that the magnetic susceptibility of iron does not play any part in the case of such rapid motions. It would be interesting to investigate the behaviour of electrolytes in this respect. In their case we should expect a smaller velocity of propagation, because the electrical motions are accompanied by motions of the molecules carrying the electric charges. It was found that no propagation of the waves took place through a tube 10 millimetres in diameter, filled with a solution of sulphate of copper; but this may have been due to the resistance being too high. By the measurement of wave-lengths the relative vibration periods of different primary conductors can be determined, and it therefore becomes possible to compare in this manner the vibration periods of plates, spheres, ellipsoids, &c.

In the experiments made by Dr. Hertz nodes were very distinctly produced when the wire was severed at a distance of either 8 metres or 5·5 metres from the null point of the base line. In the first case the nodes occurred at distances from the null point of −0·2 metre, 2·3 metres, 5·1 metres, and 8 metres, and in the latter case at distances of −0·1 metre, 2·8 metres, and 5·5 metres. It appears, therefore, that the (half) wave-length in a free wire cannot differ much from 2·8 metres. The fact that the wave-lengths nearest to P were somewhat smaller was to be expected from the influence of the plates and of the curvature of the wire. This wave-length, with a period of 1·4 hundred millionths of a second, gives 200,000 kilometres per second for the velocity of propagation of electrical waves in wires. Fizeau and Gounelle (Poggendorff's *Annalen*, Vol. LXXX., p. 158, 1850) obtained for the velocity in iron wires 100,000 kilometres per second, and 180,000 in copper wires. W. Siemens (Poggendorff's *Annalen*, Vol. CLVII., p. 309, 1876), by the aid of Leyden jar discharges, obtained a velocity of from 200,000 to 260,000 kilometres per second in iron wires. Dr. Hertz's result is very nearly the mean of these, from which we may conclude that the order at any rate, of the vibration period as calculated by him is correct. The value obtained cannot be regarded, independently of its agreement with experimental results otherwise obtained, as a fresh determination of the velocity, since it rests upon a theory which is open to doubt.

(To be continued.)

THE ELECTROLYTIC PURIFICATION OF ALCOHOL.

M. Ponthière, of the University of Lourain, has published some interesting information with regard to the methods employed in France for purifying the products of the distillation of various substances containing sugar or starch, by means of the electrolytic process of M. Naudin. The alcohol of beetroot, for instance, when subjected to this treatment, and afterwards rectified in the usual manner, is entirely free from the unpleasant smell which characterises the crude product; whilst the alcohol of the Jerusalem artichoke, which is, as a rule, completely useless, yields as good results if treated by the Naudin process as that distilled from maize.

The earliest attempts in this direction were made by M. Eisenmann, who, although he employed electricity, made no use of electrolysis. M. Eisenmann passed a current of ozonised air at 70°C. through the liquid to be purified. To ozonise the air, it was sent through a glass tube placed between the terminals of an inductive coil. This process certainly oxidised some of the deleterious constituents of the liquid, but did not seem to act on the aldelydes which form the principal impurity of crude alcohol.

In the Naudin process the liquid is first hydrogenised by means of a Gladstone and Tribe zinc-copper element. At M. Boulet's works, at Bapaume-lez-Rouen, wood or iron vats are used containing a number of zinc plates which are alternately flat and corrugated. The weight of zinc in a 150-hectolitre (3,300 gals.) vat is 6,200 kg. (6 tons); the number of plates is 105, and the active surface equals 1,800 square metres (19,800 square feet). Sulphate of copper is dissolved in the alcohol to be treated, and the reduced copper is deposited on the zinc plates. Five solutions containing ·5 per cent. of copper sulphate are employed in succession. The total weight of copper deposited is 360 kg. (0·35 tons) in the case of the 150-hectolitre vat. The temperature at which the deposit is made is a matter of supreme importance; it ought to be from 30°C. to 35°C.; five degrees more or less injuriously affect the process. If the temperature is too low, the action ceases; if it is too high, the copper does not adhere firmly to the zinc plates. Each solution requires 24 hours to completely deposit the copper contained in it, so that the entire zinc-copper process requires five days. Owing to the formation of oxidised zinc-hydrate, 5 kg. of hydrochloric acid are added every week for every 150 hectolitres of alcohol treated.

The above process is generally sufficient to completely purify the crude alcohol, but owing to the presence of other impurities it is sometimes necessary to employ electrolysis before rectification. The voltameters in which this latter process takes place are glass cylinders 125mm. in diameter and 60mm. long, furnished with ebonite caps, through which pass the copper electrodes and the supply and overflow pipes. To treat 300 hectolitres in twenty-four hours M. Naudin employs twelve voltameters, two in series and six in parallel, using a total current of 36·65 amperes and an E.M.F. of 113·5 volts. The current is furnished by a four horse-power Siemens shunt-wound dynamo. To neutralise the small quantity of hydrochloric acid employed to acidulate the solution some zinc is placed in the vat supplying the still in which the spirit is rectified.

M. Naudin has furnished the following figures as to the cost of each of the above operations in producing one hectolitre (twenty-two gallons) of pure alcohol.

Treatment of 200 hectolitres of products of the first distillation by the zinc-copper process in twenty-four hours.

Commercial hydrochloric acid, 1·25 kilog., at 6fr. the 100 kilog.	·075fr.
Sulphate of copper, 1·25 kilog., at 56fr. the 100 kilog. zinc consumed	·70 ,,
By the acid or sulphate of copper, 2 kilog. .... / By the liberation of hydrogen, 1·5 kilog., at 60fr. the 100 kilog.	2·10 ,,
Labour, 24 hours	7· ,,
Power	2· ,,
Maintenance and repairs	1·50 ,,
Depreciation, 15,000fr. in ten years	4·50 ,,
Total	17·875fr.

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Owing to the increase in the number of pages of "The Electrician," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months.
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	... 12 6	... 24 0
„ Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	... 14 6	... 28 0
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THE NEW PATENTS BILL.

In our issue of October 5th we printed the clauses of a Bill which will be introduced in the forthcoming Session of Parliament under the title of "An Act to Amend the Patent Designs and Trade Marks Act," and in the same issue we expressed a general approval of the scope of the measure. At that time a somewhat vigorous opposition was manifesting itself in the columns of one of our engineering contemporaries. We have since been happy to observe, however, that this does not by any means represent the feeling of the entire engineering profession, and a very considerable amount of support has been accorded to the view to which we have given expression. The matter is one of considerable importance to the electrical profession; considering the admittedly unsatisfactory state of the patent law it is perhaps a matter for regret that it *should* assume such importance; but we must, of course, deal with the facts as we find them. It is probably beyond the power of human ingenuity to devise a patent system of an even reasonably perfect character. It would seem as if the securing to the inventor an incontestable right to the results of his invention, without infringement on the equal rights of others,

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can never be effected in any other than an extremely haphazard and fortuitous manner. There is, therefore, all the more reason that any effort which promises to remove any one of the stumbling blocks with which the path of the inventor is strewn should receive encouragement.

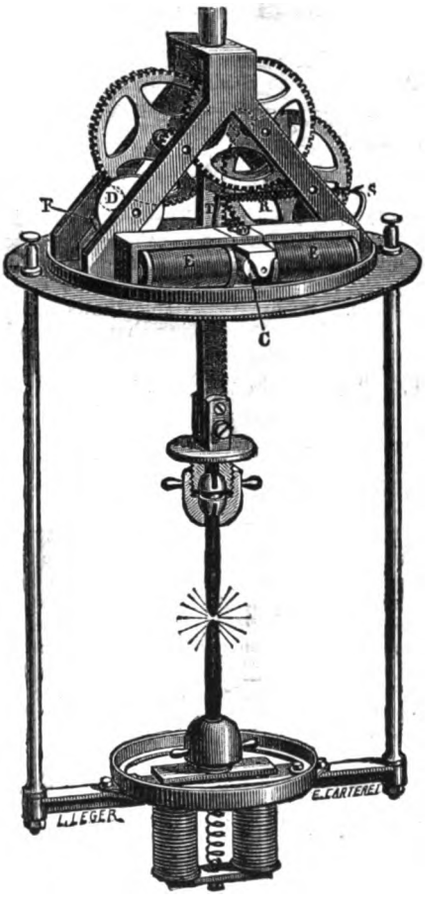
The object of the present Bill is, as we have already explained, to deal with one of the first and most elementary stages in the process of securing a patent. It is, of course, by no means necessary—nor does the Bill propose to make it necessary—for an inventor to seek the services of a patent agent; but seeing that the patent law confessedly aims at securing to the poor, and may be uneducated, inventor the fruits of his ingenuity, it is certainly desirable that the law should take cognizance of the qualifications of those who profess to be the qualified interpreters of its requirements. At the present moment the patent agent has absolutely no legal status whatever; anyone who is so desirous may achieve such success as he can command as a patent agent without any preliminary inquiries or initiation. Now, this state of things is of little consequence to the rich man, who has means of discovering, and will take good care to discover, an agent who is really qualified for the work which he undertakes. Not so the poor man. He is probably incapable of drawing up his specification without the assistance of an agent, and as a rule he is absolutely without means of ascertaining the competency of the individual whom he employs. It is therefore quite as much, or even more, in the interest of the poor inventor as in the interest of the patent agent that we are inclined to support the proposal for effecting compulsory registration.

In fact, the Bill goes but a very little way towards the desired end. Every agent who has been established in practice for twelve months previous to the 1st July last will be entitled to registration without inquiry, and although the Board of Trade are empowered to draw up regulations which new candidates will be required to satisfy, yet it is scarcely to be supposed that they will see their way to making these very *exigeant*. Another point which ought not to be overlooked is that the creation of a roll of patent agents, and the consequent raising of the present admittedly low status of the profession, will of itself have a tendency to attract a better class of men into its ranks. The amount of knowledge demanded of a competent patent agent is by no means inconsiderable; not only is it desirable, to say the least, that he should be an engineer, and still further that he should have special knowledge of as many branches of industrial enterprise as he can contrive to master, but he has over and above all to become acquainted with patent law, and with the voluminous and ever-increasing mass of patent law decisions. This is no light task, and any man who has thoroughly mastered the legal branch of this business would seem to be fairly entitled to the status of a member of a learned profession.

The preparation of a specification which is intended to describe and protect an invention of real value is a matter of no slight difficulty, and involves a responsibility which ought not to be lightly incurred. It is unfortunately a fact well known to those who have made themselves acquainted with the records of patent litigation that owing to the badness of many specifications the most deliberate infringements of important inventions have and do occur, whilst the patentee finds himself without redress, even if he be not saddled with heavy costs incurred in an attempt to defend his claim. Against all these weighty arguments in favour of the Bill we are unable to find any solid contention on the part of its opponents. The idea that the Bill will prevent an inventor from drawing up his own specification, or from getting it drawn up by a friend, simply arises from a total want of acquaintance with the terms of the measure. This exhibits a degree of negligence which we view with surprise and regret in the editorial columns of the oldest engineering journal. The only other argument which we have been able to find is based upon the assertion that it is undesirable to allow the patent agents to become a close corporation. We think that we have already sufficiently exposed the fallacy of this argument, but we may just add that it is not proposed to confer the power of admission to the roll upon the Institute of Patent Agents, but to vest it in the Board of Trade, and it is perfectly gratuitous to suppose that that power will not be fairly and honourably exercised. The subject is one which might well occupy the attention of the Committee of the Electrical and Allied Trades section of the London Chamber of Commerce, and we should be pleased to find that they had decided to take active steps in support of the Bill.

THE GRAVIER ARC LAMP.*

The essential feature of the Gravier arc lamp consists in a train of clockwork supported on a triangular frame, the last wheel D



The Gravier Arc Lamp.

(*see* figure) being clutched by the brake F, which is actuated by the armature C, of the electromagnet E E, placed in shunt upon the main circuit. The spring R, uniting the two levers S and T, brings the armature back to its normal position when the electromagnets cease to act. A thick wire electro-magnet, actuating the

* Translated from M. Hippolyte Fontaine's "Éclairage à l'Electricité," by kind permission of the author.

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lower carbon holder, causes the arc to be struck when the current passes. The working of the lamp explains itself. The only feature worthy of notice is the method employed in constructing the armature C. A thin copper cylindrical mould is placed vertically between the poles of a powerful electro-magnet, and filled with iron filings. When the filings have arranged themselves under the influence of the poles, melted paraffin is poured into the mould. A cylinder is thus obtained in which the magnetised particles are distributed in a special manner, and which moves between the two poles exactly like an iron excentric. This lamp works tolerably well if all the parts are properly fitted, but it is needless to say the cylinder, with its magnetised molecules, in no way adds to the regularity or fixity of the arc.

UNDERGROUND WORK IN BROOKLYN, N.Y.*

BY W. D. SARGENT.

The extension of underground conduits in Brooklyn has been restricted, since my last observations on the subject, to short sections for the purpose of connecting our new buildings in the Brooklyn and Williamsburgh districts with the underground system. All of the new conduits have been made of the creosoted wood, the ducts 3in. square, inside measure, with the exception of one short section of Macdonald creosoted wood, with round holes 2½in. in diameter. It is fully decided, however, that hereafter no ducts will be laid with an opening of less than 3in. in the clear.

In order to make ample room for the conduits reaching to our principal office, No. 16, Smith-street, we have built a tunnel the whole width of the street, high enough and wide enough to walk through, and it now carries 108 ducts, with room for, perhaps, 60 or 100 more. There are special features in this tunnel and method of bringing the terminals of the cables into the building which it is difficult to describe or to reproduce in a drawing. The *New York Electrical Review* of August 4th, 1888, gives illustrations which will convey some idea of the character of the work, and the members of the Association are cordially invited to visit the office and inspect the arrangements for themselves.

The first sections of our creosoted wooden conduits have now been in service four years. There is no evidence of decay, and the ducts remain clean and dry, enabling us to draw in and withdraw the cables without any difficulty.

So far as conduits are concerned, we think experience has fully sustained our judgment in favour of the creosoted wood.

One of the most important things, after the conduits, in underground work, is the manholes, which should be as large and commodious as possible. Within reasonable limits it is almost impossible to get these manholes or working chambers too large. While we from the start realised the importance of this part of the work, we have in quite a number of instances been compelled to rebuild and enlarge the manholes as first designed. Given a conduit of durable material, connecting with commodious manholes, this part of the underground problem, so far, presents no serious difficulty.

The character of the cables to be drawn into the ducts, and the method of distributing wires from them, are questions that demand our most earnest attention.

Experience has taught us that larger conductors and thicker insulation, together with twisted metallic circuits, are an essential part of perfect service. Conductors of ·035 to ·040 of an inch in diameter, insulated to ·125 of an inch in diameter, and twisted in pairs, with 100 to 104 wires, or 51 or 52 metallic circuits, make up a cable of from 2 to 2¼in. in diameter. Such a cable will weigh between 4 and 4½ pounds per foot, according to the amount of lead; and on account of the tendency of the lead pipe to buckle in bending, we do not believe that it is practicable to handle cables of larger diameter and weight. The consideration of these facts led us to decide that our ducts should hereafter be three inches.

We are using nothing but the lead-covered types of cable, some of which has been in service underground for four years and is still in good condition. Of the cables which were laid four years ago, those covered with pure lead appear to be more than half eaten through. One that has been drawn out during the writing of this article has been underground for two years and is badly corroded, there being holes eaten in it in many places nearly one-sixteenth of an inch in depth. Of the cables furnished by the Western Electric Company at the same time, in which there is a small percentage of tin mixed with the lead, the corrosion is very slight, and we are led to believe that cables covered with this alloy will last from three to four times as long as those covered with pure lead. We believe that if in addition to the tin the cables were drawn through a bath of gas tar or asphaltum, then covered with a good stout braid and run through the gas tar or asphaltum again, the cables would be practically imperishable, so far as the outside covering is concerned, and it is a question whether this additional expense would not be justified by their increased length of life. It is certainly worth the trial.

The air-tight terminals which were put on all our lead cables more than a year ago appear to have removed all the difficulties which we formerly had at that point, and the tests of our cables, making due allowance for temperature, &c., show that there is no deterioration during the past year.

Of the cables mentioned by me last year, one of 7,180ft., containing 100 wires, twisted indiscriminately, manufactured by the Western Electric Company, has been reduced by the change to the new Central Office to 6,344. Tests made Aug. 16, 1888, give the insulation 300 megohms, capacity ·22 microfarads, resistance of the conductors 43½ ohms per mile. The conductors are ·038 of an inch in diameter, insulated to ·088 of an inch. For a time during the past year all the conductors were in service, but recently the trunk lines to Bedford office have been taken out, and there are now thirty wires working through it. The condition of this cable in regard to cross-talk is the same as last year—that is, it is not bad enough to prevent its use.

The cable manufactured by the New York and New Jersey Telephone Company, with 100 wires, twisted in pairs, has been reduced to 6,117 feet. Tests Aug. 19, 1888, give the insulation 39 megohms per mile, capacity ·275 microfarads, and resistance of the conductors 43 ohms per mile—temperature in both these cases being, in the air, 80 degrees, and of the water from the hydrants 73 degrees. We assume that the temperature of the water from the hydrants is the temperature of the air in the conduits. Seventy-four wires are working through this cable, and the cross-talk is no worse than last year, and is not so bad as to prevent its constant use. In both cases all the dead wires are kept grounded at the cable terminals.

The greatest length of cable we have now underground is 11,800 feet, between our Bedford and Williamsburgh offices, consisting of 100 wires, twisted in pairs, the pairs broken up at all the splices, conductors ·025, insulated to ·075. The insulation of this cable is 99 megohms per mile, capacity ·26 microfarads, resistance of the conductors 47 ohms per mile; 17 conductors in this cable are in use for trunk service between the two offices, the rest of the wires being grounded close to the terminals at both ends. The cross-talk in this cable is very slight, and is, indeed, less than in the Western Electric cable of 7,000 feet. We received complaints from both these offices that the talking by subscribers through this cable was difficult and unsatisfactory. A special investigation of these complaints at the points they originated demonstrates that the difficulties complained of are not in the cable, but rather in the condition of the transmitters and instruments in the various offices and carelessness of the subscriber. Considering this cable as a whole, two miles in length, its electrical qualities are—insulation 50 megohms, capacity ·52 microfarads, resistance of conductors 94 ohms. We are inclined to think this is about the limit of good working in that type of cable, and that the complaints we are getting about the service over it are due to the fact that it loads up the circuit so that there is no margin for any deficiency in the subscribers' circuits connected to it; whereas if its efficiency was higher there would be a margin to cover such defects, and complaints would be prevented. There is no doubt that the reduction of the cross-talk and the increase in the capacity is due to the fact that the 83 of the 100 wires are grounded at the terminals, and that when the whole cable is put into service this condition of affairs will be changed more or less; that is, the capacity will diminish and the cross-talk will increase.

It was a consideration of the difficulties to be encountered in the use of greater lengths of this type of cable, which the above experience emphasizes, that decided us during the past year to make a special cable for our trunk lines, doubling the weight of copper and thickness of insulation. This resulted in our ordering three miles of cable, conductors ·052 of an inch in diameter, insulated to ·125 of an inch, sixty wires laid up indiscriminately; and, during the past two months, two miles of this cable, or 10,560ft., have been put upon the elevated railroad structure connecting the Brooklyn Central Office with the Bedford Central Office. The insulation is between 1,200 and 1,500 meghoms per mile, capacity ·27 microfarads, resistance of conductors between 21 and 22 ohms per mile, at a temperature of 74 degrees. This cable, though of the same length as the one between the Bedford and Williamsburgh offices just mentioned, gives surprisingly better results, the cross-talk being very slight, and the volume of sound full and strong. Forty of these wires are grounded at the cable terminals, and twenty are in active service.

There does not seem to be anything in the electrical measurements to indicate what causes the difference in the practical working of the two cables, but the results are gratifying, and seem to plainly indicate that increasing the weight of the copper and thickness of the insulation is a step in the right direction, and I am inclined to think that grounded trunk wires of this last type may

* Paper read before the Telephone Convention in New York.

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work successfully between our various Brooklyn offices, the distances between which do not exceed two and one-half miles.

All the new cables we have used this year have been of 108 wires, or 51 pairs, twisted, laid up in regular cable form, in alternate reverse directions, conductors ·035 of an inch in diameter and insulated to ·125 of an inch. The insulation of these cables when placed in position underground ranges from 1,500 to 3,000 megohms, capacity from ·17 to ·18 microfarads, and the resistance 52 ohms per mile. We believe that this type of cable will fulfil all the conditions required in our underground work, but at the present time we have no length sufficient to give actual working results.

The transition period between grounded and metallic circuit systems will be very troublesome and annoying, and may last several years. It is our intention, in ordering the type of cable just described, to make provision in the manholes for joining the sections together by devices which will enable the joints to be opened readily without cutting the cable and the pairs broken up in order to prevent cross-talk on grounded circuits; and at the same time allow of access to them for straightening them through when twisted metallic circuits are required. The necessity for getting at the joints in this way from time to time, and the space required to accommodate connecting boxes, is another argument in favour of large and commodious manholes.

The durability of lead pipe, with a slight mixture of tin, the maintenance of a uniform and high insulation, together with uniform resistance of conductors, after four years of service, are indications of length of life that are very encouraging.

Up to the present time we have met with no serious accident in our underground work, either from explosions of gas or the men being overcome with foul air. We believe it quite likely that gas is not as plentiful in the streets of Brooklyn as it is in many other cities, and therefore the accumulation in the ducts and manholes is not so great; but we have been very careful not to spare any precautions that would insure our safety.

The Dorsett conduit, of which we have five miles, with ducts two inches in diameter, has proved to be very unsatisfactory, and the ducts, on account of inequalities at the joints, will only permit of a cable an inch and a quarter in diameter being drawn in. This reduces the capacity enormously, and is therefore a source of inconvenience to us.

It is plainly proved that the use of underground wires reduces the margin of good working very largely, and will therefore require that extraordinary care must be taken to bring the service to its highest efficiency at all other points.

The most fruitful source of our trouble is the transmitter and battery, and while there have been very great improvements during the past year or two, there is still room for much more improvement before we reach perfection. The numerous contacts, in the magneto bells and other apparatus, need especial attention and care, and platinum should be used wherever possible.

Another source of trouble is carelessness in running the wire from the insulator outside the building to the instruments in the building. The writer knows of many cases where the subscriber's wire is run through the window casing with the ordinary cotton-covered wire and but little care taken in the inside of the building to keep it away from possible dampness.

As the mileage of underground wire increases, these and other faults now overlooked will become more and more apparent, and the expense of maintenance and inspection will be largely increased. There is only one way to bring back the easy working margin we have enjoyed on pole wires, and that is by the use of metallic circuits, and the sooner we get down to that basis, the better it will be for the service.

The following shows the actual extent of our underground work on September 1st, 1888:—

Length of conduit	15·17	miles.
,, ,, duct	105·5	,,
,, ,, cable	22·93	,,
,, ,, conductor	2053·3	,,

1,913 subscribers are working through underground wires using 1229·9 miles of wire.

The Indian Telegraphs.—The *Indian Engineer* says:—"A telegraph line has been constructed between Assam and Burma, through Munipur and Tummoo, and, besides connecting the two provinces, it forms an additional link in the telegraphic communication between India on the one side and China and Australia on the other. The telegraph has been already laid to Mansehra from Abbottabad, on the Oghi route. The laying of the line to Darband has been suspended for the present, until the troops have been pushed up in front of the working party.'

CHARLESWORTH'S PORTABLE PROJECTOR APPARATUS.

Messrs. Charlesworth and Co., electrical engineers, of Oldham, have recently designed an improved search-light apparatus, especially adapted for the Suez Canal traffic. The lights required for this purpose are a search light hung in a cage over the ship's bow, for use when under weigh, and an arc lamp hung in the rigging, for use when mooring at the stations.* The current is generated by an engine and dynamo taken on board with the lamps, and supplied with steam from the ship's boilers.

The engine and dynamo made by Messrs. Charlesworth are shown on the engraving (Fig. 1). The engine is of the open frame type, this form having been decided upon in preference

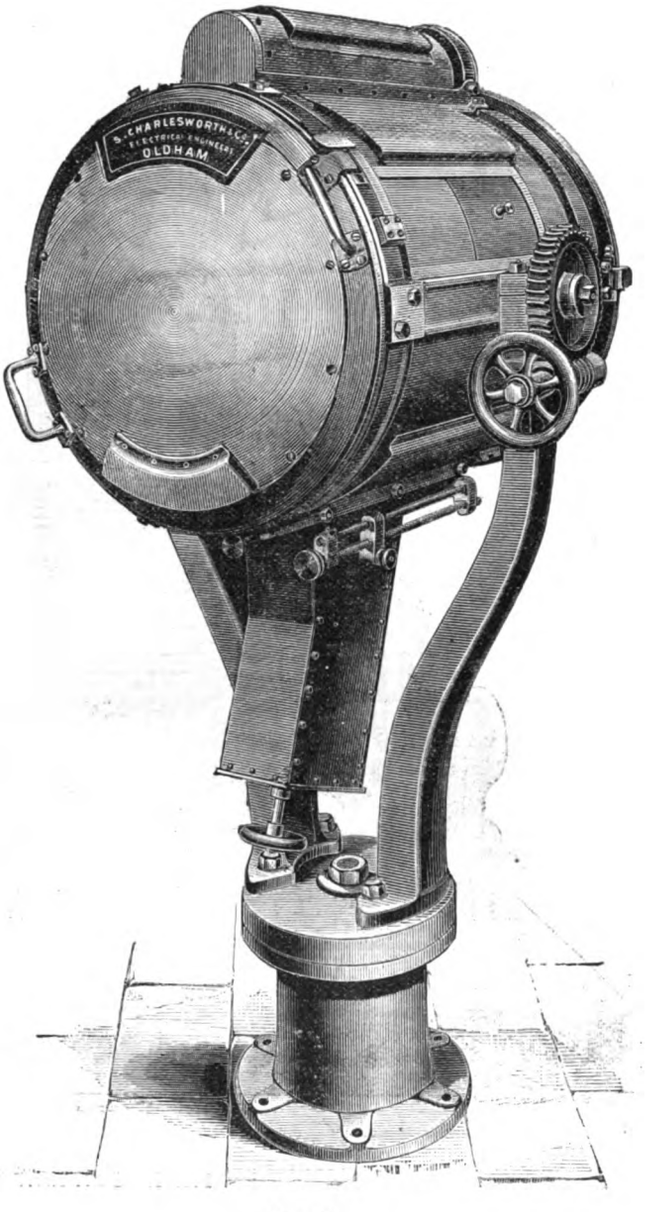

FIG. 2.

to any rotary or closed-in engine. The cylinder is 7in. diameter, stroke 6½in., and speed 425 revolutions per minute. It is usual in passing through the Suez Canal, on account of the slow speed at which the vessels proceed, to allow the pressure in the boiler to fall considerably below the normal, and on this account the engine has been constructed to work at the low-pressure of 40lb. per sq. in. On some vessels, however, this custom is not followed, pressures as high as 120lb. being carried occasionally. A throttle-valve governor does not work efficiently as a reducing valve through such wide limits, and so a hand expansion gear is fitted capable of varying the cut-off from ¼ to ⅞ stroke. By this means

* *See* also *The Electrician*, September 28th, 1888, p. 669.

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the engineer can set the cut-off to suit the pressure, leaving a reasonable margin for the governors to deal with. In order to reduce wear on the valve gear, a piston valve is used. The crank shaft is of Whitworth steel and has cast-iron balance discs shrunk on the crank webs.

The dynamo, which is one of Messrs. Charlesworth's No. 5, is carried on the engine bedplate, the armature shaft being coupled to the engine shaft by means of a conical interchangeable coupling. It is compound-wound, and gives 65 volts, 55 amperes and 425 revolutions per minute.

The resistances are as follows:—Armature, ·151 ohm; shunt, 39·87 ohms; series, ·037 ohm. The machine is made rather large for its work in order to allow for the extra heating to be expected in the latitude of Suez. In order to protect the engine and dynamo from injury when being lifted on and off the steamers, they are enclosed in a strong steel box, not shown in the engraving, the sides of which can be removed when working. A ring bolt is provided on the top for lifting and rollers on the bottom. The engine has no tendency to walk about when working, so that there is no necessity to bolt it down, a few wedges only being required under the bedplate to take up the round of the deck.

The projector, which is one of Messrs. Charlesworth's Suez Canal type, is shown in Figs. 2 and 3. It is of very strong construction, the barrel being of rolled cast steel, with brass rings, and longitudinal stay bars. It is fitted with best quality Chance mirror and dispensing lens, and has the usual horizontal and vertical movements for directing the beam of light. In order to place the lights under the direct control of the pilot a switch, similar in appearance to an engine-room telegraph, is provided to be fixed on the bridge. Flexible armoured cables are provided for making the connections, and the necessary instruments and cut-outs are in the same box as the engine and dynamo.

The engine, projector, and general arrangement are chiefly the design of Mr. Claude W. Hill, who was engaged for some time on electric light work on the Suez Canal. The apparatus was passed by the Suez Canal Company at the first trial, and Messrs. Charlesworth have received orders for several sets.

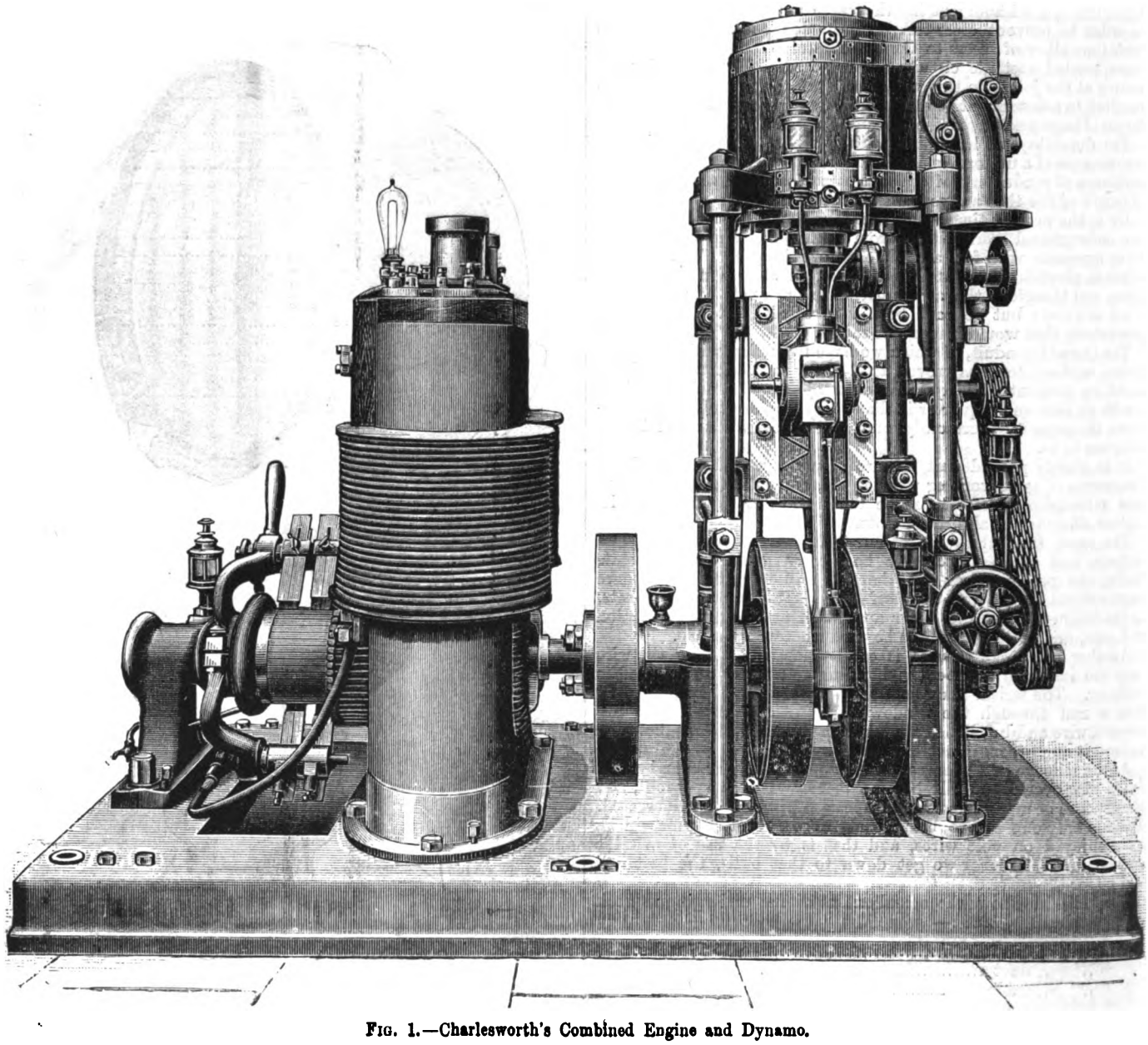

Fig. 1.—Charlesworth's Combined Engine and Dynamo.

THE USE OF MICA AS A DIELECTRIC.*

BY DR. JGNAZ KLEMENCIC.

These investigations were made to determine the specific inductive capacity of mica, and its suitability for the manufacture of condensers, and the following results have been obtained:—The value of the specific inductive capacity is 6·64. The capacity in the case of perfectly dry mica is independent of the charging E.M.F., and was found to increase by only 1·8 per cent. when the time of charge was increased from ·002 second to 20 minutes, the time of discharge

* Abstracted from Exner's "Repertorium der Physik."

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in each case being ·007 second. The specific resistance is not less than 6×10^{21} times the specific resistance of mercury.

But little is to be found in electrical literature on the subject. Fleeming Jenkin found about a 7 per cent. variation of capacity between a momentary charge and one of five seconds. Colley found that the two best out of a number by Elliot varied 10 per cent. under similar circumstances, and Kägi has also done good work on the subject. There can be no doubt that the discrepancies between the results obtained by different investigations are to some extent due to variation in the mica itself, but the author believes that the great differences between his results and those just referred to are to be ascribed rather to the fact that in his observations the mica was absolutely dry. Temperature has also a great influence on capacity; but this has been left for a future investigation.

Determination of the Specific Inductive Capacity.

Two plates of mica were experimented with, 400 square centimetres area, and 0·00508cm. and 0·0108cm. respectively in thickness. The thickness was determined with great accuracy, and the methods employed are described by the author in detail. Each plate was then made up as a condenser in the following way:—A perfectly true iron plate 18 by 18 centimetres was electro-plated with copper and amalgamated; it was then carefully dried and cleaned, and placed with its amalgamated side upwards. A few drops of mercury were then poured on, which immediately spread over the whole, forming a pasty but at the same time a firm surface. The mica plate was then slid quickly on, pushing all dirt before it, and leaving a perfectly bright surface of mercury amalgam in contact with its under side. Any air bubbles were at once apparent, and could be worked out by moving the plate about. In the thicker plate some small air bubbles were noticed in the plate itself, but none were observed in the thinner one.

The upper covering was also formed of mercury. A strip of sheet iron, ·5 millimetre thick and 1 centimetre wide, was made into a ring about 17 centimetres mean diameter. This was stood on the middle of the mica plate, the lower edge being first tested on a surface plate and made perfectly true, and the upper edge stiffened to prevent deformation. The tube was coppered and amalgamated, as there was otherwise a slight error due to the mercury not touching the iron all round the edge. The diameter was of course measured to the *outside* of the tube. The S.I.C. was determined from the formula

$$\sigma = \frac{4 \pi d k}{S},$$

where σ = the specific inductive capacity of the dielectric, k the capacity of the condenser, d the distance between the coverings, and S their area.

The capacity was measured by discharge throw compared with that of a known air condenser. To avoid errors due to absorption

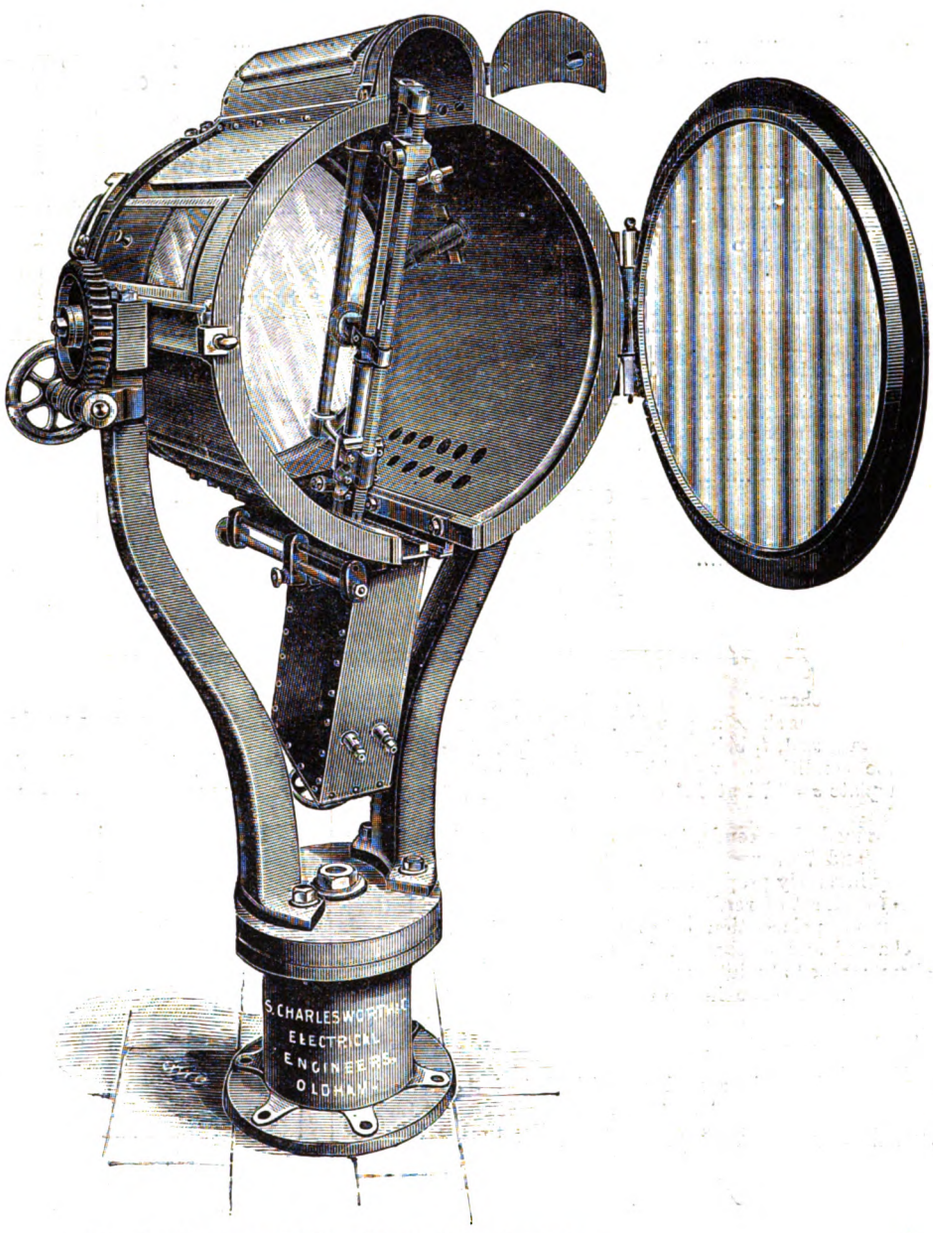

FIG. 3.—Charlesworth's Portable Projector Apparatus.

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WORKING EXPENSES OF THE BIRMINGHAM TRAMWAYS COMPANY.

STEAM DEPARTMENT.

	Average per mile run. d.	d.
To Engines—		
Wages	2·01	
Fuel	1·04	
Water and gas	0·22	
Stores	0·26	
Sundries	0·04	
Repairs—Wages	0·82	
,, Materials	0·50	
		4·89
To Car Repairs—		
Wages	0·09	
Materials	0·16	
		0·25
To Traffic Expenses—		
Wages	1·28	
Water and gas	0·12	
Stores	0·07	
Printing tickets, &c.	0·12	
Sundries	0·02	
		1·61
To Permanent Way and Buildings—		
Wages	0·15	
Materials	0·29	
		0 44
To General Charges—		
Stationery and incidentals	0 07	
Salaries	0·12	
Compensation	0·11	
Rates, taxes, and insurances	0·49	
Professional charges	0·12	
Sundries	0 04	
		0·95
		8·14
To balance to revenue account		5·66
		13·80

HORSE DEPARTMENT.

	Average per mile run. d.	d.
To Horses—		
Wages	2·32	
Forage and bedding	4·12	
Veterinary and shoeing	0·48	
Water and gas	0·06	
Harness repairs	0·10	
Stable utensils	0 01	
Sundries	0·03	
		7·12
To Vehicle Repairs—		
Wages	0·18	
Materials	0·18	
		0 36
To Traffic Expenses—		
Wages	1 12	
Water and gas	0 03	
Stores	0·04	
Printing tickets, &c.	0·07	
Sundries	0·04	
		1·30
To Permanent Way and Buildings—		
Wages	0·00	
Materials	0·07	
		0·07
To General Charges—		
Stationary and Incidentals	0 08	
Salaries	0·14	
Compensation	0 03	
Rates, taxes, and insurances	0·33	
Professional charges	0·13	
Sundries	0·06	
		0 77
		9·62
To Balance to Revenue Account		1·34
		10·96

CABLE DEPARTMENT.

	Average per mile run. d.	d.
To Cable Haulage—		
Wages	2·41	
Fuel	0·60	
Stores	0·62	
Water and gas	0·17	
Sundries	0·13	
		3 98
To Car Repairs—		
Wages	0·15	
Materials	0·24	
		0·39
To Traffic Expenses—		
Wages	1·61	
Water and gas	0·17	
Stores	0·06	
Printing tickets, &c.	0·29	
Sundries	0·08	
		2 21
To General Charges—		
Stationery and Incidentals	0·09	
Salaries	0·16	
Compensation	0·33	
Rates, taxes, and insurances	1·62	
Professional charges	0 31	
Sundries	0·38	
		2 89
		9·47
To Balance to Revenue Account		7·94
		17·41

both the time of charge t_1 and the time between charge and discharge t_2 were made as short as possible. Hiecke's method* with a falling weight was used, t_1 being ·00026sec. and t_2 ·007sec.

Under these conditions two tables of tests are given showing for the thin plate $\sigma = 6·74$ at 14° Cent. and for the thick 6·54 at 14·3°.

When t_1 was made 20 seconds, t_2 still remaining ·007, the values of σ rose to 6·97 and 7·07 respectively. This apparent increase is nearly exactly inversely proportional to the thickness of the plates. At the end of each set of readings one was taken with the battery reversed, but no polarisation effect was obtained. When continuously charged and discharged for two hours by tuning fork the capacity remained absolutely unchanged.

The 3 per cent. difference in the value of σ for the two plates the author attributes to some slight irregularities which were observed in the thicker one, and possibly to a small error in determining the thickness.

The value found is not in accordance with that of the refractive index according to Maxwell's "Electro-Magnetic Theory of Light," the refractive index for mica being, according to Landolt and Börnstein, 1·6; but as has been often pointed out before, in dispersion formulæ there is no certain method of determining the refractive index for waves of infinite length.

THE COST OF STEAM, CABLE, AND HORSE TRACTION ON THE BIRMINGHAM TRAMWAYS.

The working of the Birmingham Tramways at the present moment affords a favourable opportunity for the comparison of the cost of the various systems of traction. Some further information on these points may be found amongst our "Notes" this week. In the above table we give detailed figures as to the cost per average mile run, obtained from the balance-sheet showing the working expenses for the year ended June 30th, 1888.

* *Sitzungsberichte der K. Akademie* Vol. XCVI.

ASBESTOS-PACKED COCKS.

The disadvantages attending the ordinary method of packing cocks has led to Bell's Asbestos Company taking up a system of asbestos packing,

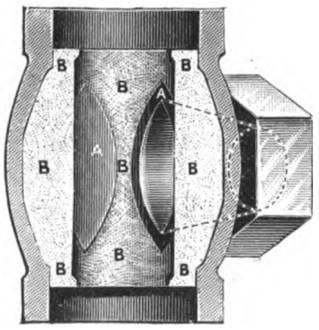

Fig. 1.

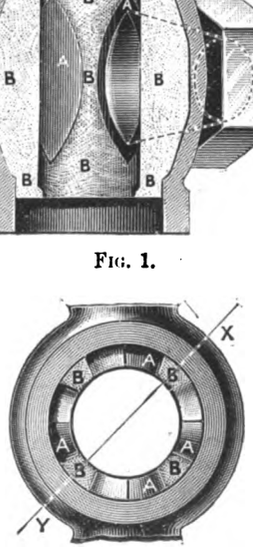

Fig. 3.

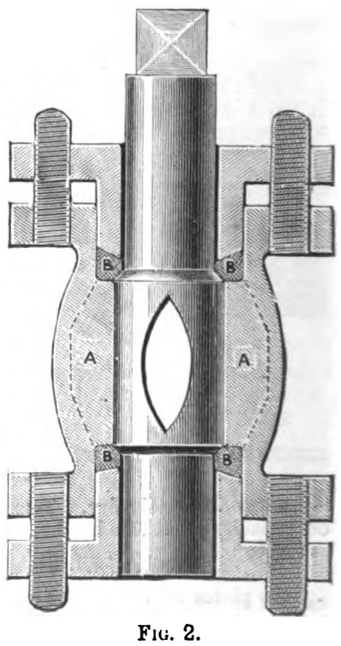

Fig. 2.

the invention of Mr. Baines, which is a marked improvement upon the old system. These asbestos-packed cocks are shown in Figs. 1, 2, 3. Fig. 1 is a section on the line X Y, Fig. 3; Fig. 2 a sectional elevation; and Fig. 3 a plain view of this cock. On the inner circumference of the shell four projecting pieces, A, of oval form are cast, having pointed ends at top and bottom, through two of which the way passes. The grooves B

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thus formed increase in depth as they decrease in width, so that they are of the same sectional area throughout their length. The packing when acted upon by the glands will flow easily along the grooves B, and owing to the peculiar formation of the grooves (their holding capacity being the same at their greatest and least diameters) the packing cannot become jammed. When further packing is required, it is added at the glands in the usual way, and this can be done while under pressure, no special skill or tools being required. There is no packing between the bottom of the plug and the barrel, so that friction and wear are reduced, and the cock is more easily opened and closed. Screwing down the glands merely affects the packing, tightening it, or, in case of leakage, taking it up. There is no liability of the plug jamming, or of metal to metal contact between the periphery of the plug and the barrel, both being parallel. Cocks thus packed have been in satisfactory use for some time past, being highly spoken of by users. One engineering firm states that it has severely tested them with water at 1,000lb. and steam at 70lb. per square inch for two months, and finds them superior to any packed cock ever seen.

PRACTICAL STANDARDS FOR USE IN ELECTRICAL MEASUREMENTS.

Report of the British Association Committee, consisting of Prof. G. Carey Foster, Sir William Thomson, Prof. Ayrton, Prof. J. Perry, Prof. W. G. Adams, Lord Rayleigh, Dr. O. J. Lodge, Dr. John Hopkinson, Dr. A. Muirhead, Mr. W. H. Preece, Mr. Herbert Taylor, Prof. Everett, Prof. Schuster, Dr. J. A. Fleming, Prof. G. F. Fitzgerald, Mr. R. T. Glazebrook (Secretary), Prof. Chrystal, Mr. H. Tomlinson, Prof. W. Garnett, Prof. J. J. Thomson, Mr. W. N. Shaw, Mr. J. T. Bottomley, and Mr. T. Gray, appointed for the purpose of constructing and issuing practical standards for use in electrical measurements.

The committee report that the work of testing resistance coils has been continued at the Cavendish Laboratory, and a table of the values found for the various coils is given :—

Legal Ohms.

No. of Coil.	Resistance in Legal Ohms.	Temperature.
Elliott 193, C.C.L. 178	·99971	15°·5
Elliott 201, C.C.L. 181	1·00005	14° 8

B.A. Units.

No. of Coil.	Resistance in B.A. U.	Temperature.
Elliott 200, C C.L. 71	1 00049	13° 8
Elliott 43, C.C.L. 72	·99955	14° 7

In conformity with the opinion expressed by the committee in their last report some steps have been taken towards the construction of an air condenser. A meeting was held in London, and Dr. Alex. Muirhead exhibited an air condenser, capacity about ·0035 mf. This condenser consists of a series of concentric cylinders of brass, insulated from each other by glass rods. Dr. Muirhead expressed his willingness to lend this condenser to the committee, with two others of similar construction, and it was agreed that the secretary should be requested to test them and to make a determination of their absolute capacity. Some delay in sending the instruments to Cambridge unavoidably took place, but the experiments requisite are now in progress. So far, of the £80 granted last year for the purpose only £2. 10s. has been expended.

During the year the original resistance standards of the Association have been compared with each other by the secretary and Mr. T.. C. Fitzpatrick ; an account of the experiments is given in the appendix to the report, together with a chart giving the values of their resistance between 10° and 20°. The general result of the comparison is that, with perhaps one exception, the relative values of the standards between the temperature of 10° and 20° have not changed since they were constructed in 1865 until June, 1888. A change of about ·0002 B.A.U. has been observed in the coil F since the end of June, 1888.

The attention of the committee has been directed by several practical electricians to the desirability of a redetermination of the value of the specific resistance of copper. It is known that copper wire is now made having a resistance three or four per cent. less than Matthiessen's standard. In view of the importance of copper to electricians the committee have undertaken to make experiments on the specific resistance of copper, and wish to thank the various gentlemen who have brought the matter forward for their offers of help.

At the last meeting of the committee it was resolved on the motion of Mr. W. H. Preece to adopt the name "therm" for the gramme water degree Centigrade unity of heat. Thus, one "therm" is the quantity of heat required to raise one gramme of water at its maximum density 1° Centigrade. It was also agreed to adopt the name "joule" for 10^7 C.-G.-S. units of work. Thus, a joule is equal to 10^7 ergs. It is the work done in one second by the power of 1 watt, or, again, the work done when a current of 1 ampere flows for one second between two points between which the difference of potential is one volt, and hence a power of 1 watt is 1 joule per second.

Hence, also, if we take the value of the mechanical equivalent of heat as $4{\cdot}2 \times 10^7$ ergs, we have 1 therm is equivalent to 4·2 joules.

In accordance with a suggestion made at the Manchester meeting, the value of the resistance of mercury in terms of the B.A. unit has been again determined by the Secretary and Mr. Fitzpatrick. They find that a column of mercury, 1 metre long, 1 square millimetre in section, has at 0° C. a resistance of ·95352 B.A. units, and that the value of the ohm in centimetre of mercury is 106·29. The committee are of opinion that they should be appointed, with the addition of a name of Mr. T. C. Fitzpatrick, to continue the experiments already referred to, and with a grant of £100. They propose that Prof. G. Carey Foster should be the chairman, and Mr. R. T. Glazebrook the secretary.

THE JASPAR ARC LAMP.*

The accompanying figure shows the arc lamp designed by M. Jaspar, of Liége ; it is a lamp of the Achereau pattern, though more complete in its details and of greater sensitiveness than its prototype. The rod *t* is in connection with the positive terminal, and is completely insulated from the frame of the lamp. To the top of this rod the positive carbon-holder is fixed, and at the bottom a stud, sliding in a vertical groove, prevents the rod and holder from turning round. As in the case of the Serrin lamp, two regulating screws allow the upper carbon to be accurately adjusted with respect to the lower arc. A small cord attached to the projecting stud and to the pulley R serves to connect the movements of the two carbon-holders. The negative carbon is fixed to the rod *t'*, which is in electrical connection with the frame of the lamp and the negative terminal. This rod *t'*, which is of iron, penetrates into the solenoid S, and is connected by a cord to the rim of a pulley, which is upon the same axle as R, but which has a smaller diameter, so that the rod *t'* rises just half as much as *t* falls. Close to the solenoid S there is a cylinder, D, which is in the lamp's circuit, and contains a plunger, having a slight lateral play, and moving in a column of mercury. The plunger is connected to *t'* by a rod. The counter-weight P slides upon a horizontal lever, and from it a cord runs to a third pulley, fixed to the same axle as the other two. The screw B regulates the position of P, and thus increases or diminishes the effect ; another counterweight, *r*, is fixed between the spokes of the first pulley R, with a view to counterbalance the increasing pull of the solenoid upon the rod *t'*, as it rises further and further.

The working of the Jaspar lamp is easily understood. As soon as the current passes through the coils of the solenoid the rod *t'* is pulled down, and the arc is struck ; the rods are clutched in this position so long as the solenoid acts on its armature. The lengthening of the arc causes the attractive force of the solenoid to weaken, and the carbons, acted on by the weight of the rod *t*, come slightly closer together ; this naturally increases the strength of the current, and the solenoid again attracts its core. The counterweight P acts in opposition to the movement of the rod *t*, and by sliding the weight further along the lever the effect of P is increased, thus allowing us to use the same lamp on very different circuits. The piston moving in the mercury produces two equally useful effects ; *t* prevents sudden jerks and ensures a good electrical contact for the negative carbon. Contact is made with the rod *t*

* Translated from M. Hippolyte Fontaine's "Éclairage à l'Électricité" by kind permission of the author.

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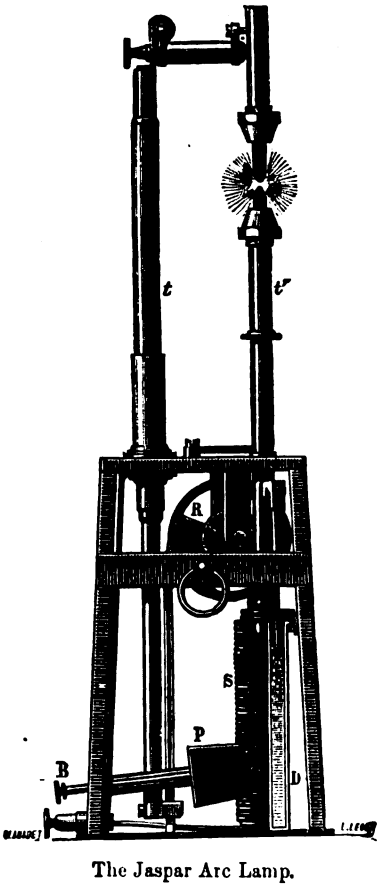
either by the friction of the rod against its case or by a little brush. M. Jaspar has overcome the difficulty presented by the additional magnetic effects of the solenoid the further the core rises, in a highly ingenious manner. Where the arc is struck, the weight r opposes the motion of the moving rod, but as the pulley turns, its effect slowly diminishes to nothing, and then gradually increases to a maximum in the opposite direction. By the figure we see that at the moment when the carbons are nearly consumed the weight of the rod t is increased by the full effect of the counter-weight r, and that if the pull of the solenoid is a maximum so is the counter-pull of t and r. The three chief features of the Jaspar lamp are—first, the mercury cylinder; second, the sliding counter-weight, allowing the lamp to



The Jaspar Arc Lamp.

be used with different currents; third, the variable counter-weight, keeping the length of arc constant so long as the lamp is burning.

ELECTRIC LIGHTING: ITS PRESENT POSITION AND PROSPECTS.

LECTURE BY Mr. W. LANT CARPENTER, B.A.

A lecture upon this subject was delivered at St. George's Hall, Langham-place, on Sunday last, 21st inst., by Mr. Wm. Lant Carpenter, B.A., B.Sc., before a large and aristocratic assemblage. In his opening remarks the lecturer said that the subject of electric lighting had an important bearing upon the social welfare of mankind. In New York it was considered that every arc lamp was worth a policeman, and the lamentable state of affairs in Whitechapel could not have existed so long if the district had been better lighted. As regarded the sanitary aspect of the question they all knew that buildings, shops, rooms, &c., lighted by electricity, were in a much freer condition from carbonic acid and other products of combustion in the air, than they would be if gas were used. There was also very little risk of fire. One of the reasons why electric lighting had not at present made greater progress had been the wild promises which had been made by inventors of primary batteries. People had been told that batteries could be supplied which would require no attention whatever. They merely had to purchase the article and put it in their cellars, and the whole thing was done. The sooner this fiction was exploded the better it would be for the prospects of electric lighting. Within the last few years enormous improvements had been made in the construction of dynamos, particularly with regard to their electrical commercial efficiency, which between 1882 and 1887 had been increased from 67 to 93 per cent., while their weight, bulk and cost had been correspondingly reduced. The dynamo of the present day was almost a perfect machine. People who were at present reluctant to take up the matter would endeavour to justify their position by saying that they would wait until the whole thing had been brought to perfection. To this he would reply, that as far as commercial efficiency was concerned, perfection had almost been reached, and that no further improvements were likely to be made in that direction, though possibly the weight, bulk and cost might be further reduced. There were, as they knew, two systems—the arc and the incandescent. With regard to the comparative cost of the two systems as against gas, he might say as to the arc lighting, that if they took into account the number of candle power which was produced, the arc light, under almost any conceivable set of conditions, was much cheaper than gas light. The reverse, however, was the case with the incandescent. He might incidentally mention the enormous saving of time and consequent expense effected by the use of electric light on ships passing through the Suez Canal at night, the result of which had been an annual saving to maritime commerce of £100,000. In consequence of the improvements in ventilation which had been made in coal mines the velocity of the air had been considerably increased, the effect of which was to make the Davy lamp decidedly dangerous. Here the electric light stepped in, and a syndicate was now bringing out a portable lamp (a specimen of which was shown in action) which it was thought would remove all liability of danger from contact between the flame and anything which might cause explosion. The lamp in question weighed 4½lb., would burn for twelve hours, and immediately the glass front was broken by accident or opened by design the light would go out. Several illustrations were given of private installations, notably those of Messrs. Pears, where accumulators were used, and of Baron Rothschild's mansion at Tring, where there were no accumulators but a duplicate set of machinery, dynamos, &c. The installation of the arc light at the Waverley Station, Edinburgh, was also instanced; here the cost per hour of each lamp had been reduced to a little over 1½d. Since the passing of the recent Electric Lighting Act the question of central station lighting had assumed considerable importance. When the question of central station lighting first arose electrical engineers were met by the wide and difficult question of distribution. There were two great systems of distribution, the first of which was known as the battery or storage system, and the second as the converter or transformer system. High potential currents would travel over very small wires, and the higher the pressure the smaller the wire. But these high pressure currents were dangerous for domestic lighting, and the Board of Trade would not allow a higher pressure than they considered safe, and engineers were then face to face with the problem of finding some means whereby a high-pressure current could be converted into a low-pressure current before it was safe for the supply to enter a house. There were then two systems introduced, one much older in point of time than the other—the battery or storage system which required continuous currents, and the transformer or converter system which required alternating currents. In the latter connection, several lantern photographs were exhibited on the screen, illustrative of Messrs. Gaulard and Gibbs' system. There was, of course, one objection to an alternating-current machine, and that was that it could be only used for lighting, while a continuous-current machine could be used for either lighting or motive power. The recent Electric Lighting Act of course materially improved the prospects of the industry, and, indeed, might prove to be the turning point in its history, inasmuch as it offered inducements to capitalists to put their money into new ventures; but still it was felt that new electric light companies were not given the same advantages as new gas companies. Since the passing of the Act in question at least 30 stations had been not only projected, but actively pushed forward, notably in Kensington Court (where the plant had recently been tripled), at Chelsea, and at various other places in London, the whole of the business part of Liverpool, at Bradford, at Leamington and elsewhere; all these were on the battery system. Transformer stations had been projected for Chatham and elsewhere. There were several towns which had not quite made up their minds, notably Tunbridge Wells, Southampton, Reading, &c., while Brighton, Hastings and other towns already had their installations. As they knew, the wires in connection with the electric lighting industry were at present overhead, but all electrical engineers were agreed that for permanent work there was no question but that wires must be laid underground. One of the obstacles in the way of overhead wires was the extreme difficulty of getting wayleaves. From this cause the Grosvenor Gallery installation could proceed no further east than the Gaiety Theatre. There had been considerable progress made in the direction of electric lighting abroad and even Honolulu, in the Sandwich Islands, had its installation. One of the reasons of the rapid progress it had made in the United States was the high price the Americans had to pay for gas, for which the usual charge was two to two and a-half dollars per 1,000 feet. He would give them some instructive figures as to the extent of electric lighting in the States. There were no fewer than 5,350 electric plants and stations, about 1,925,000 arc lamps, and about 2,250,000 glow lamps, absorbing together about 460,000 horse-power. Four or five factories can turn out 10,000 incandescent lamps in a day. The lecturer referred incidentally to the two great patent cases which had been recently heard, and suggested that instead of these very technical disputes being tried in the usual way in a court of law by the orthodox judge the matter should be left to the decision of experts, in the same way as naval questions were. It had been truly said that the first two or three days of the hearing of the cases in question were occupied in "educating the judge," which was rather a costly proceeding for those who had to pay the piper. A gentleman of his acquaintance, of high repute in the electrical world, had said that at the present time there was one great obstacle standing in the way of the greater extension of the electric lighting industry, namely, the natural conservatism of the English nation, which showed itself most strongly in the opposition of local and municipal authorities to all attempts in the direction of co-operative supply. The lecturer concluded by saying that if this country were to take the lead in the future application of electricity to lighting its common sense would have to be reawakened.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October 13th*, 1888.

The report presented at the annual meeting of the Western Union Telegraph Company this week fully confirms the favourable anticipations which I have expressed in my letter. It appears that the gross revenue for the year ended June 30 was $19,711,164, and that the expenditure was $14,640,592, leaving a net income of just over five million dollars. Out of this sum close upon four millions were spent in dividends, and the balance of about $500,000 was carried to surplus, which now figures out $7,500,000. This is a good showing for a company with a capital stock of $86,000,000. During the last 22 years of its existence the company has earned and collected the magnificent sum of $91,383,000, and has paid in dividends $51,185,000. These figures are an indication that even if the Western Union stock has been somewhat liberally watered, the proportion between its capital and its earning capacity is not an unreasonable one by any means. It will be remembered, too, that the stock includes the amount of $5,000,000 issued during the year for the purchase of the Baltimore and Ohio system. At the close of its fiscal year the company owned and operated 171,375 miles of poles and cables, carrying 616,248 miles of wire, from which were sent during the year 51,463,955 messages. The company also carried on its business through 17,241 offices. The average amount received per message during the year was 31⅕ cents, as compared with 30⅘ cents the year before. Altogether, it must be admitted that the report is creditable to the management of such large interests in private hands, and it is evident that the transfer of such a system to Government control would not only require a very large sum of money, but would also present questions of the first national and political importance. It is somewhat significant of the smoothness with which the vast machinery of the company is kept in operation that at the meeting at which the report was presented only four gentlemen were present, two of whom are engaged in the building in the service of the company, Dr. Green and Mr. Van Horne. As regards the earnings of the company it is, of course, clear that the current year should show a much better record than that whose figures I have just recited above. The past year affords traces of the old fight with the Baltimore and Ohio Company, and the cable war was also carried on until a very few weeks ago. Thus the anticipations of those who expect to see the Western Union Company's Stock going to 100, and the dividends going up to 7 or 8 per cent., bid fair to be realised.

A very interesting article which appeared in this week's *Electrical World* gives an idea of the manner in which, even in such an old and well-established business as that of telegraphy, important improvements and economies can be introduced, bringing out better results and yielding better returns on the capital invested.

It appears that the old Siemens machines which supplied current for the circuits in the Western Union office in this city, till they were replaced by a new Edison plant, have been put up in the new office of the company at Pittsburg, and that they are used for similar circuits under somewhat novel conditions. These machines are now employed not only to supply current for the long-distance circuits, but are also drawn upon very largely for the "local" circuits, and this is the first time, we believe, that dynamos have been employed for that class of circuits. Another remarkable feature is that instead of the Siemens machines being driven from an engine they are operated by means of motors put in by the local Alleghany County Electric Light Company, and driven by current from that company's station, the motors being directly connected to the regular power circuit. It will thus be seen that the Western Union Company dispense altogether with the worries incidental to a large steam plant such as it would have had to put in, and that it is saved from the expense of engineers, firemen, &c., as well as from the annoyance of coal, ashes, &c. Moreover, the arrangement displaces about 12,000 cells of battery on the main lines, and about 1,100 on the locals, and those who are familiar with gravity batteries will know what it means to be relieved from the care, renewals, &c., of over 13,000 cells. The motors not only keep the telegraph generators going, but they furnish power to run the blower for the pneumatic tubes between the operating room and the receiving and delivery departments on the ground-floor. This is said to be the only telegraph office in the world where not a single cell of battery is in use, and the results obtained appear to have been highly satisfactory. It is also worth mentioning that fifteen calling generators are also driven for the telephone company in Pittsburg on the motor circuit of the Alleghany County Company. Such a utilisation of the motor both in telegraph and telephone service may strike some of your readers in England as a novelty, but we have already more than one instance of this kind in the United States, and the general impression is that there will be a very rapid extension of this class of work, and that the consequence will be a diminution in the field of usefulness of the primary battery.

The telephone litigation has once more been brought to public attention by an argument which took place this week before the United States Supreme Court at Washington. Some time ago a suit was brought by Acting-Attorney-General Jenks in the United States Circuit Court at Boston to have cancelled the two Bell patents, on the ground that they were obtained by fraud. The case, it will be seen, is a variation on the big suit recently decided, and was the outcome of the action of the Government in taking up the matter. In this suit the Bell Company entered a demurrer, in which they maintained, among other things, that in the absence of any specific statute the United States had no power to obtain a Bill in equity to cancel a patent for an invention. In this contention it was supported by the Court, which held the point to be well taken, and ruled also that even if the Court were not to go to such an extreme length the demurrer must be sustained on the ground that the main question raised against the validity of Bell's patents could be advanced in an infringement suit, and that the Attorney-General could not bring a suit to cancel a patent on grounds which constitute a defence in an infringement case. It is against this decision that the Government have brought the matter to the Supreme Court. Special interest was given to the argument from the fact that it was opened by Mr. Allen G. Thurman, who appeared on behalf of the Attorney-General, and who, in addition to being well known, now occupies a very conspicuous position before the country as the Democratic candidate for the Vice-Presidency.

In my last letter I made some reference to the utilisation of water-power in this country for electrical purposes, and gave a few statistics of the work that has been done or is proposed. In this connection it is interesting to note the report that has been made to the *Railroad Gazette* by Mr. E. H. M'Henry, engineer-in-chief, on the work done at the Stampede Tunnel in Washington Territory. This tunnel is the second in length in the United States, being 9,844ft. long, and it pierces the main range of the Cascade Mountains at an altitude of 2,800ft. above tide water. During the period of its construction arc lights were used with very good results, but it was deemed advisable to adopt the incandescent system for permanent use, the engineers on the Northern Pacific Railroad being of the opinion that with the incandescent system a better distribution of light would be had, with an economy in attendance and the cost of renewals. The plant was furnished by the North Western Supply and Construction Company, of Seattle, Wash. Terr., and consists of an Edison municipal machine, running at an E.M.F. of 1,200 volts, and maintaining 300 lamps of 30 candle-power each. These lamps are supported on iron brackets at intervals of about 66ft. on each side, thus giving a lamp to every 33ft. The lamps are arranged in six circuits, so that any or all of them can be lighted at will for the convenience of workmen or of trains, and it is noticeable that the lamps are placed rather low down, it being necessary to avoid the smoke which accumulates in the crown of the arch. Ordinarily this interesting plant is operated by water-power from the falls of Mosquito Creek, which furnishes a head of about 160ft., with but 400ft. of piping at the eastern entrance of the tunnel,

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Provision is made against drought by a plant of a 50 horse-power high-speed Ball engine and a 60 horse-power steam boiler, and the dynamo is arranged to connect with either the steam engine or the Leffel water-wheel. This is not only an interesting plant in itself, illustrating the utilisation of water power and the use of electric lights in railway tunnels, but it shows very clearly how little distance is allowed in this country to interfere with this kind of work and the employment of the latest and most advanced facilities. Even to Americans the name of the Stampede Tunnel is still somewhat unfamiliar, and the region seems remote, as it undoubtedly is; and yet it will be seen that the work is carried out in good shape and under contract by an electrical supply company at a place where a few years ago not a single house was standing.

The American Institute of Electrical Engineers held a meeting this week at which Mr. Frank J. Sprague's Paper, delivered at the close of last season, on "The Electrical Solution of the Principal Rapid-Transit Problems," came up for discussion. The subject elicited quite a lively debate, which was opened by the presentation of two formal Papers, one of which was read by Mr. M B. Leonard, who is a resident of Richmond, and as a telegraph official familiar with electrical questions was enabled to take a disinterested view of the operation of the big Sprague road in that city. Mr. Leonard's Paper contained a number of valuable criticisms, some of which were well-directed and important, but none of which presented insuperable obstacles to the continued successful operation of the road. Mr. Sprague availed himself of the opportunity to reply to most of the points raised, and to add to his statements made last June. Perhaps the most striking fact he mentioned as showing the difficulties with which the road had had to contend was that for a period of some nine or ten months since the road started none of the cars had been under roof, but had simply been "housed" in the street or in the open car yard, subjected to all sorts of bad weather and other detrimental influences. In many cases the cars had to run through big pools of water and long stretches of mud. The result was that not only did the machines become beplastered with dirt till they were well-nigh unrecognisable, but they were constantly subjected to the danger of short-circuiting and burning out from the accumulation of moisture. Apparently it is along this line of improvement that Mr. Sprague's ingenuity has been working, for he reiterated his remarkable statement, that he proposed to have on his cars a motor that could practically be washed down with a hose, and an armature that could be plunged into a barrel of water and taken out and used. As to the use of the storage batteries upon which Mr. Leonard had touched, and for which he had expressed a preference, Mr. Sprague said that he considered the present storage battery altogether too heavy and certainly out of consideration for such work as was involved at Richmond, with its grades of 10 per cent. and sharp curves. At the same time he expressed his conviction, from what he knew of experiments being made, that the storage battery would very shortly be materially improved, not only being made up of plates that are practically indestructible, but having its weight cut down for the same output to a figure altogether within economy and practicability. As usual Mr. Sprague was positively brilliant in his discussion of the various criticisms offered, and won not only admiration for his ability as a practical electrician, but for his frankness in acknowledging shortcomings and defects. In his case, as in that of other of our workers in this field, however, the difficulties are acknowledged simply to be overcome.

As you are aware, there has been during the past year a marked movement in this country in the formation of local electrical clubs and societies, in which, according to the tastes of the organiser, the social or the scientific element has predominated, and in all of which the platform has been the promotion of intercourse among those engaged in the same lines of work. Cincinnati, Ohio, has now fallen into line, and has organised an electrical society. The step was timely from the fact that the Cincinnati Centennial Exposition just being held in the city has been notable chiefly for its electrical display, and for the reason that there has consequently been great activity in electrical circles. The first meeting was held this week, when Dr. Otto A. Moses, who is acting for the Commissioners of the Exposition as their juror for all groups containing electrical apparatus, was to deliver an address on "Electrical Education."

I alluded at the beginning of this letter to the condition and prospects of the Western Union Company, but it is, perhaps, not out of place to note that some of the New England papers have been talking about new opposition springing up in their section of the country on the completion of the Delany synchronous multiplex lines there. It is understood that the system, which, as you know, was acquired some time since by the English Government, and has been beset here by financial difficulties in its early stages, is about to go into operation between Boston and New York, and it has also been reported that gentlemen representing the Standard Oil Company and Pennsylvania Railroad were interested in pushing things. The statement is made that the new company will pay particular attention to the commercial transactions between the principal business centres, and will lease wires to the daily newspapers at $2,500 a-year; whereas the Western Union rate has been $4,000. As regards the Standard Oil Company, however, it may be well to point out, as offsetting some of the rumours, that one of the new Western Union directors is Mr. H. M. Flagler, a leading representative of that corporation. For a long time past the enmity between the Western Union and Standard Oil management has been a pretty well-known fact; but the adoption of Mr. Flagler into the Western Union directorate looks like an *entente cordiale* between the two parties, if, indeed, it may not mean something more. Probably those only know what it means who are in the swim.

CORRESPONDENCE.

PRACTICE *V.* THEORY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The correspondent whom you quote on the first page of your last issue, though he says some true things, is guilty of a serious exaggeration in his last sentence when he says that the practical men are usually one generation behindhand. In theoretical matters, and on points which do not appear to them likely to have an immediate practical bearing, they usually are, but it is a matter for admiration how rapidly their leaders manage to place themselves abreast with the latest scientific developments as soon as they appear likely to have a commercial bearing.

And this keen interest and rapid assimilation of new ideas on the part of men of application, who have such an immense mass of detail to attend to from which men of pure science are comparatively free, often put to shame the lethargy of pure physicists of the old school.

The healthy and vigorous activity of the science of electricity at the present time, the enterprise, one may almost say the existence, of journals such as your own, are all consequences of the applicability of electricity to daily life, and they are consequences which react upon pure science with the most beneficial and stimulating effects.—Yours, &c.,

19th October, 1888. OLIVER J. LODGE.

LIGHTNING CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The enclosed fragment of a letter from Dr. Hertz to myself may perhaps be of interest to your readers, as showing, at any rate, what he thinks of some points which are in this country almost matters of dispute.—Yours, &c.,

OLIVER J. LODGE.

"Karlsruhe, 14th October, 1888.

"I read the Papers with the greatest interest, especially your Address before the Society of Arts 'On Lightning Conductors.' I often thought that these things would apply to lightning conductors, but did not know that the best part of such an application had already been given by you. In the

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future I hope that such ignorance will not last, for I shall be glad if you will send me your Papers, and I will act accordingly. A colleague of mine is very interested in lightning conductors, and came to me a week ago to ask information about your heretic opinions. I tried to give it him, but it is very difficult to tell an electrician of the elder school that lightning does not go through copper nor iron, but goes only by means of air or gutta percha or insulators. I myself have made a great many experiments during the summer, which clearly illustrate the truth, and some of which are very similar to some of yours. I am proceeding now, and am very glad I did not publish anything before knowing your Paper.—Yours, &c, "H. HERTZ."

LIGHTNING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The phenomenon to which Mr. W. P. Adams refers in his letter to *The Electrician*, p. 775, is one that I have observed on one occasion only, and though I have described it to several people, I have not hitherto found that it has been noticed by others.

It is now so long ago that I cannot remember all the circumstances, but the impression produced at the time was so vivid that I am certain of the following particulars:—

A thunderstorm travelling from S. to N. passed immediately over the village of Wing, in Rutland, at about 9 or 10 p.m. When it had travelled so far away that the thundercloud was low on the horizon, and the altitude of the top of the cloud was about half or a third, or possibly less, that of the lower bright stars in the Great Bear, at that time in their lowest position (and this fixes roughly the time of year), I noticed that while the true flashes of lightning between the cloud and the earth were often visible themselves, they were mostly accompanied by long thin flashes which extended up well into the space between the bright stars of the Great Bear, which were shining brightly in a perfectly clear sky. Sometimes but one of these lines of light would be formed, generally two or three, and I remember distinctly that one flash of real lightning, in or below the cloud, was accompanied by seven of these mysterious lines which simply went up from the cloud into the clear sky and left off.

These flashes had all the usual character of ordinary lightning, except that they seemed much thinner or less luminous. Their light, though seen direct, was much less than that in or below the cloud. I was sure that they were not the only flashes, but that they accompanied what I have called above the real lightning.

Though I have often recalled the circumstances I can offer no explanation. Perhaps they will be of interest to Dr. Lodge.—Yours, &c., C. V. BOYS.

Physical Laboratory, South Kensington.

THE "DARK" FLASH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The dark lines in some photographs of lightning flashes are owing, in the opinion of the writer, to the exceeding transparency of the air occupying the space corresponding to the dark line. This would probably be proved by a close examination of the photograph; but to account for the transparency itself is another matter.

There can be no doubt that absolute uniformity in the density of any matter would render it transparent. Therefore, if we presume that the dark lines or flashes are the effect of comparatively perfect transparency of the corresponding portions of the air, we may take it for granted that they (the dark flashes) represent air, whether common or of any other kind, having an extreme uniformity of density in its constituent atoms; or, perhaps, it would be better to say groups of atoms. This throws a strong light on the nature of electricity.

Although it may not affect the *average* specific gravity of matter, electricity evidently affects the distribution, or what may be called the arrangement of its density amongst the atoms composing it.

There are probably few substances in nature, perhaps none, in which the specific gravity is absolutely uniform throughout, and the writer is of opinion that each substance is also liable to temporary variations of the manner, or pattern as it were, in which its different densities are arranged—sometimes abnormally approaching uniformity (which might be called an absence of pattern), at other times the reverse, namely, with an increased difference between the several densities; the direction in which the alteration may tend depending on the kind of electricity, positive or negative, with which it is charged. When that electricity is discharged the normal arrangement obtains, but not always, if ever, at one bound, but by oscillating from one of the two kinds of derangement, described above, to the other; for instance, supposing the charge of electricity to be of such kind as to produce an abnormal uniformity in the density of the substance, then a discharge of that electricity would produce (by what may be called oscillation) a system of densities having greater differences amongst them than there would be in the usual or uncharged state of the substance. It would now be charged with residuum electricity, to use the language of early electricians.

According to this, it would depend upon the number of oscillations that had taken place which kind of electricity, positive or negative, would be obtained from a residuum discharge.

To follow out this idea, it is evident that if we admit that the transparency of matter depends upon a uniformity of its density, nothing that is perfectly transparent can be charged with electricity, except at the expense of its transparency; and though that of the atmosphere is not perfect, experienced persons can often tell by its appearance that it is charged with electricity. The weather is then said to be "thundery," and after a thunderstorm the air is said to have been "cleared" by the storm.

To theorise a little more: an electrical discharge occurs when two substances (whether of similar or different natures), having their respective densities in two different states, come into contact. That is to say, for instance, when the arrangement of the several densities of one substance is normal, and that of the other abnormal, or when both are in abnormal states, one approaching uniformity more than usual, and the other the reverse.

When this occurs between two volumes of air, an oscillation follows the discharge, one extreme of which consists of a comparatively perfect uniformity in the density of the portion of the atmosphere affected; this produces transparency, and transparency with no luminous or illuminated body beyond it means darkness. Hence the dark flashes in some photographs of lightning.—Yours, &c., JOHN P. MOSS.

[We fear that our correspondent's views as to the relation between the homogenity and the transparency of matter are not borne out by facts, as commonly understood.—ED. *E.*]

"REMARKS ON TELEPHONIC SYSTEMS."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In his article in *The Electrician* of October 19th Mr. Munro says that the telephonic exchange wires in Edinburgh and Dundee are supported on wooden standards. The matter is not perhaps of much moment, but, in the interests of accuracy, it may be well to correct an error into which Mr. Munro has no doubt inadvertently fallen. The wooden standards in Edinburgh, which Mr. Munro probably mistook for the Telephone Company's, belong chiefly to the Post Office, the North British Railway Company, and to various private proprietors. The Telephone Company own but very few, and these date from 1880 and 1881. In Dundee there are but two wooden standards belonging to the company, that at the central exchange and one other. The Edinburgh and Dundee wires are supported, like those in Glasgow and the other Scotch towns, by iron standards fitted with channel iron four-wire and six-wire cross arms and upright shackle insulators, on the system introduced by Mr. Bennett in Glasgow in 1881.

Mr. Munro likewise says that it was in London that the first public call offices were opened, but I venture to assert that the statement is not susceptible of proof. Would he mind giving the date and locality of the first London call office?—Yours, &c., A. S. T. E. AND E.

Edinburgh, October 22nd, 1888.

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NOTES AND QUERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I ask when we are likely to get a description of the floating charging station of Messrs. Immisch? You stated, "We hope shortly to give a description of this station." That was some months back, since which we have seen nothing of the sort. I think the description would be of interest in view of the comparatively small space at Messrs. Immisch's disposal.

I was much interested in the description of the electrical tramway given this week in *The Electrician*, more particularly the way in which the motor stood the severe strain described by Mr. Dolan. Taking friction at 10lb. per ton (2,000lb. per ton), total horse-power = 35·5, and this will surely be under the mark, as 10lb. is a low estimate even for a Yankee street railway. Without allowing anything for curves, but taking it as it stands, this motor stood 137 per cent. above its nominal output, taking average weight of each passenger at 150lb. It would be interesting to know something of the construction of this motor and its weight.

In your account of the Leamington Central Station you state that the 3-wire system has been given up on account of the difficulty of regulation between the two circuits, and state that this difficulty may be stated to vary inversely as the number of lamps in circuit.

I am curious to know how this is, as we do not hear of any difficulty of the sort being met with on the other side of the water, and surely if they can manage it in Yankee-land we can manage it here. It has also been frequently stated that the 3-wire system saves upwards of 60 per cent. of the copper required for simple parallel. Now I can quite see that this is possible as a *tour de force*, but I do not quite see how much more than 30 per cent. can be saved in *practice* unless we neglect *heating effects;* for example—Let C = 2 (parallel system), diameter = 2, and R = 2; then energy wasted = $2^2 \times 2 = 8$. Now halve C = 1. If we make cross-section proportionate to C, and use a round conductor, as usual, then circumference radiating heat $\frac{2}{\sqrt{2}}$ and resistance = 2; therefore energy wasted $= 1^2 \times 2 = 2$, just a quarter of what it was before, and it has a larger proportional surface to radiate from, so all is safe; but if we are to keep the proportion $\frac{\text{total work}}{\text{lost work}}$ equal, then R = 8, and cross section $\frac{1}{8}$ and diameter $= \frac{2}{\sqrt{8}} = \frac{2}{2{\cdot}828} = 0{\cdot}71$; therefore, we have the same energy to be dissipated through less than half former area. Under these circumstances I should be afraid for my insulation, the weight being proportional to cross section, weight in each cable = $12\frac{1}{2}$ per cent. Now, we must make the centre wire equal in section to other two, else what would happen if one side had *no* lamps on? Therefore, total weight = $3 \times 12\frac{1}{2} = 37\frac{1}{2}$ per cent. of simple parallel, total saving = $62\frac{1}{2}$ per cent.

If we make cross-section proportionate to C, then weight of each cable = 25 per cent, and total weight = $3 \times 25 = 75$ per cent., and we save 25 per cent.; of course this saving may be increased by not having the centre wire the same section as the others. This seems to me the correct view of the matter, but I believe you hold the contrary.

I suppose your readers have often noticed the curious fact that tools (metal worker's) subjected to continuous vibration become somewhat strongly magnetic. In the course of the last eighteen months I have tested some hundreds of chisels, with the result of discovering the curious fact that they had N polarity at the cutting end. I have only found three exceptions, and those on inquiry had only been used for about half an hour, having just been to the toolsmith, and they had S poles at the cutting edge. It appears, therefore, that the polarity is reversed after some hours' use, as I found on testing them again after two or three hours' hard work. Scrapers are the same, but the polarity is less strongly marked. I do not know if this is new to you, as it is to me, but it is a very curious fact. I may mention that the works are lighted with gas, so that there are no means of accounting for it, except by vibration. Apologising for wasting your time to such an extent.—Yours, &c.,

MECHANIC.

COMPANIES' MEETINGS & REPORTS.

Western and Brazilian Telegraph Company. (Limited).

The sixteenth ordinary general meeting of this Company was held at Winchester House, 50, Old Broad-street, on Thursday, under the presidency of Mr. W. S. Andrews.

The SECRETARY (Mr. R. M. Cunningham) read the notice calling the meeting, and the minutes of the last ordinary and extraordinary general meetings.

The report of the Directors was taken as read.

The CHAIRMAN: This is the first half-yearly meeting of the Company held in pursuance of the resolution which was come to at the last annual general meeting, that the meetings in future should be held half-yearly. The matter for consideration to-day is confined to the report and accounts, and, therefore, I take it that we shall not have to detain you long, but that the business will soon be over. It is my pleasing duty on this occasion, as it was at our last meeting, to congratulate the shareholders upon the continued increase in the revenue. On that occasion I drew attention to the fact that the increase was continuous, and on this occasion, of course, that fact remains unaltered. We have had a continuous increase upon former satisfactory increases. We are considering at this meeting the working of the lean half year, not the fat one. The result of the half-year's working to the 30th June is a gross receipt of £86,874, compared with £81,419, showing an increase in the revenue for the half year of £5,454, which is very satisfactory. Now that deals with the revenue of the half year ended June, but I think the shareholders are entitled to information as to whether that satisfactory state of things is continuous, and I am glad to say that it is, and it is continuing in an augmented ratio, which is also satisfactory. Down to the present time in the current half year there is an increase, compared with the corresponding period of the previous year, of something like £25,000. That is a very large increase. Of course, in giving you the figures, you must understand that I am taking them from our estimates of revenue, but substantially you may rely upon the amount. It may be £100 or £200 more or less, but practically it is correct. Of course there are two and a-half months still to pass, and we do not know what the outcome of those two and a-half months may be, for we cannot predict the unknown. But judging from what has taken place, and what is taking place, we have no reason to think, in the absence of any misfortune—and we can see no misfortune on the cards—that the outcome of the year will be other than satisfactory to the proprietors. Having dealt with the revenue I will now go on to the expenditure of the same six months ended on 30th June last. The main fact in reference to that is that that an increase of revenue has been earned with a decrease of expenditure, but you must quite understand that that is owing to a particular circumstance with respect to renewals of cables, because everyone here must know as well as we do ourselves that you cannot conduct a larger business with smaller expenses. If you conduct your larger business with a small increase on the expenditure you are, generally speaking, extremely well satisfied. Well, now, with respect to the items of expenditure, the shareholders generally like to have all the information that can be given to them, and if you turn to abstract "A" you will find that the gross expenditure was £13,853, being a total increase on that account, which includes salaries, wages, and items in the working of the cable of £847. Then there are savings, which reduce that increase to £705. The largest item going to make up that £705 is £385, which is partly made up by increased payments in exchange account of some £60—and I explained that on the last occasion—and further by probationers who come on to the regular staff before they become telegraphists, and also on account of the increases of pay under our agreements. The next item of increase is that for travelling expenses £170, and that is owing to more time-expired men coming home and to more clerks having had to go out to take their places than was the case in the corresponding period. For new furniture we have spent £91, and £94 has been spent for addional stationery and printing required on account of our increased business. The sum of £54 was paid for quarters where we had to send our clerks, owing to the unhealthiness of the place they were stationed at. You will find those items make up £700. There are other small items not worth mentioning, and on the other hand there is a saving which brings the net increase in the expenses under Abstract "A" to £705, as I said before. Under Abstract "B," maintenance of ships, there is a gross increase of £791, and a net increase of £312. The "Norseman" was employed more actively during the half-year, consequently she used more coal, and there were more general expenses. Then the "Viking" was less actively employed, and there was a saving in her expenses of £479. The net increase under Abstract "B" is thus £312. The "Norseman" is the largest ship, and she was more actively employed. The increase in the expenses was rather larger than the saving which was effected by the less employment of the "Viking," that vessel being smaller. Under "C" expenses in London, there are increases of £162 and decreases of £232, and therefore under that heading there is a reduction of some £70. Then there is an item in the profit and loss account which really causes a considerable reduction in the expenses of the year for new cable, namely, in the half year ended June, 1887. We spent £2,430 upon new cable, whereas in the past half year to June last we spent £735, so that there is a saving of £1,695. The final result of all this is a net revenue of £54,061, to which we must add £3,464, brought forward, making together £57,525. Then we have paid during the half year £13,500 for debenture interest, £7,500 has been put to the renewal fund, and £6,000 has been placed to the redemption of debentures. Deducting these items we have a balance to deal with of £30,525. The shareholders have so fully endorsed that policy of redemption of debentures that I do not propose to go into it now. The outcome

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is that the Directors are able to recommend a dividend at the rate of 4 per cent. per annum for the half year, as against one at the rate of 2½ per cent. per annum in the corresponding period of last year, and that is an increase at the rate of 1½ per cent. We then carry forward £3,293. There is a fact mentioned here with respect to the Platino Company. You will observe that we say in the report that the accounts do not include the contribution which we shall have to receive from the Platino Company. The accounts of the Platino Company have been generally somewhat later than ours. They have a number of stations a long way up the country. Communication is not so perfect. There are references to and fro, and the consequence is the arrival in London of their accounts at a later period than ours. It appears to have been usual in the Platino Company to declare interim dividends at the rate of 2½ per cent. Now, the revenues are pretty much the same, and I take it that in all probability the Directors of the Platino Company will declare an interim dividend at that rate. If so there will be a receipt by the Western Company from the Platino Company of between £300 and £400, which will go to the benefit of the current half year. With respect to the future the Board have it very much in their minds to accelerate these Platino accounts, because it would be manifestly far more convenient, and it would present a much more complete and more accurate picture of our affairs if we could bring the accounts of the Platino Company in simultaneously with our own, so that all our contributions and our figures, the whole thing, in fact, could be seen together, and you would know the exact outcome of the proceedings of the entire concern. We hope to do it. At all events Major Wood is doing his utmost locally to endeavour to bring about that desirable state of things. Well, gentlemen, there is really very little else that I have to tell you. At our last meeting we discussed the questions of debenture redemption, &c., and we discussed these questions, perhaps, at rather an early period; but we did it then because it was necessary to obtain your authority to put by certain sums in view of provision being made to deal with these questions when they were ripe to be dealt with. They are not ripe just now; but with the very sensible steps taken by the shareholders in giving their approval to the collection of certain funds, and with their assistance towards the very important objects that we all had in our minds, I think we shall rather hasten the reopening of these questions. We shall be able, I hope, to deal with them earlier than we otherwise might, and the outcome of this year, which we all think will be satisfactory, will probably enable us to somewhat accelerate the settlement of these questions. Of course we cannot say how far we may be successful, as there are many legal points involved, but we are giving our best attention to them, and we shall do our utmost at the first, so to say, prudent moment that occurs, to pull these things through. The exchange of shares with the Platino Company is going on very successfully, and it might perhaps be interesting to the shareholders to know the great change that has taken place in the Company's constituency. In 1882 we had 688 shareholders, and in October, 1888, we have 1,865, so that for every shareholder we had in 1882 we have three shareholders at the present time. The average holding in 1882 was 98 shares, while in 1888 the average holding is 60 shares, showing that the basis of the constituency of the Company is becoming much wider and the shares much more spread about in small numbers. That I think is a satisfactory feature as a rule, because the wider the basis, generally speaking, the greater the stability. There is nothing more for me to say except to move the resolution, which is

"*That the report and the accounts for the half-year ended June 30th, 1888, be and are hereby approved and adopted, and that a dividend at the rate of 4 per cent. per annum, or 6s. per share, free of income-tax, be and is hereby declared payable on the 1st of November next.*"

One of my colleagues will doubtless second that, and when it is seconded I shall be happy to reply to questions that may be put, if it is thought necessary to put any, and to give any further information that may be desired.

Mr. H. WEAVER: I beg to second that.

Mr. YOUNG asked whether he understood rightly that the Directors had provided a dividend at the rate of 4 per cent. on the £312,930 shares of the Western and Brazilian Company given in exchange for shares of the Platino Company; and that, on the other hand, the Western Company had not taken anything in the accounts presented as the proceeds of revenue from the Platino Company?

The CHAIRMAN replied that that was so, and that the revenue which the Company would receive from the Platino Company would come into the current half year's accounts.

Mr. YOUNG asked if there would be any objection in publishing the estimated weekly traffics to state those in the corresponding period of the previous year?

The CHAIRMAN pointed out that the shareholders could work out the information for themselves.

Mr. YOUNG said he wanted only to know if there was any objection to publishing the information.

The CHAIRMAN replied that there was. When a concern was very prosperous it was not wise to give every information; but they would be very happy to give any information to the shareholders at the offices.

Mr. GUESDON said there was one point he would like to express his satisfaction with, namely, that the Company were building up a reserve fund. The primary object to his mind for the consideration of all Directors was not the speculative but the *bonâ fide* investor, and it should be a first consideration to afford such information and to pursue such a course as would give to the Company that stability which would enable them to meet unforeseen contingencies. It was not the expected but the unexpected which was to be considered, and he assumed from the remarks which the Chairman had made that there was something lurking in his mind which had induced the conservative policy which the Directors had thought best for the Company. He did not wish to cavil, but he really thought that the office expenses, and so forth, were unnaturally large. The Company had passed through very serious vicissitudes, and it was now beginning to be understood that South America was a country which, at all events, had to be developed. Their shares had reached a price which he thought very few of the more sanguine among them expected to see reached at this period. It was clear that advantage had accrued from the reduction in the tariff which had been made to meet the competition. He held very strong views respecting the £8,000 cash which had been paid to the Directors of the Platino Company and others. He thought that a Director should not lose sight of the fact that he was a partner in an enterprise, and to handicap the concern with £6,000 for Directors was something that he regretted to see as a citizen. He felt very sorry that the Directors of the Platino Company should have exacted £6,000 for themselves and £2,000 for their *employés* as the basis of the bargain which had been made with the Western Company.

The CHAIRMAN pointed out that Mr. Guesdon was speaking about the affairs of another company, and that the Directors of the Western Company were going to give the shareholders their labour for nothing, so that the amount which had been paid to which Mr. Guesdon had referred would be recovered by the shareholders.

Mr. GUESDON said that that did not exonerate those who had exacted the claim in question. The fact was that the Directors of the Western Company were "cornered" in the matter, standing, as they did, in a position with respect to the Platino Company which rendered them powerless in the contingency of being forced into law.

The CHAIRMAN: That is not so. We were advised with respect to their claim, and I stated at one of the meetings that we did not think much of their claim, but it certainly did appear to us that these arrangements were in themselves beneficial for both companies. I think the Directors of the Platino Company made a very good bargain for their shareholders, and with respect to ourselves we determined, in order to smooth matters, and make them as agreeable as we could, that we would perform the labour of the Platino Company without any charge. Therefore, the Platino Company will be still charged year by year without any charge to this Company with Directors' fees, which will come back into the pockets of the Western and Brazilian Company, and you will be recouped every farthing of that money.

Mr. GUESDON: I see all that.

The CHAIRMAN: The arrangement being on the whole very beneficial for the shareholders of both companies, would it not be as well—it has been twice passed—to let the matter drop? There is nothing to be gained.

Mr. FRY said he had understood that a feeler had been thrown out to the Directors that the Globe Trust, having largely increased its interest in the Company, should be represented on their Board, but he thought, after their experience of the claim which had been made on them by the Directors of the Platino Company, that they ought to be chary before taking as a representative on their Board any member of the Globe Company. The Directors had the shareholders' confidence, and he trusted that the Directors had the same confidence in the shareholders. If it were necessary for the Directors to increase their strength he trusted they would consult the shareholders and ask for that strength from them.

The CHAIRMAN: I may say at once that there is no intention of increasing the Board or of appointing an additional Director.

Mr. W. GRIFFITH suggested whether the time had not arrived for appointing a second auditor.

The CHAIRMAN replied that it was not competent for the present meeting to consider that matter.

Mr. GRIFFITH merely desired to throw it out for the consideration of the meeting. At present everything in the accounts depended on the signature of one gentleman.

A SHAREHOLDER rose to order, and said that they could not go into the question at that meeting.

The CHAIRMAN put the motion, which was carried.

Mr. GRIFFITH protested, and said that he was quite in the dark as to the state of the Company's affairs.

A SHAREHOLDER: You should have come to the meeting earlier, and then you would have heard.

Mr. GUESDON said that the point referred to by Mr. Griffith could be met by Messrs. Turquand, Youngs and Co. being asked to select a fresh gentleman each time to audit the accounts.

Mr. RICHARD JAMES asked whether it would be convenient for the Directors to print in the accounts in red ink the amount earned and expended in the corresponding half of the previous year, so that the shareholders could easily compare one statement of accounts with the statement corresponding to it.

The CHAIRMAN said that it had been done at one time and was discontinued, and gave rise to a great deal of explanation.

Mr. GUESDON said it was competent for any shareholder to take his own accounts and put in the figures in red ink himself (laughter).

The CHAIRMAN: That is a very simple solution, and I congratulate you, Mr. Guesdon, in suggesting it.

On the motion of Mr. GUESDON, a vote of thanks to the Chairman and Directors was passed.

The CHAIRMAN having briefly acknowledged the compliment, the proceedings terminated.

The Brazilian Submarine Telegraph Company (Limited).

Report and accounts of the Directors for the half-year ended 30th June, 1888, to be submitted to the thirtieth ordinary general meeting, to be held at Winchester House, Old Broad-street, on Wednesday, the 31st October, at 12 o'clock:—

2. The revenue for this period amounted to £109,548. 11s. 9d., and the working expenses to £21,385. 9s. After providing £12,880 for debenture interest and sinking funds, and £1,660. 3s. 8d. for income-tax, there

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remains a balance of £73,622. 19s. 1d.; to this is added £12,916. 4s. 6d. brought forward from 31st December last, making a total of £86,539. 3s. 7d. A quarterly interim dividend amounting to £19,500 has been paid, and £30,000 transferred to the reserve fund, leaving a balance of £37,039. 3s. 7d.

3. The Directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both free of income-tax, which together will amount to £32,500, being a distribution in the aggregate of 7 per cent. for the year ended 30th June, 1888, leaving a balance of £4,539. 3s. 7d. to be carried forward.

4. On the 31st July last the sum of £13,900 was transferred to pay off the 139 bonds of the 1884 issue, drawn for redemption in April last. This repayment reduces the debenture debt to £174,000.

5. On the 4th August last the cable between Lisbon and Madeira, laid in 1874, was interrupted near Madeira. The Telegraph Construction and Maintenance Company's steamship "Britannia" was without delay despatched to make the necessary repair, which was accomplished after laying four knots of new cable, when the electrical condition of the cable was found to be perfect. During this interruption the entire traffic was satisfactorily carried by the duplicate cable.

6. All the Company's cables are in good working order except the one first laid between Pernambuco and St. Vincent, in which a slight fault has developed near the coast of Brazil; this, however, does not in any way interfere with the due transit of traffic. The Directors have made arrangements for the removal of the fault at an early date.

7. Sir Thomas Fairbairn and Mr. Henry Daniel Gooch retire by rotation at this meeting, and, being eligible for re-election as Directors, offer hemselves accordingly.

8. The two auditors, Mr. Henry Dever and Mr. John Gane, also offer themselves for re-election.

Maxim-Weston Electric Company (Limited).

At an extraordinary general meeting of this Company, held on the 19th October, 1888, at the Cannon-street Hotel, Mr. John Marks (Chairman) presiding,

Mr. SAMUEL JAMES BOYCE, the Secretary, read the notice convening the meeting.

The following special resolution, passed on the 3rd inst. :—

"*That the capital of the Company be reduced from £125,000, divided into 500,000 shares of 5s. each, to £62,500, divided into 500,000 shares of 2s. 6d. each, and that such reduction be effected by cancelling capital which has been lost or is unrepresented by available assets to the extent of 2s. 6d. per share upon each of the 312,000 shares which have been issued and are now outstanding, and by reducing the nominal amount of all the shares in the Company's capital from 5s. to 2s. 6d. per share,*"

was unanimously confirmed; and Mr. NEWTON moved, Mr. H. R. JONES seconded, and Mr. W. H. WHITE supported, the following resolution, which was also passed unanimously :—

"*That this meeting hereby requests and authorises the Directors to issue a circular to the shareholders, embodying the remarks of the Chairman, and accompanied by a form of application for shares, and that the shareholders be urged to apply for shares within a week of the issue of the circular, and that the Directors are hereby authorised to go to allotment upon applications being received for not less than 80,000 shares.*"

A vote of thanks to the Chairman terminated the proceedings.

The Edison and Swan United Electric Light Company (Limited).

The following is the report to be submitted to the shareholders at the fifth annual general meeting of this Company, to be held at the Cannon-street Hotel, on Tuesday, October 30, at 12 o'clock :—

2. The sale of lamps has progressed in a satisfactory manner during the year. The volume of the Company's business has increased, and has resulted in a credit balance of £25,123. 9s. 7d.

3. The directors have already informed the shareholders that in the recent suit against Mr. Holland, one of the users of the Anglo-American Brush incandescent lamps, Mr. Justice Kay decided that the defendant infringed the Company's Cheesbrough Patent, but that the Edison Patent, under which he was sued, was invalid.

4. The Directors, after consultation with their legal advisers, lodged an Appeal against Mr. Justice Kay's decision on the Edison Patent. The Appeal will probably be heard before Christmas.

5. The possession of the Cheesbrough Patent gives the Company a decided advantage over other makers of incandescent lamps; and as this patent has been pronounced valid by two Courts of First Instance, as well as, in one case, by the Court of Appeal, the Directors hope that the Company may not be put to any further necessity to defend their rights as to this valuable patent.

6. The Anglo-American Brush Company have brought two actions against the Company; the one in connection with electrical distribution, and the other alleging that we infringe one of their patents, in a matter of detail, in the manufacture of our lamps. The former is a matter of small concern to the Company, and in the latter we are advised that we have a complete answer to the alleged infringement. Much as the Directors regret these legal proceedings, they feel that they have no choice but to defend the Company's rights.

7. Lord Thurlow's Amendment of the Electric Lighting Act of 1882 is leading to a considerable development of electric lighting, and to a corresponding increase in the Company's business.

8. Mr. J. S. Forbes and Mr. F. R. Leyland retire from the Board, and offer themselves for re-election as Directors.

9. Messrs. Quilter, Welton and Co., the auditors, also retire, and offer themselves for re-election.

THE LIGHTS AT PADDINGTON.

A well-known electrical engineer sends us a reply to "Lines to the Electric Light at the Great Western Terminus," by a "Misanthropic Gasholder," from which we extract the following :—

You say I jump and jerk, sometimes in turn.
You always flicker, never steady burn;
Each puff of wind will make you flaunt and flout,
If such a trifle does not put you out.

'Tis clear to me, within your mind there lurks
Imagination as to jumps and jerks;
These don't occur with me, my friend so bold,
Since you yourself have said, "both are controlled."

Such contradictory statements stand for nought,
And show "the wish was father to the thought,"
Proving that your conclusions are all fudge,
And showing you a biassed, envious judge.

For by my brilliant light the streets around
Security to traffic now have found;
And tho' by an old gas holder I'm twitted,
The splendour of my light by all's admitted.

By a later post we receive another effusion of the same character, from which we make an extract :—

Though through my inconstancy
Many a bitter foe have I,
Votaries I still possess
Who my frequent flickerings bless.

Mark the lovers' grateful glance
After my eccentric dance!
Could a soft farewell take place
Were I ne'er to dim my face?

Why should we be so correct?
Who perfection can expect?
Were you ne'er accused of greed?
Did you never overfeed?

Does your mental series coil,
Inclination, never spoil
Bankers' balances by sore
Tempting you to overdraw?*

Should such inclination show
When your E.M.F. is low?
Does your shunt coil, conscience, mark
And contract your lengthening arc?

C. A. B.

* This is really intolerable.—ED. *E.*

LONDON CHAMBER OF COMMERCE.

MEETING OF THE ELECTRICAL AND ALLIED TRADES' SECTION.

A meeting was held on Monday at the offices of the London Chamber of Commerce, Botolph House, Eastcheap, for the purpose of completing the organisation of an Electrical Trade Section of the Chamber.

On the motion of Mr. H. S. Price, seconded by Mr. Emil Garcke, Mr. R. E. Crompton was voted to the chair.

The SECRETARY (Mr. Kenric B. Murray) read the minutes of the meeting held on the 13th July last, and scrutineers were afterwards appointed to go through the ballot-papers for the election of the proposed working committee.

In their report, the organising committee recommended that a working or executive committee (elected annually by the general body of the trade in accordance with the bye-laws of the Chamber) be charged with the ordinary business of the section, and that in the first instance it consist of 33 members, this number to be increased to 48 at the first annual meeting of the section, if the membership then obtained should warrant a larger representation. It was proposed that the working committee should meet whenever occasion required, and that meetings of the whole or part of the section, in addition to the usual annual meeting, should also be called from time to time. With a view to an equitable representation on the working committee of the various branches of the electrical trade, the organising committee, after preparing a classified list of members, recommended that the committee be divided into the following sub-sections, viz. : Telegraph companies, 5 members; telephone companies, 3; electrical supply companies, 6; electrical manufacturers and contractors, 13; consulting electrical engineers, 4; general, 2. The committee recommended that members of the working committee be elected by ballot. Having regard to the bye-laws and regulations of the Chamber, the committee did not advise the adoption of special rules to govern the section and its committee, as they were of opinion that for the present it would suffice to follow the procedure of other trade sections. As regarded applications for admission into the section it was suggested that the working committee should be allowed an opportunity of scrutinising them before presentation to the Council of the Chamber for election.

The CHAIRMAN invited remarks or questions on the report, and stated that the organising committee would be prepared to answer them. He

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would also then be very glad to afford any information, and explain the reasons and line of thought which had governed them when they prepared the report. He might state that the way in which the sub-section had been drawn up had not been fixed on without considerable heartburnings. The number of 33 members was that which was allowed by the rules of the London Chamber of Commerce until such time that they could increase it up to 48, which would be the full number. The organising committee thought that 33 was sufficiently large to represent the section at its present strength; but there was every reason to believe that their numerical strength would soon be increased by 50 per cent., if not doubled, when they could increase the number of their sectional committee up to 48.

Major-General WEBBER said that the organising committee had felt very strongly that the working committee should be of as representative a character as possible, that its members should be elected as far as possible by the actual suffrages of the members of the section, and that there should be no recommending, as it were, from themselves. They started with about 200 members, and it had, therefore, been a comparatively easy matter to send out voting papers to the members, with the list of the whole number of their body, from whom they might select the 33 members they desired to form the working committee. In that respect he thought that the organising committee were to be congratulated on having made a fair start. Having answered certain criticisms in the electrical press on their mode of procedure in this matter, and defended the course taken by the committee, he expressed his belief that when the committee of 33 met together, the real work of the section would begin, and that their increase in number to 48 would very soon take place.

Mr. ROBERT HAMMOND stated that he had been to San Francisco since he had last met his electrical friends, and the measures adopted for the formation of the section had been taken during his absence. He could only say that he was very glad to see that the City had at last been recognised as the centre where subjects interesting to their trade or profession could be discussed. He would like to hear something as to what this particular section of the London Chamber of Commerce was going to do, as there were one or two other societies connected with electricity.

The CHAIRMAN replied that for some time past most of them who had been working at their new branch of engineering—electrical engineering—had felt that united action was most desirable on many points, as isolated action with other bodies—local authorities, for instance—had had a bad effect, and certainly had not advanced their interests. At that moment he held in his hands a series of regulations which had been addressed to them from the Board of Trade, and other papers had been forwarded for approval by the Board of Trade. At the present moment, to speak of the metropolis only, the London local authorities were face to face with many applications either for provisional orders or licenses under the new Act. It would appear far better that they should discuss dispassionately the mode in which they should deal with the local authorities. It had been asked whether the latter would make them pay "ransom" in connection with the public lighting, or whether they were to be rated on the mains under the streets, or whether they would have to put their wires underground or run them overhead. All such questions could best be discussed among themselves, and when they had arrived at a general opinion as to what was best for their interests they could agree as to the conditions on which they would or would not accept the terms that might be offered by the local authorities. To take a personal question, about six months ago—owing to an order given by the Amalgamated Engineers regarding piecework—there was a strike at the works of his firm; and this was a question which affected every one connected with the manufacturing branch of their industry. His firm held out, and dismissed the men who were connected with the Amalgamated Engineers; but it would have been a good thing for his firm—or any other firm where the strike might have occurred—if concerted action could have been taken in the matter. There were various other questions which had to be dealt with—the hours of electric light men, and the subject of overtime paid in regard to hours in other trades, which were the regular hours in the electrical trade. There was one matter which he rather fought shy of at the present moment, but which he was convinced would come up—the question of prices. Many of those present might think that the trade would never be able to come to an agreement on that point, but they found it was customary in other trades for an agreement to prevail as to the question, and why should not that be the case in their own business generally. They were all now "standing on their feet." They knew that they were in strong competition, and most of them knew when an estimate was given in whether they could make a profit on it or not. Although the subject of prices would not enter into their discussion at that meeting, yet he considered it quite reasonable to suppose that electrical manufacturers and contractors would eventually fix on some standard lists and would keep to them as closely as was done by makers of gas and steam engines. That would be a great point gained. Beyond that there were many questions which concerned the public. A great many names were entered under the heading of "general," many of them being consumers of electricity. It had not been very usual, he believed, in these cases to include consumers among the working body of the committee, but he believed that that course would prove advantageous to their interests. They desired to increase their trade, and they wanted to take those who purchased their goods into their confidence. He thought in their future deliberations they would have the benefit of getting the views of consumers. Among consumers of electricity he saw the name of Mr. Alexander Gordon, a gentleman who used more electricity than almost anyone else in London, and his views as to how it paid and on other points it would be advantageous to know, and they were matters which could be discussed among themselves, though not at places devoted to the more scientific aspect of the subject. He thought he had mentioned the points which had struck him most forcibly; but there were many other matters which if he had had notes he might have mentioned to them. His deficiencies, however, in that respect might be supplied by other speakers. He might mention that the organising committee had had considerable difficulty in getting at the members to form the different proposed sub-sections, 33 being too small a number, and many names had been omitted from certain sub-sections which they would have liked to include. They could not help themselves, however, being bound down to the number of 33 at present. The telegraph companies had had an organisation among themselves for a long time, but the committee could not have allowed those companies a less number than proposed, though it was doubtful whether they would take any great part in the future proceedings of the section.

Colonel RAYNSFORD JACKSON observed that the Chairman had no doubt represented generally the views of the London Chamber of Commerce; but having himself been a director of the Manchester Chamber and also connected with employers' associations, he confessed that he had thought the Chairman was somewhat intermixing the functions of the two. He had never known a Chamber of Commerce to deal with the question of wages or of disputes between employer and employed, or to take part in fixing the prices which were to regulate the dealings of any trade. He had always considered such questions as outside of the function of a Chamber of Commerce. With reference to the work of the organising association, he thought the members of the section must feel thankful to the committee for the way the work had been done. He had no doubt it had been a difficult matter to fix the representation of the different portions of the electrical trades, and he had no doubt that what had been done by the organising committee would be perfectly satisfactory to them all. He thought it would be a pity if any one of the classes into which the section was divided was entirely unrepresented at the working committee, and he thought that provision might be made that each class should have one representative on the committee. Let them take, for example, the case of the telephone companies; there were matters with which the Chamber might be asked to deal very similar to those alluded to by the Chairman—the running of wires overhead or underground, the powers to be obtained from Parliament, and many other points; and if any one of the proposed sub-sections was entirely unrepresented on the working committee the effect might be that the interests of that class might be lost sight of, although possibly there might be means of communication between the working committee and outsiders which would enable the interests of the latter to be dealt with.

Mr. F. L. RAWSON observed that it was proposed in the report of the organising committee that there should be two members of the "general" sub-section; but supposing all the members present voted for only one name, in that case the working committee would choose some one themselves. He understood from Mr. Murray that that was the course taken in similar cases where the sections were not completed. He assumed that the committee would not take into consideration any matter in respect, say, to electrical engines, unless a quorum of electrical engineers were present. With reference to the question of the subjects to be dealt with by the sectional committees, the London Chamber of Commerce left it to each committee to take up what questions it liked. They must remember that their section of the Chamber was the offspring of an idea which had endeavoured to fructify a good many times in the shape of having a representative body to deal with various subjects, and there were many questions outside those ordinarily taken up by the Chambers of Commerce which were vital to to those interested in electrical matters. There was the all-important question of electric lighting fire rates; another question was the price to be charged where companies overlapped. No doubt different companies among the electrical supply companies would overlap certain districts, and if any differences arose from that cause it would be much better if they could be arranged through the working committee. That led up to the question of arbitration, and he was sure that most of them would willingly go to an arbitrator or arbitrators appointed by the committee. Then it might be found that certain bodies would proceed against certain members of the trade, and they themselves might like, as a general body, to take up the question at issue. Again, there was the large question of parliamentary matters. There was no doubt that a requisition or statement coming from a body of electrical engineers, backed by the London Chamber of Commerce, would come with far more weight than it would coming from any individual. There were, also, the questions of patents and of rates of rental. He suggested that the working committee should have the power to elect their chairman and vice-chairman from outside their own body, if they wished to do so.

Mr. ROGER WALLACE proposed a resolution in accordance with this suggestion. He agreed with Col. Jackson that a Chamber of Commerce was not the body to deal with the question of wages, as a chamber should look to the interests, not of one class of a trade, but of all classes. His (the speaker's) interests, as those of a consumer, were that electricity should be supplied to him as cheaply as possible, but Mr. Crompton's view on that point might be different. There would thus be an issue between two sections of the committee, and therefore he thought that that kind of dispute should not come within the limit of the matters to be discussed by the Chamber of Commerce. As to other questions referred to by the chairman—questions as between rival companies and the way in which they should act with regard to the Board of Trade and local authorities—they were most important points which the committee would have to consider.

The motion of Mr. Wallace having been seconded by Mr. BROWN MARTIN,

Mr. GARCKE said they knew from experience that all past attempts to form the association had failed almost entirely from the difficulty of formulating their functions. He thought it very fortunate that they had found in the London Chamber of Commerce a constitution and set of rules under which they could come together and settle what questions they should discuss and what questions they should leave alone. He agreed that most of the topics mentioned by the chairman would form suitable subjects for the section to consider, but one or two of them he hoped the section would not attempt to deal with. He did not consider

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it unfortunate that he should differ from Mr. Crompton on this particular point; on the contrary, he thought they should have the opportunity of coming together and finding out where they agreed and where they differed. What they wanted was a centre of intercommunication where they could gather at any critical time and ascertain the views of the trade. He really felt that the most important functions of the committee would be of a deliberative rather than of an administrative character. An important direction in which the section would be of immense use would be in the selection of one to speak for the general interest—say, in regard to legislative matters or to the fire offices. He was, however, sure that any attempt to regulate prices or stifle competition would end in failure. All electrical contractors were aware that from time to time specifications of an imperfect character were issued for carrying out electrical work—specifications which no electrical contractor would work to. Contractors in acting in their individual capacity felt a difficulty in dealing with such contracts, but if they could be brought together at a few hours' notice the question could be discussed as to the desirability of that sort of work being contracted for. Every interest was represented in the section, and he believed they would thus have the opportunity of ascertaining the views of every section interested.

The CHAIRMAN put the motion, and it was carried *nem. con.*

Mr. RAWSON said he presumed that when the working committee was appointed they would have the power to subdivide as much as they liked, and that the committee need only communicate with those sections whose interests were affected.

The CHAIRMAN said he believed that that was so. In reply to Mr. Garcke, the Chairman added that he had, in his former remarks, suggested that the price question would be likely to crop up because he was sure that it would. It was, however, unfair, when one spoke of regulating prices in a manner which everyone could understand, to talk of stifling competition—a matter which had nothing whatever to do with his suggestion. The idea was to fix on a price from which such discount as could be afforded could be allowed. It was possible that it might be outside the objects of the Chamber to deal with the labour question, but it should be remembered that the electrical trade was not, like other trades, long-established, and which had their associations of employers. That would be the first association of a commercial nature connected with the electrical industry, and it would no doubt give them the opportunity of forming an employers' association. The chamber had also means within itself of providing references.

On the motion of Mr. WALLACE, seconded by Mr. BROWN MARTIN, a vote of thanks was passed to the organising committee.

Mr. REEVES then proposed, and Mr. BROWN MARTIN seconded, a resolution for the adoption of the report of the organising committee. This motion was carried unanimously.

The meeting then terminated, it being arranged that the secretary should inform the members by post of the 33 names elected for forming the working committee.

ELECTION OF THE WORKING COMMITTEE—RESULT OF THE VOTING.

The names are placed in order of number of votes given, and those bracketed together indicate a tie.

Telegraph Companies (5).

SIR JAMES ANDERSON.
SIR JOHN PENDER, K.C.M.G.
MR. J. HERBERT TRITTON.
THE MARQUIS OF TWEEDDALE.
ANGLO-AMERICAN TELEGRAPH COMPANY. } MR. C. W. EARLE. MR. R. K. GRAY.

Electrical Manufacturers and Contractors (13).

MR. R. E. CROMPTON.
MR. ALEX. SIEMENS.
MR. MORITZ IMMISCH.
MR. E. GARCKE.
MESSRS. WOODHOUSE AND RAWSON.
MESSRS. JOHNSON AND PHILLIPS.
MESSRS. LAING, WHARTON AND DOWN.
MESSRS. CALLENDER AND SONS.
MESSRS. DRAKE AND GORHAM.
SIR DANIEL COOPER.
MESSRS. W. T. GOOLDEN AND CO.
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY.
VERITY BROS. } MR. J. J. COURTENAY.

Telephone Companies (3).

MR. J. BRAND.
COLONEL R. R. JACKSON.
ORIENTAL TELEPHONE COMPANY.

Electricity Supply Companies (6).

MAJOR-GENERAL WEBBER.
THE EARL OF CRAWFORD.
MR. J. E. H. GORDON.
MR. ROGER WALLACE.
MR. MARK PARKER.
MR. R. S. ERSKINE.

Consulting Electrical Engineers (4).

MR. W. H. PREECE.
MR. GISBERT KAPP.
MESSRS. H. ALABASTER, GATEHOUSE AND CO.
MR. W. H. SNELL *(Electrician).*

General (2).

SIR DAVID SALOMONS.
MR. QUINTIN HOGG.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

14,687. J. LOWE, H. M. ALBOTT, and G. GWILT. London. An improved portable electric lamp, applicable also for house lighting. October 12, 1883.

14,691. T. N. VAIL and J. A. SEELY. London. Improvements in telephone central station apparatus. [Date applied for under Section 103 of the Patents, &c., Act, 1883, April 20, 1888] October 12, 1888.

14,731. F. H. NALDER, H. NALDER, C. W. S. CRAWLEY and A SOAMES. London. A siren actuated by electricity. October 13, 1888.

14,741. T. PEASE. Cheshire. Improvements in the application of electricity to the propulsion of tramway cars and railway trains, or of other vehicles and canal or other boats. October 13, 1888.

14,772. G. F. REDFERN. London. A meter or apparatus for measuring the strength of continuous or alternating electric currents (L. Brillie, France). October 13, 1888.

14,781. J. GIBSON and C. B. GIBSON. Edinburgh. Electric apparatus for indicating when a mutual choice has been made by two among several individuals and also for cancelling the choice when not mutual. October 15, 1888.

PATENT

SILICIUM BRONZE AND SILICIUM COPPER WIRE.

The best for overhead Telephone and Telegraph Lines,

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ROLLED AND DRAWN PHOSPHOR BRONZE.

PHOSPHOR BRONZE BEARINGS, BUSHES, AND OTHER PARTS OF ELECTRICAL MACHINERY.

SOLE PROPRIETORS of the British, Indian and Colonial Patents,

THE PHOSPHOR BRONZE COMPANY (Limited),

87, Sumner Street, Southwark, London, S.E.

WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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14,789. T. Pease. Cheshire. Improvements in applying electricity to the driving of tramway cars, railway or road carriages, barges or other boats. October 15, 1888.

14,829. W. J. S. Barber-Starkey. Manchester. Improvements in portable galvanic batteries. October 16, 1888.

14,843. J. Oulton and J. Edmondson. Halifax. Improvements in electric meters. October 16, 1888.

14,885. G. Pitt. London. Automatic current regulators (C. Sautter and Co., Switzerland.) October 16, 1888.

14,888. T. D. Hollick. London. Improvements in electric cranes. October 16, 1888.

14,901. B. A. Doughterty. New Cross. Electric heat and fire detector test board, and is part of No. 14,790 of 15th October, 1888. October 17, 1888.

14,910. S A. Lovick Derby. The regulation of electrical induction coils. October 17, 1888.

14,924. E. Böhm. London. An improved incandescent electric lamp. October 17, 1888.

14,932. S. W. Maquay. London. Improvements in and connected with portable electric incandescent lamps and batteries. October 17, 1888.

14,941. A. Gauge. London. An electrical apparatus for the prevention of burglaries in dwelling-houses. October 17, 1888.

14,963. E. Cox-Walker and A. A. C. Swinton. London. Improvements in electric bells and signals, and in appliances for use therewith. October 18, 1888.

14,979. R. R. Hutchinson. London. Improved electrical brake apparatus for automatically actuating same. (Complete specification.) October 18, 1888.

14,980. R. R. Hutchinson. London. Improved method of and apparatus for operating capstans, windlasses, hoists, and the like by means of electricity. (Complete specification.) October 18, 1888.

14,981. R. R. Hutchinson. London. Improved method of and apparatus for actuating printing machinery by means of an electric current, and instantaneously checking or arresting the motion thereof when required. (Complete specification.) October 18, 1888.

14,982. R. R Hutchinson. London. Improved method of and apparatus for operating turntables for railways and other purposes, by means of an electric current. (Complete specification.) October 18, 1888.

14,984. R. R. Hutchinson. London. Improved method of and apparatus for rotating hydro-extractors by means of a current of electricity, and automatically checking or arresting the motion thereof when desired. (Complete specification.) October 18, 1888.

14,985. R. R. Hutchinson. London. Improved method of and apparatus for utilising a current of electricity for operating pile driving machinery, and rendering the action of same automatic. (Complete specification.) October 18, 1888.

14,986. R. R. Hutchinson. London. Improved method of and apparatus for applying electricity as a motive power to cranes, sheer legs, and the like. (Complete specification.) October 18, 1888.

14,987. R. R. Hutchinson. London. Improvements in fans, air propellers and the like, and method of operating the same by means of an electric current, and apparatus therefor. (Complete specification.) October 18, 1888.

14,988. R. R. Hutchinson. London. Improvements in "mashers" and "mixers," as employed in brewing and other processes, and method of and apparatus for applying electricity as a motive power for same. (Complete specification.) October 18, 1888.

14,989. R. R. Hutchinson. London. Improvements in steering apparatus for ships, and method of and apparatus for utilising electricity as a motive power for same. (Complete specification.) October 18, 1888.

15,008. J. Fyfe London. Improvements in electric arc lamps. October 18, 1888.

COMPLETE SPECIFICATIONS ACCEPTED.

Note.—*All persons interested in opposing the grant of a patent on any one of the undermentioned applications may, at any time within two months from the date in italics, give notice at the Patent Office in the prescribed form of such opposition.*

October 20, 1888.

14,445. R. Haddan. London. Improvements in the insulation of submarine telegraphic cables and other electrical conductors (E. G. Pfillwitz, Germany). October 24, 1887.

14,461. A. Stetson. Liverpool. Improvements in electric accumulators or secondary batteries. October 24, 1887.

14,729. W. H. Douglas. Birmingham. An improved meter for measuring electrical currents. October 29, 1887.

14,834. W. R. Lake. London. Improvements relating to the regulation of steam engines and other motors for working dynamo-electric machines or electric generators (C. L. R. E. Menges, The Netherlands). October 31, 1887.

15,118. W. Clarke and C. A. Parsons, of the firm of Clarke, Chapman, Parsons and Co. London. Improvements in electric incandescent lamps. November 5, 1887.

15,922. A. Coleman, H. F. Jackson and E. L. Dudley. Birmingham. An improved spring jack for telephonic and other electrical purposes in which it is desired to change or switch a current from one conductor to another. November 19, 1887.

16,217. F. C. Allsop. Bexley. Apparatus for automatically conveying and delivering letters and small parcels by electricity. November 25, 1887.

16,370. H. J. Allison. London. Improvements in or relating to switching, feed, and call appliances for automatic telegraph systems (The Writing Telegraph Co., Incor., United States). November 29, 1887.

16,863. F. King. London. Improvements in or connected with means for the automatic electrical distribution and charge of secondary batteries. December 7, 1887.

17,175. G. E Gouraud. London. Improvements in phonographs and phonograms (T. A. Edison, United States). December 14, 1887.

20. J. Sherrin and J. V. Sherrin. Ramsgate. Improvements in the entire or partial propulsion of velocipedes and other vehicles by means of electromotors worked by primary batteries. January 2, 1888.

12,455. J. Sherrin and J. V. Sherrin. London. Improvements in the application of primary batteries or electromotors to tricycles or other velocipedes. August 29, 1888.

12,986. R. Cresswell. London. An improved electric or galvanic sponge or pad for stimulating and curative purposes. September 8, 1888.

13,192. E. M. H. Andreoli. London. Improvements in and relating to bleaching by electrolysis. September 12, 1888.

PATENTS SEALED.

October 19, 1888.

10,611. R. P. Mellburn. Newcastle-on-Tyne. Improvements in electrical batteries. August 2, 1887.

10,833. J. R. Boardman. London. Improvements relating to electric lamps. August 6, 1887.

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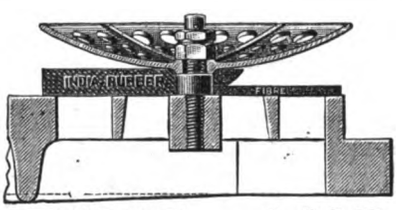

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10,839. F. L. Rawson and W. White. London. Improvements in electrical switches. August 6, 1887.

10,962. L. Anspach and L. Gerard. Brussels. Improvements in or connected with dynamo-electric machines and electro motors. August 10, 1887.

12,203. J. L. Hemming. Birmingham. Improvements in dynamo-electric machines. September 9, 1887.

13,320. J. G. Statter and S. L. Brunton. West Drayton. Improvements in electric regulators. October 1, 1887.

13,558. P. Everitt and R. R. Allen. London. Improvements in or relating to casings for electrical conductors and apparatus. October 6, 1887.

13,567. A. M. Clarke. London. Improved automatic electrical fixing mechanism for naval ordnance (F. Oriolle, France). October 6, 1887.

14,024. N. de Benardos St. Petersburg. Improvements in secondary batteries or electrical accumulators. October 15, 1887.

14,029. F. C. Allsop. Bexley. Improvements in electrical tramways and railways. October 15, 1887.

5,681. C. S. Snell. Saltash. Improvements in switches used for electrical purposes. April 17, 1888.

SPECIFICATIONS PUBLISHED DURING THE WEEK.

13,605, 1887. Coate, J. Automatic coin-freed dynamo metric machine. (Price 8d.)

14,996, 1887. Hopkinson, E. Transmitting motion from electric motors to driving axles of vehicles. (Price 8d.)

15,760, 1887. Webster, W. Electrolytic treatment of sewage and sea-water. (Price 8d.)

16,185, 1887. Barber-Starkey, W. C. S. Electric meters. (Price 8d.)

16,772, 1887. Macdonald, J. A. Electric bells. (Price 6d.)

8,611, 1888. Laughton, W. Galvanic belt for medical purposes. (Price 8d.)

1,830, 1882. Fleming, J. Transporting goods, &c., by electricity. (Price 8d.) Second Edition.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended October 19th, 1888, amounted to £5,123.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY.—The directors of this company have declared an interim dividend at the rate of 5 per cent. per annum, payable on the 14th prox.

EASTERN TELEGRAPH COMPANY.—This company announce the payment on November 1st of interest for the half year ending October 31st on their Four per Cent. Mortgage Debenture Stock. Transfer books will be closed from October 27th to November 1st, both days inclusive.

GREENWOOD AND BATLEY (LIMITED).—Application has been made to the Stock Exchange for a special settling day and quotation for the Ordinary shares, Seven per Cent. Cumulative Preference shares, and Five per Cent. Debentures in this company.

INDO-EUROPEAN TELEGRAPH COMPANY.—The Board of Directors of this company, on Monday, declared an interim dividend for the half year ended the 30th June last, at the rate of 5 per cent. per annum, the same as a year ago, free of income-tax, payable on and after the 1st November next.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended October 19th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £4,282.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—At the approaching half-yearly meeting of this company the Directors will recommend a dividend of 12s. per share on account of arrears on the first preference capital, placing £2,000 to the reserve fund, and carrying over £1,255. The estimated traffic receipts for the half month ended October 15th, 1888, were £2,482, as compared with £2.742 in the corresponding period of 1887. The June receipts, estimated at £5,484, realised £5,550.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Oct. 24, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Oct. 24, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American	47½ 48½	2 16 3	Jan., Apr., July, Oct.	48⅜	47⅜
2,614,820	Stock	10/0	Do. Preferred	80 81	3 7 11	,, ,,	80⅞	80
2,614,820	Stock	nil.	Do. Deferred	16¼ 16⅞	...	February	16⅝	16¼
130,000	£10	8/0	Brazilian Submarine	13⅜ 13⅝	5 1 0	Mar., June, Oct., Dec.	13 9/16	13¼
16,000	10	9/0	Cuba Submarine	13¼ 14¼	5 10 9	February and August	...	...
6,000	10	10/0	Do. Preference	18 19	5 5 3	,, ,,	18½	...
12,931	5	2/0	Direct Spanish (£4 paid)	3¾ 4¼	3 15 4	March & September	3⅞	...
6,000	5	5/0	Do. Preference	9 10	5 0 0	April and October	...	...
60,710	20	2/0	Direct United States	10 10½	3 18 1	Jan., Apr., July, Oct.	10½	...
380,000	10	4/6	Eastern	12⅜ 12⅝	4 15 1	,, ,,	12⅝	12⅜
70,000	10	3/0	Do. 6 per Cent. Preference	14¾ 15¼	3 19 0	,, ,,	15 7/16	14⅛
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	3 18 0	February & August	...	...
250,000	10	2/6	Eastern Extension	13 13½	4 18 1	Jan., Apr., July, Oct.	13½	13
22,050	10	8/3	German Union Telegraph and Trust	9 9½	7 7 4	January and March	...	...
179,177	10	3/0	Globe Telegraph and Trust	7 7½	4 16 7	Jan., Apr., July, Oct.	7½	7
178,992	10	3/0	Do. 6 per Cent Preference	14⅛ 14⅜	4 3 6	,, ,,	14 7/16	14⅛
150,000	10	5/0	Great Northern	14 14½	5 3 5	Jan., July, and April	14 7/16	14⅛
17,000	25	37/6	Indo-European	38 40	6 5 0	April and October	39½	39
33,348	10	3/0	London Platino Brazilian	6 6½	...	May and November	...	...
9,000	8	4/0	Reuter's	7½ 8	5 0 0	April and October	...	...
338,225	Stock	13½%	Submarine	135 145	10 0 0	February & August	...	...
30,000	10	6/0	West Coast of America	7⅜ 8½	6 1 3	January and July	...	...
150,000	Stock	8%	Do. Debentures	117 121	6 12 3	June and December	...	...
88,321	10	nil.	West India and Panama	1⅝ 1⅞	...	...	1⅛	1⅛
34,563	10	*10/0	Do. 1st Preference	12 12½	7 12 0	April and October	...	...
45,181	15	9/0	Western Brazilian	13¼ 13½	4 14 5	March & September	13 9/16	12⅜
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 6	March & September	...	...
			TELEPHONES.					
224,850	14/0	£5 7s.% '87	Consolidated Telephone and Maintenance	1/16 1/4	5 10 0	Yearly	1/16	...
220,000	£1	2½% '87	Oriental (11s. paid)	5/16 7/16	3 9 0	...	...	...
80,000	5	10/0	United	13¼ 13⅜	5 9 1	June and December	13½	13⅜
275,000	5	4/6	United River Plate	5⅜ 5⅝	...	July and January	5⅝	5½
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	4 4½	...	...	4⅝	4½
28,692	5	nil.	Do. (fully paid)	5 5½	...	February & August	5⅝	5⅛
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2½	...	...	2⅜	...
312,000	½	5% '86	Maxim-Weston	1/16 1/16	...	February	1/16	...
			MISCELLANEOUS.					
87,350	12	36/0	Telegraph Construction and Maintenance	39 40	6 3 10	March and July	39½	...
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works	16½ 17½	5 14 3	February & August	17½	17

* On account of arrears of dividend.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL SCIENCE, INDUSTRY AND ENGINEERING.

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NOTES.

At the meeting of the Society of Telegraph-Engineers and Electricians on Thursday next the Members will be called upon to vote upon the momentous question of changing the title of the Society to that of "The Institution of Electrical Engineers." It is already known that the result is a foregone conclusion; out of the 846 replies which have been received to the circular sent out in February last 837 expressed approval.

If, according to a famous dictum, "chemicals" are the barometer of British trade, it is at least equally certain that the condition of the trade in incandescent lamps forms the readiest clue to the progress of electrical engineering. It must, therefore, be a cause for general and unqualified satisfaction that as a result of the year's trading the Edison-Swan Company can show a balance of over £25,000 to the good on the profit and loss account, and moreover that it has now wiped out the losses on account of actual working expenses incurred during the earlier years of its existence. In fact, the Chairman was clearly justified in asserting that the company has at length arrived at the status of a money-earning concern. On the other hand, the unfortunate shareholders will derive no immediate benefit. In the present state of uncertainty as to costs in the recent action and the pending appeal, any distribution of profits has been rightly judged to be out of the question. It must, however, be a source of unqualified gratification to the lawyers that both the Edison-Swan and their opponents, the Brush, are showing such unmistakable signs of vitality.

With regard to the future of the incandescent lamp trade, no less than that of electric lighting in general, we entertain no doubt whatever that a substantial reduction in the price of lamps would be rapidly followed by a more than commensurate increase in the demand. The experience of those who are engaged in central station lighting work seems to be unanimous on this point. The cost of lamp renewals is an item which appeals very closely to the economical instincts of the would-be consumer, and is regarded with even greater disfavour than the rental of the meter. We think that the Edison-Swan Company would be doing a wise and politic thing in announcing a reduced rate *before* the result of the pending appeal case is made known, since it is quite certain that if the judgment is not in their favour their hand will very soon be forced.

The situation in Chelsea is rapidly becoming exciting, there being signs that this district will form the battle ground on which some of the outstanding questions relating to electric lighting will be fought out. Legal as well as Technical matters are involved. The Chelsea Electricity Supply Company have had their Provisional Order confirmed in the last session of Parliament and are already at work upon their underground mains. Meanwhile the Cadogan Company have invaded their territory with overhead wires, and the London Electric Supply Corporation have given notice of their intention to follow suit. Here then, is the crux:—How far does the possession of a Provisional Order (confirmed by Act of Parliament) operate to exclude an opponent who seeks to escape altogether from the scope of the Electric Lighting Act by keeping to the housetops? This is a question which the position of affairs in other parts of London as well as in Chelsea will shortly press for decision.

Meanwhile, in self-defence the Chelsea Electricity Supply Company have issued to their "future customers" a very ably-written pamphlet, in which the superiority of underground to overhead wires, of batteries over transformers, and of this particular company over all others are expounded in forcible and well-chosen terms. The company "trusts that the residents of Chelsea will not encourage desultory and indiscriminate competition, which can only result in unsatisfactory service." It is, however, noteworthy that, as a result of the threatened competition (however "desultory or indiscriminate"), the Company have decided to charge only 8d. per Board of Trade unit, instead of 10d., to which they are entitled by the Act. This charge does not seem at all too high for a battery system, although we have sufficient confidence in the promoters of this undertaking to believe that they will not fix a tariff which would prove finally unremunerative. In this particular the Supply Company are also entitled to sympathy, owing to the somewhat sharp practice of the Cadogan Company (whose central station was described in *The Electrician* of July 20, 1888). The latter company profess to charge 6d. per unit, but since this is based upon the current put into the consumer's battery, there is not in reality much difference between the two tariffs.

The company-mongering scandals which have been the disgrace, as they have also proved well-nigh the ruin, of the electric lighting interests in this country, have nowhere found more vigorous or unsparing denunciation than in these columns. We venture, however, to add that our criticism has also been of

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a discriminating character, and has again and again been justified by events. This is just the element which is conspicuously lacking in a leading article which appeared in the *Financial Times* of Monday last. In this remarkable effusion almost every prominent name which has been connected with electric lighting is held up to contempt and ignominy. But in this wholesale abuse the writer betrays either an exemplary ignorance or a most reprehensible disregard for facts. His remarks on the "Duplex," the "Phœnix," the "Fyfe-Main," and the "Maxim-Weston" Companies are, no doubt, of a defensible character. But such statements as that the Whitehall Electric Supply Company "is a trumpery concern," that Edison-Swan "exists in a sort of a way," that Gülcher "has retired into obscurity," that the works of the Brockie arc lamp know it no more, and that Jablochkoff (like Edison-Swan) has "a sort of existence," are of a kind which makes it necessary to remark that a little accurate information should not be considered altogether superfluous in leader writing for a financial journal.

At the end of the article referred to in the previous Note we are warned against confounding any other concern with that of the "London Supply Company" (*sic*), "which has an organised system and possesses works and patents." It may therefore be as well to state that the London Electric Supply Corporation—which we presume is referred to—are not the owners of any patent rights. With regard to the Ferranti patents, they simply occupy the position of customers.

The laying of the foundation-stone of the first municipal electric lighting station in this country is an event which deserves a passing notice. The Corporation of Bradford, by their liberal and enlightened policy in this matter, have earned for themselves a position of some historical importance in the annals of electrical engineering. Several unforeseen obstacles have retarded the progress of the work during its earlier stages, but we are not sure that this is entirely a matter for regret, and although the event of Friday last was described as the laying of the "foundation-stone," yet the actual building operations are in a forward state, and the laying of the cables will commence almost immediately. Under the able superintendence of Mr. Shoolbred, and with Messrs. Siemens Bros. as contractors, we may look for success in the fullest sense of the word.

Dr. Oliver Lodge, in his letter on "Lightning," which will be found elsewhere, proposes that experimental—or rather observational—lightning conductors should be set up at every meteorological observatory. This should certainly be done, especially as the cost need not be great. Definite results would, however, be sooner arrived at if such experiments were carried out in latitudes where thunderstorms are somewhat more frequent and more violent than with us. Possibly some of the Submarine Telegraph Companies, which have already done so much for the cause of science, and which possess especial facilities for the task, may be inclined to undertake it. It would certainly be difficult to over-estimate either the scientific or the practical value of a well-conducted series of observations of the character suggested.

Mr. Raine calls attention, in our correspondence columns, to the fact that as long ago as 1842 Prof. Henry had obtained experimental evidence of the existence of the oscillatory discharge. Although this was new to us, we were already conscious that the work of Prof. Henry has been too much neglected, and readers will have noted that in our last issue Dr. Fleming commenced some Papers on Electro-Magnetic Induction with a brief history of Prof. Henry's researches. It will shortly be found that by the application of modern theory to these early experiments Dr. Fleming has been able to arrive at some conclusions which are both novel and important.

In the columns of a contemporary, Prof. Elihu Thomson and Mr. Wightman have recently described an interesting experiment which seems to indicate a novel method of obtaining rotation by means of an alternating current. The experiment is described in several forms, but the principle is briefly this: A bar of iron, preferably unlaminated, is wound with a coil of wire, of which the turns near the end of the bar form a closed circuit. This is brought near to a thin disc of iron, balanced at its centre on a vertical pivot. When an alternating current is sent through the coil the disc rotates. The best effect is obtained when the centre of the disc is brought in a line with the junction of the two parts of the winding. We are told that the effect is sufficiently powerful to produce rotation at a distance of three or four feet, with a coil of nine or ten inches in length, but the current employed is not mentioned.

The inaugural *conversazione* given on Tuesday evening by the directors of the Institute of Medical Electricity, at the rooms of the Medical Society in Chandos-street, was a decided success. The graphophone was, of course, to the fore, and attracted the usual amount of attention. In another room the Woodhouse and Rawson Company made a fine display of electro-medical appliances. A miniature incandescent lamp for lighting up the cavities of the throat was the first object of considerable curiosity; indeed, one venturesome spirit undertook to illuminate his vocal chords *pro bono publico*, but in spite of recent publications, no one present knew where to look for them, so that the public-spirited experiment was wasted. Microbes and bacilli were also on view, so that there was a highly judicious blend of electricity and medicine. After a brief address from the chairman, Mr. Wm. Lant Carpenter, explaining the objects of the Institute, Prof. Silvanus Thompson began his lecture "On Old and New Views of Magnetism." The lecture was naturally of an elementary character, and was greatly appreciated by the audience. Prof. Thompson did not let slip this opportunity of rescuing the name of Dr. Gilbert from the partial oblivion it so little merits. Dr. Gilbert, and not Charles II., we were assured, was the real founder of the Royal Society; Dr. Gilbert, and not Bacon, was the genuine inductive philosopher; and,

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if we remember rightly, Dr. GILBERT and not the overrated SHAKESPEARE was *the* glory of the Elizabethan era. We are afraid nothing short of an entire re-arrangement of historic reputations will satisfy the professor. The Institute of Medical Electricity has made an excellent start, and we look to it to clear medical electricity from the stigma of quackery under which it has too long laboured.

SOME progress has been made with the erection of the telephone wire between London and Birmingham. Between 30 and 40 miles have been completed, and the way-leaves have been obtained for the greater part of the remaining distance. It is also intended to run a line to Reading, and the way-leaves for this are being obtained. Lastly, the Croydon line is being extended to Sutton and Mitcham. And yet people say that the United Telephone Company shows no enterprise.

OH! electricity,
With what delight
Do we saunter where
Thy effulgence bright
Knocks nightness into dayness
And darkness into light!

Progressive Age (New York).

Blenheim Palace.—Blenheim Palace has lately been fitted with a fine installation of the electric light, no less than 1,200 incandescent lamps being employed.

The Electric Light at the Royal College of Surgeons.—The magnificent library of the Royal College of Surgeons has just been provided with the electric light, and the installation has given great satisfaction.

Dublin.—On Monday last the Dublin Corporation, by 20 votes to 2, adopted the report recommending that steps be taken to supply electricity for private as well as public purposes, and that a special committee be appointed to give effect to the provisional order.

The Ironmongers' Exhibition.—The International Ironmongers' Iron and Metal Trades Exhibition opens at the Agricultural Hall, Islington, on Monday, November 12th, at 1 p.m., and remains open till Saturday, November 24th. This, the first exhibition of the kind, bids fair to be one of general interest.

Belfast.—The National Telephone Company has just completed the reorganisation of the Central Exchange Office in Belfast. The system in use up to the present having become insufficient for the increasing business of the exchange, the company has introduced the multiple switch-board of the most recent type.

The Electric Light at Suakin.—The Eastern Telegraph Company's ship "Electra" left Suakin on Thursday last for Suez direct, taking the wounded and sick. Great credit is due to the electricians, engineers, and officers of the "Electra" for repairing the electric light on the Shata Gate and for the general assistance rendered by them to the Government.

Mr. Magnus Volk.—We are pleased to hear that the Sultan of Turkey has decorated Mr. Magnus Volk. This well-known electrician has recently joined Messrs. Immisch as manager of their launch department. He is now at Constantinople with the electric dog cart recently supplied to the order of His Majesty the Sultan. The dog cart seems to give great satisfaction.

Personal.—We are requested by Mr. A. A. Campbell Swinton to state that his appointment as consulting electrical engineer to Messrs. Sir W. G. Armstrong, Mitchell and Co., of Elswick, which we mentioned last week, in no way affects his position as manager of the Equitable Telephone Association, which position he will still retain, and that his address will continue to be 75, Queen Victoria-street, E.C.

The Cox-Walker-Swinton Magneto Bells on Board Ship.—A number of these bells are being fitted by the Equitable Telephone Association on board the cruiser "Piedmonte," now being armed on the Tyne for the Royal Italian navy. The fact that these bells do not require any battery is expected to prove a great advantage, particularly for use at sea and in hot climates, where batteries are apt to get out of order.

Queensland.—From the Queensland Postmaster-General's Report for 1887 we learn that at the end of that year the mileage of telegraph lines in Queensland was 9,037, the mile age of wire being 16,447¼. There were 293 telegraph stations in daily operation, of which 23 had been newly opened during the past year. The net revenue from telegraph and telephone services amounted to £83,908. 18s., and the expenditure to £107,113. 13s. 1d.

Restoration of Communication with Australia.—Telegraphic communication with Australia was restored on the 29th of October by the ss. "Sherard Osborn," which is now engaged on a renewal of the duplicate cable, and in order to complete the work as carefully and expeditiously as possible the Eastern Extension, Australasia and China Company's ss. "Recorder" is assisting in the work. It is, therefore, hoped that no further inconvenience will be caused to the telegraphing public.

Otley.—The Otley Local Board are making inquires with a view of seeing whether their surplus water-power at Ellar Gill can be applied economically to the lighting of the public streets. The members recently inspected the Victoria Printing Works of William Walker and Sons, of Otley, which are now lighted by electricity in all the departments. The installation consists of a 300-light dynamo, serving a large number of glow-lamps, and three arc lamps of 3,000 candle-power each. The plant has been fixed by Messrs. John Roper and Co., of Bradford.

The Lighting of the Brighton Pavilion.—At the meeting of the Finance Committee of the Brighton Town Council, on October 22nd, a letter was read from Messrs. Boxall and Boxall, stating that the solicitors to the Maxim-Weston Electric Company had referred their dispute with the Corporation to arbitration, and requesting the committee to name an arbitrator to act on behalf of the Corporation. It was resolved to refer the matter to the town clerk and the solicitor to the Corporation, with power to take such course as they might think most advisable under the circumstances.

Electric Light and Telephone Contracts.—The following circular has been issued to members of the Electrical and Allied Trades Section of the London Chamber of Commerce:—"The following is a translation of a paragraph which appears in a report of the Belgian Consul-General on openings for the investment of foreign capital in the Canary Islands:—'Electric lighting is also wanted at St. Croix (Teneriffe) and Las Palmas (Grand Canary), and a contract would be made with a company willing to undertake it. It is the same for the telephone for the various towns of these islands.' The full report may be consulted at the offices of the Chamber."

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The Electrical Purification of Quartz and Kaolin.—Electricity is gradually being introduced in ceramic operations to purify quartz and kaolin from oxide of iron. The powder to be operated on is placed in a hopper, whence it falls into a receiver rotating rapidly on a vertical axis. This receiver is surrounded by powerful magnets of triangular section. The purified powder then falls into a second receiver, and after undergoing a similar purification in this, it is, as a rule, ready for use. The cost of this process is small, and it is stated that owing to its employment substances can now be used which were formerly rejected on account of the amount of iron contained in them.

Bath.—A meeting of the Town Council, sitting as the Urban Sanitary Authority, was held on Tuesday, October 23rd. The report from the Electric Lighting Committee was read. Alderman Gibbs formally moved the adoption of the report. Mr. Sturges, who seconded, thought the electric light would be a great advertisement for Bath. Mr. Cox was prepared to accept the report with the addition of this admendment:—"That the Corporation shall have the power to buy the whole of the plant at the end of seven years, at a fair valuation." Captain Franklin seconded Mr. Cox's amendment. When the amendment was put, 25 members voted for it. No one holding up his hand agaist it, the ex-Mayor declared it carried uuanimously.

The Buckingham Electric Light and Power Supply Company.—A meeting of the directors and shareholders of the Buckingham Electric Light and Power Supply Company (Limited) was held on Wednesday, the 17th inst., at Buckingham, Mr. A. C. Rogers presiding.—The Chairman said they had much upon which to congratulate themselves. They had forty shareholders, holding 858 shares, and the sum of 10s. had been paid on each share. They had ample capital for lighting the town by electricity. Several shops were already illuminated in this way, and the light was giving every satisfaction. Altogether the scheme promised to be a most successful undertaking. The directors for the coming year were then elected unanimously—Messrs. A. C. Rogers, J. W. Thorpe, A. Vyle, Geo. W. French, and H. Thorpe.

Society of Telegraph-Engineers and Electricians. — A special general meeting of members of the Society of Telegraph-Engineers and Electricians will be held at the Institution of Civil Engineers, 25, Great George street, Westminster, on Thursday, 8th of November, 1888, at 7:45 p.m., when the following resolutions will be proposed:—1. That the name of the society be changed to "The Institution of Electrical Engineers." 2. That the office of honorary secretary be abolished, and that the Articles of Association be altered by omitting all reference to the honorary secretary in Articles 36, 38, 40, and 43. Should the resolutions be passed by the required majority, they will be submitted for confirmation as special resolutions to a second special general meeting of members, which, in the absence of further notice, will be held on Thursday, November 22nd, at the same place and time.

Milan.—A correspondent, who has recently returned from Italy, writes enthusiastically as to the electric lighting of the city of Milan. The principal streets are lit by Thomson-Houston arc lamps, which are suspended high up above the centre of the roadway, an arrangement which effects a very satisfactory distribution of the light. He continues as follows:—"But the most perfect and startling effect is in the Piazza del Duomo, which is the large open space in front of the Cathedral. Here the Thomson-Houston lamps are on exceedingly handsome and artistic iron standards. The exquisite carvings on the old cathedral can be seen in bold relief, and the effect of the soft light of the electric lamps, which burn without a flicker, show up the white marble of this magnificent piece of architecture in a marvellous manner, and it may now truly be said that Milan Cathedral by night is probably one of the most impressive ecclesiastical edifices in the world."

Mill Lighting.—The installation at the mills of Messrs. Merrall and Son, spinners, Haworth, near Keighley, which has been put in under the supervision of Mr. W. Ricketts, has just been completed. The plant consists of two Luther shunt-wound dynamos, which are run in parallel, and have an output of 166 amperes at 90 volts. The dynamos are fixed in a separate room, upon a solid bed of stone; they are driven by the mill engine through 9in. single belts. In the dynamo room there is a fine slate switch-board, 4ft. by 2ft. 9in., supplied by Luther Hanson and Co., of Halifax, and provided with the necessary switches, voltmeters, ammeters, and Woodhouse and Rawson automatic magnetic cut-outs. There is also a smaller switch-board similar to the above. All the cables and branches are run in casing. In addition to the two main machines there is a small pilot 3½-unit dynamo, run off a water-wheel, and intended to supply three 32 candle-power lamps in each room of the mill when the machinery is stopped.

The Direct Spanish Telegraph Company and the Barcelona Exhibition.—The landing place at Barcelona of the Direct Spanish Telegraph Company's cable from Marseilles being within the grounds of the International Exhibition, it was arranged between the Municipality of Barcelona and the Company that as the iron hut which had done duty as a cable house for several years required replacing, a new and suitable cable house would be erected by the company before the opening of the Exhibition. In this cable house specimens of the different testing and other apparatus used in the company's service were shown, but for adequate reasons it was not considered desirable for the company to be included among the exhibitors. The jury of the Electrical section of the Exhibition, in their signed report to the council, have now recorded "That if the Direct Spanish Telegraph Company (Limited) had been included amongst exhibitors, the gold medal would have been awarded for the model cable house and fittings of the Barcelona-Marseilles cable, erected in the Maritime portion of the Exhibition."

Barnsley.—At the last meeting of the Barnsley Town Council Mr. Tinker moved "That the Lighting Committee be recommended to take into consideration some scheme for providing a better and more economical system of lighting the public lamps in the borough." He pointed out that in Barnsley the lamps were lit 2,500 hours per annum for £2 each; five-light Bray's lamps were charged £10. 10s., and three light lamps £6. 6s. per annum for that time. In Dewsbury the lamps were £1. 16s. 8d. per annum, and the Bray's lamps averaged £4. 9s. each, burning from dusk to dawn all the year round. Halifax paid £1. 4s. 11d., less 12½ per cent., each lamp burning 3,250 hours; Wakefield £1. 6s. per lamp, each burning 3,477 hours per year. The Barnsley price was too high, the number of hours too small, and the result was that on many dark mornings there was no light for people going to work. He thought the gas company might give them 500 hours per year more for the same money, and if it would not meet them the committee could inquire as to the cost of the electric light, which had been introduced in many towns.—Mr. Haigh seconded the motion, and it was ultimately carried.

The Barnet Central Station.—At the meeting of the Barnet Local Board on the 9th inst. a committee presented a report to the effect that as the electric lighting contractor had failed in his contract, and the light was indifferent, he be given fourteen days' notice to terminate the contract. At the urgent

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request of certain members of the Board, it was decided to suspend the notice for a fortnight to see if the contractor made satisfactory progress. The matter accordingly came before the Board at their meeting on the 23rd October, on the question of serving the notice, and Mr. Pooley observed that the report and recommendation of the committee having been agreed to at the previous meeting, their duty was clear. They must have some report as to the progress made, and if it was unsatisfactory, all they had to do was to proceed with the resolution. The surveyor (Mr. W. H. Mansbridge) submitted a report as to the general condition of the lighting from the 3rd to the 22nd inst.; and, in answer to the chairman (Mr. C. Stephens), said he could not regard it as satisfactory. It was therefore proposed that the notice suggested by the committee should be served on the contractor. An amendment was, however, brought forward to grant him another week's grace, and if by that time satisfactory progress had not been made, to give him notice to terminate his contract. Eventually this was agreed to.

Electric Lighting in Birmingham.—The most complete and extensive installation of the electric light which has yet been attempted in Birmingham has just been finished. The Corporation-street Estate Company (Limited) have erected one of the most important blocks of business premises in the town at the corner of Martineau-street and Corporation-street, from the designs of Mr. J. P. Sharp. The building consists of 19 large shops and basements, with spacious and well-ventilated offices on the floors immediately above. The two upper stories of the building are arranged for warehouses, work rooms, or dwelling-apartments as may be required, and access will be given to these rooms by lifts worked by electric motors. The electrical plant and appliances have been designed by Mr. T. C. Sharp, C.E., and consist of two 50 I.H.P. semi-portable compound steam engines, which have been made by John Fowler and Co., of Leeds. Current is generated by two 600 light shunt-wound dynamos, by Elwell-Parker, of Wolverhampton, who have also supplied large storage batteries, switch-boards, and all the necessary wiring. Fowler and Lancaster, of Albert Works, Birmingham, have provided the lamps and fittings. When the works are quite complete the total number of lights supplied will be about 1,000 16-candle-power incandescent lamps inside the buildings, and two 3,000 candle-power arc lamps on the exterior. The arc lamps supplied are of the Brockie-Pell pattern. One of the engines and a dynamo was run for five hours as a trial on Saturday with a satisfactory result.

Abandonment of the Electric Lighting Scheme at Exeter. At a meeting of the Exeter Town Council last week a report was considered from a special committee on electric lighting. The committee opened tenders for lighting the selected district by electricity as follows:—Exeter Electric Light Company, 65 arc lamps, 1,200 candle-power, £19. 17s. 6d.; wires, £3; total per lamp per annum, £22. 17s. 6d. Messrs. Allen and Son, Taunton, 65 arc lamps, 1,200 candle-power (Thomson-Houston)—overhead, per lamp per annum, £24; underground, £28. 10s.; Brockie-Pell or Pilsen-Joel, 1,000 candle-power, £21 and £25. 10s. respectively. Messrs. Newall and Co.—Thomson-Houston, 1,200 candle-power, overhead, £23. 10s. underground, £27. 10s.; Brush, 2,000 candle-power, £25. 10s. and £29. 10s. respectively. Messrs. Sharp and Kent, 2,000 candle-power lamps, £35 and £40. Anglo-American Brush Electric Light Corporation (Limited), 2,000 candle-power lamp, overhead, £43 per annum. The whole of the above figures were on a seven years' basis. The committee pointed out that the lowest tender represented a cost of £1,486. 17s. 6d. per annum, while the present cost of lighting the same district by gas was, according to the surveyor's report, £666. 11s. 8d. The total illuminating power of the existing gas lamps at the posts would be 2,000 candle-power, while that of the electric light would be 32,000 candle-power. Having regard to the large increase in the cost, as compared with that of gas, the committee did not recommend that any of the tenders be accepted, and the Council concurred.

Swansea.—At the meeting of the Swansea Town Council last week, the minutes presented by the Special Gas Committee stated that at a meeting held on the 2nd inst. reports from the town clerk as to the powers of the Corporation with regard to the erection of new gasworks and the lighting of the borough by electricity were received. The surveyor was directed to obtain such information as would enable him to fully report on the extent of works for public lighting which could be erected by the Corporation for an annual expenditure of £4,060, and also as to the cost of such further works as would admit of a supply to private consumers. He was likewise instructed to report as to the desirability of adopting oil lamps. It was resolved that, in the opinion of the committee, it was desirable to light the borough by electricity, and that the town clerk be instructed to apply to the Board of Trade for a Provisional Order accordingly. At the meeting of the committee on the 12th inst. they decided which streets in the borough should be lighted by electricity; and it was resolved that the Council be asked to invest the committee with full powers to conclude a contract with some substantial company for the lighting by electricity of the area in question. A letter was read from the Swansea Gas Company, asking the corporation to enter into a contract with them for the supply of gas to the public lamps for one, two, or three years at 2s. 10d. per 1,000 cubic feet; and the Town Clerk was directed to reply that the corporation were not at present prepared to enter into any contract. The minutes were adopted.

The Proposed Electrical Railway in the New Forest.—A meeting of the New Forest Union Highway Board was held on Monday, October 22nd, when a letter was read from Mr. St. Aubyn Angrove on behalf of the promoters of the Lyndhurst Road Tramway, in which he said they intended "to avail themselves of a further opportunity for more effectually gauging the general feeling of the parishioners of Lyndhurst by means provided by law." A memorial, signed by 160 persons, was read, expressing their approval of the scheme of Messrs. Haynes and Poole. Later on a telegram was received from Mr. St. Aubyn Angrove, stating that he withdrew his letter, and that Mr. Haynes would attend. It was unanimously decided to hear what Mr. Haynes had to say. Mr. Haynes was then called in, and said they had amended their plans since he was last at the Board. He found that there was an average width of 8ft. of waste on the south side of the road, and they would be able to keep their rail 4ft. to 5ft. from the side of the metalled road. The narrowest part would be 3ft.—Mr. Roy proposed that the matter be adjourned until the next meeting, the 5th of November, and that a deputation be appointed to see the proposed line as staked out.—This was seconded by Mr. Humby, and carried by 11 to 6.—Mr. Roy suggested that the Crown should be asked whether they would give their consent to the tramway being run partially or wholly over their property, which was agreed to.—It was also decided that the clerk should write to the London and South Western Railway Company, asking them if they would give the tramway promoters power to run over their property.

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NOTES ON ELECTRO-MAGNETIC INDUCTION.*

BY DR. J. A. FLEMING, M.A.

(Continued from page 786.)

Inductive Effects Produced by Transient Electric Currents.—Since secondary currents, which have, as we shall see, very brief duration, can in turn generate induction currents of higher orders, it was an obvious inference that Leyden jar discharges or the transient currents formed by discharging charged conductors, should in like manner be able to give rise to a family of induced currents in suitably placed circuits. Prof. Henry opened up this field of research, and it has been also diligently cultivated by Marianini, Abria, Matteucci, Reiss, Verdet, and many other physicists. Henry's first experiment was as follows: A hollow glass cylinder (*see* Fig. 4) of about six inches in diameter was prepared with a narrow riband of tinfoil about thirty feet long pasted spirally around the outside, and a riband of the same length pasted on the inside, so that the corresponding spires of the two were directly opposite each other. The ends of the inner spiral passed out of the cylinder through a glass tube to prevent direct communication between the two circuits. When the ends of the inner riband were joined by the magnetising spiral containing a sewing needle and a discharge from a half-gallon jar sent through the outer riband, the needle was strongly magnetised in such a manner as to indicate an induced current through the inner riband in the *same direction* as that of the current of the jar. If instead of using the magnetising spiral the ends of the inner riband were brought near together, a small spark was detected at the instant of sending a jar discharge through the outer conductor. Experiments were next made in reference to the production of induced current of different orders by electric discharges. For this purpose a series of glass cylinders with tinfoil spirals pasted on them was prepared and joined up so that the inner spiral of one cylinder was in connection with the outer spiral of another. When a

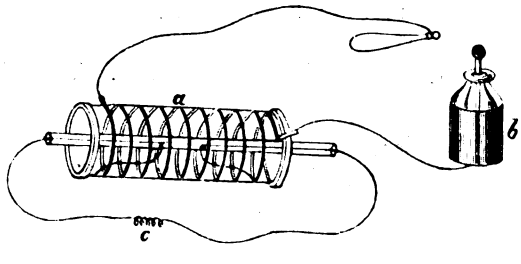

FIG. 4.

discharge was passed through the outer riband of the first cylinder it produced an induced secondary discharge circulating in the inner spiral of the first and the outer spiral of the second cylinder. This in turn generated a tertiary current, and so forth. Each of these discharges was a brief wave of current, and by the use of the magnetising spiral in each circuit an attempt was made to determine the direction of the discharge. Here, however, an anomaly presented itself. By the use of this magnetising spiral it appeared that the induced discharges were all in the *same direction*. Leyden jar discharges were then passed through the first member of the series of coils and helices used in the experiments on galvanic currents, and here the directions of the induced discharges in the several conductors were found to *alternate*. After various experiments Prof. Henry considered that he had found the solution of this anomaly in the different distances of the inducing and inductive circuits. As an experiment illustrating this he gives the following:—Two narrow strips of tinfoil about twelve feet long were stretched parallel to each other, and separated by thin plates of mica to the distance of about $\frac{1}{50}$th of an inch. When a discharge from a half gallon jar was passed through one of these an induced current in the *same* direction was obtained from the other. When the ribands were separated to a distance of about $\frac{1}{8}$th of an inch, no induced current, as evidenced by the absence of effect in the magnetising spiral, could be obtained. When the circuits were still further separated the induced current reappeared, but in the *opposite* direction to the primary discharge. The distance at which the induced discharge changes direction appears, according to Prof. Henry, to be dependent on a number of circumstances, such as the capacity and charge of the jar, and on the length and thickness of the wires.

With a battery of eight half-gallon jars and parallel wires of about ten feet long, the change in direction did not take place until the wires were separated by twelve or fifteen inches.

The currents of all the higher orders were found to change sign with a change in the distance between the inducing and inductive circuit.

One interesting experiment was made by Henry to illustrate the induction effect of jar discharges across considerable distances. In this case a primary circuit was formed consisting of an insulated wire eighty feet long. Around this and separated from it by a distance of about twelve feet was another wire one hundred and twenty feet long. When the discharge from thirty large Leyden jars was sent through the primary wire an induced discharge was obtained in the other sufficiently strong to magnetise to saturation a small needle placed in a magnetising spiral interpolated in the secondary circuit. We may, however, remark here, once for all, that all these experiments directed to determine the direction of induced discharges in which the magnetising power of the discharge is made use of for this purpose are difficult to interpret, and too much reliance must not be placed on the conclusions thus drawn. Leaving out of account for the moment all consideration of what are called electric oscillations, to which we shall allude subsequently, we can say that if two discharges are passed through a magnetising spiral, the discharges being oppositely directed and of equal *quantity* but different *durations*, the resulting direction of magnetisation will be dependent upon several conflicting elements. Speaking generally, the intensity of magnetisation is determined by the relative magnitude of the maximum current strength during the discharge, and of two discharges having equal quantity, the one lasting the shortest time would rise to the highest current strength during the period of the discharge, and exercise the greatest magnetising force. Even then it would not be safe to draw too pronounced a conclusion from the direction of magnetisation as to the relative magnitudes of the maxima of two alternate discharge currents rapidly succeeding each other, for, as Abria has pointed out* long ago, the demagnetisation of a steel needle requires a less magnetising force than that necessary to magnetise it in the first instance, and hence the final results are complicated by the relative order of imposition as well as the relative maximum magnitude of the magnetising discharge currents. One fact which has to be borne in mind in attempting to interpret these results of Prof. Henry is that the magnetising current whose direction we are seeking to determine acts by induction on the mass of the needle or iron in the testing magnetising coil, and generates in its mass induction currents circulating round its surface. Under the head of *Magnetic Screening* in a later section we shall examine the circumstances under which such currents induced in a metallic mass shield to a greater or less extent conducting circuits lying beyond them from inductive effects. Meanwhile we can say that the effect of a very *sudden* discharge in one direction in the magnetising coil is to induce eddy currents in the surface of the needle which shield the inner and deeper portions of the steel from the magnetising action, and the resulting magnetisation is chiefly superficial. If, however, the discharge is prolonged or dragged out whilst retaining the same electric quantity, the shielding action will not be so pronounced, and the magnetisation will penetrate deeper down into the mass of the steel. Accordingly two equal discharges, *i.e.*, discharges of equal quantity, may produce a greater or less magnetic moment in the steel, according as the duration of the same is greater or less, a *very* sudden discharge having much less relative magnetic-moment-producing power than the same quantity more dragged out. We may in general also say that the magnetising power of a discharge current is determined by the value of the maximum current strength during the discharge,

* Abria, *Ann. de Chim. et de Phys.* [3] Vol. I., p. 429, 1844.

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and hence, of two equal quantity discharges, the one which lasts the shorter time, and which has, therefore, the greatest maximum value, will, if the discharges are approximately equal in duration, produce the greatest magnetising effect.

The tertiary currents, produced by ordinary galvanic currents, and the secondary currents, produced by Leyden jar discharges, consist, as we have seen, in their simplest form of a double discharge or flow, one part *inverse*, or oppositely directed to its inducing parent current, and the succeeding part *direct*, or similarly directed, the two component currents of the total discharge having equal quantity but different durations. In general the first portion, or the inverse current, is that which has the greatest maximum value and the shortest duration, the second half, or the direct current, being more dragged out in time; and, for a reason to be stated further on, the approximation of the induced and inducing circuits exaggerates this difference, or increases the maximum value of the inverse current at the expense of its duration. The explanation which may be offered, then, of the phenomena of the magnetisation of steel by tertiary currents, or by the secondary currents due to Leyden jar discharges, is as follows:—When the induced and inducing circuits are not very near to each other, and when the inducing current reaches its maximum not very suddenly, the two halves of the induction current are not very different in duration, but the first or inverse current has, of the two, a rather greater maximum and less duration. There results then a magnetisation in the needle, which, on the whole, is in the direction produced by the inverse current, and the inference from the direction of magnetisation is that the induced and inducing currents are in the opposite direction. If, however, the inducing current reaches its maximum value very suddenly, as it does if the circuits are very close, then the first half, or the inverse induced current, is so brief in its duration that the magnetisation of the needle due to it is very superficial. On the other hand, the magnetisation due to the rather more prolonged direct current is more diffused through the needle, and the resultant magnetisation found on testing the needle is that apparently due to the *direct* current, and the inference from the resulting magnetism of the needle would be that the induced and inducing currents are in the *same* direction. By some such explanation as the above we may reconcile these anomalous results of Prof. Henry with known facts, but it is evident, since the resulting magnetisation of the needle is an effect determined by the relative maximum values of the two portions of the total induced current, and by their duration, as well as by their order of superposition, that considerable caution is necessary in attempting to interpret the results of experiments made with a magnetising helix.

(To be continued.)

LIGHTNING CONDUCTORS.—I.

BY DR. OLIVER LODGE.

Theory of the Experiment of the Alternate Path.

In the *Philosophical Magazine* for August I gave a general statement of the considerations which had to be attended to in a discussion of experiments on the division of a Leyden jar discharge between the two branches of a divided circuit, and pointed out that by making one of the branches an air-gap a considerable simplification of the theory would result.

It has recently been objected to this experiment that it does not imitate at all closely the conditions of lightning. For the moment I do not care whether it does or not; it is in any case an instructive experiment, and worth understanding; and inasmuch as it sometimes seems to give anomalous, or at least unexpected, results, it is worth analysing to the bottom. It is easy to make more imitative experiments, and to discuss them afterwards. In my lectures to the Society of Arts, the experiments of the alternative path constituted only one series of many described, some of them more directly and apparently imitative of lightning conditions, but none, perhaps, more necessary to thoroughly understand, or throwing more light upon the others when once properly understood. For the present, therefore, I propose to confine myself to a discussion of this series of experiments.

1. The diagram of connections may be drawn in various forms, which, though apparently different, are essentially the same. Figs. 1, 3, 5 are identical, and are the most convenient arrangement in practice. Figs. 2, 4, 6 are really the same thing, but they have the disadvantage of being liable to make the alternative path part of the charged system, so that it is

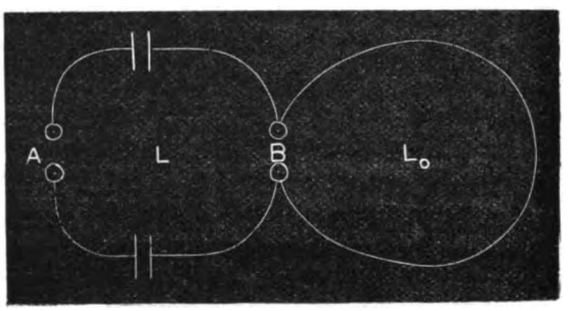

Fig. 1.

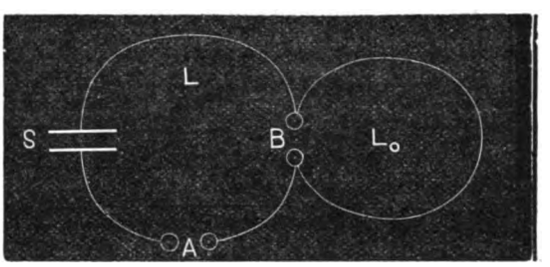

Fig. 2.

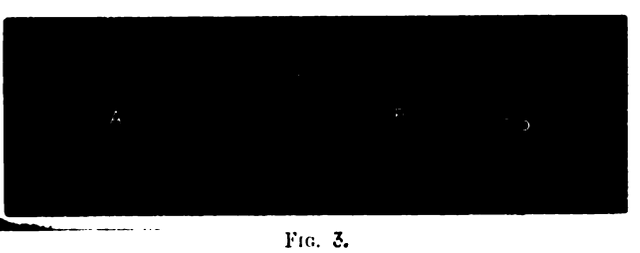

Fig. 3.

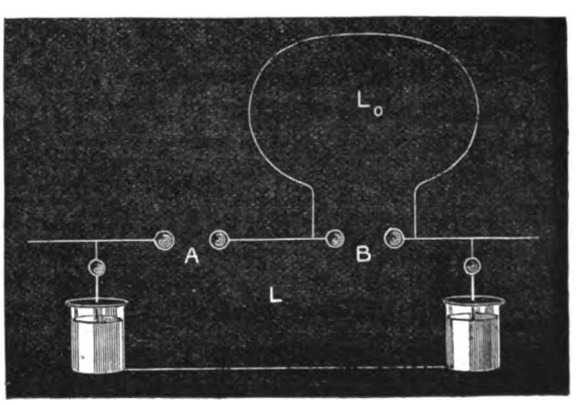

Fig. 4.

unpleasant to touch; moreover, the effective capacity is more troublesome to reckon. If these arrangements had any advantage these slight objections could be easily overcome, but I see no advantage in them. I have employed them all, however, at one time or another. Fig. 6 has the additional disadvantage of leaving the length of the A spark vague, so that there is no guarantee that the jar shall be charged to the same potential every time.

The electric machine is not shown in these figures. It can be connected up in any convenient way to the A knobs. To

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prevent the machine itself from becoming an important part of the circuit and having to be taken into account, I often connect it up to the A knobs by imperfect conductors, such as a couple of penholders or lead pencils. They supply the charge fast enough, but they take no appreciable portion of the discharge. Very often, however, the A knobs are those of the machine itself, fixed a measured distance apart.

The capacity charged is the A knobs and wires and the coats of the jars attached to them. The other two coats of the jars are obviously connected together, and may, for convenience of handling, be connected by some imperfect conductor with the earth. The difference of potential to which the jars are charged is given by the length of the A spark and the size of the A knobs. The circuit conveying the discharge current varies according to circumstances. It consists of two loops, the portion labelled L and the portion labelled L_0. One might call them the A loop and the B loop; but perhaps it is less ambiguous to call them the L loop and the L_0 loop, respectively; the latter being the alternative path.

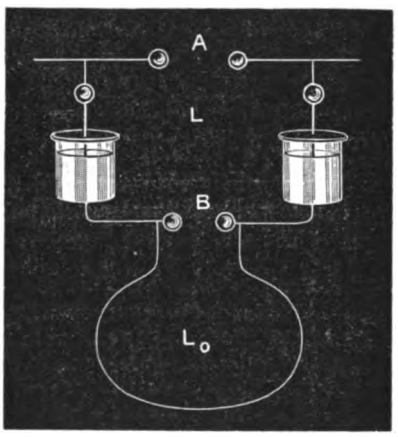

Fig. 5.

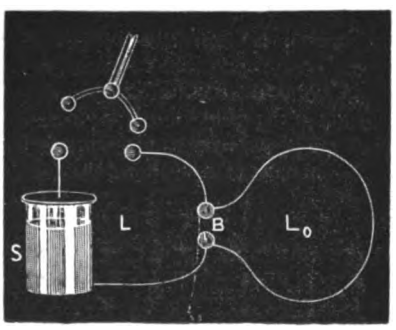

Fig. 6.

Now the circuit conveying the discharge current consists of the whole of L and a variable portion of L_0. On arriving at the B knobs the current divides, part going on round L_0, part jumping across the air gap. It is not possible without bringing the B knobs into contact, nor would it be of any service, to make the discharge circuit consist of L alone; some portion is sure to patronise the L_0 route. Only when the alternative path is removed altogether does the circuit consist of L alone.

The simplest case is when nothing jumps across the air gap; and in that case the discharge circuit consists solely of both loops in series, $L+L_0$. But ordinarily there is a spark at B, and even if there is no real spark a little brush is visible in the dark between them at every discharge. Perhaps the quantity passing in this brush is negligible; if so, the simplest case is attained by separating the B knobs until their spark just fails. Experimentally it is easier and feels more satisfactory, to separate the B knobs till about half the sparks fail and half pass; but perhaps the best combination of advantages, convenience of experiment and simplicity of theory, is secured by adjusting the B knobs so that some 90 per cent. of the sparks there fail, the occurrence of the remaining tenth showing that they are not separated altogether beyond a possible range. The distance of the B knobs is read with great ease, and more than sufficient accuracy, by supporting them on a micrometer screw arrangement with its head graduated to the 400th of a millimetre.

2. Calling the self-inductions of the two loops L and L_0, and their resistances R and R_0 respectively, we have in the simplest case when the B sparks are just failing, the inductance of the discharge circuit equal to $L+L_0$, and its resistance equal to $R+R_0+$ resistance of the A spark.

The capacity of the jars (in cascade, if there are two) and charged portion of the leads being called S, the total quantity discharged each time is SV_0; and the strength of the discharge-current at any instant after commencement of discharge is given by the equation

$$C=\frac{V_0}{n(L+L_0)}e^{-mt}\sin nt \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $$m=\frac{R+R_0+A}{2(L+L_0)};\quad n^2=\frac{1}{S(L+L_0)}-m^2;$$

and $$(R+R_0)^2=\tfrac{1}{2}n(\mu l r+\mu_0 l_0 r_0) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\simeq\frac{\mu l r+\mu_0 l_0 r_0}{2\sqrt{S(L+L_0)}}-\left\{\frac{\mu l r+\mu_0 l_0 r_0}{8(L+L_0)}\right\}^2,$$

where l is the length, and r the ordinary resistance, of the L loop; and l_0, r_0, the same things for the L_0 loop of the circuit.

The impedance of the alternative path is

$$P_0=\sqrt{\{n^2L_0^2+R_0^2\}},$$

and the difference of potential between the B knobs at any instant is

$$V=P_0C \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This is the quantity whose maximum value is measured by the length of the B spark. This, therefore, is the quantity which we experimentally observe, and have to analyse the theory for, in its applicability to different conditions.

First Approximation.

3. Now, the complete expression for V being rather long and unwieldy, it is better to begin by making approximations; and as a first approximation we can suppose resistance negligible as compared with inertia, at any rate for the first few oscillations. Making this simplification, $m=0$, and the current amplitude is—

$$C_1=V_0\sqrt{\left(\frac{S}{L+L_0}\right)}$$

$$P_0=nL_0=\frac{L_0}{\sqrt{S(L+L_0)}},$$

and $$V=\frac{V_0L_0}{L+L_0}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

a very simple expression, independent of the capacity of the jar, and showing that the B spark with the alternative path L_0 is shorter than it would be without any alternative path at all in the ratio

$$\frac{V}{V_0}=\frac{L_0}{L+L_0}.$$

It should be easy to verify this under circumstances when the first approximation is applicable; and if it turn out reasonably accurate, it would give an easy means of comparing the self-induction of two short and well-conducting simple circuits; for

$$\frac{L}{L_0}=\frac{V_0}{V}-1$$

and V_0/V may be taken as the ratio of the B spark lengths, first without, and then with, the alternative path L_0.

One sees from these equations, that when the fixed portion of the circuit, L, is much bigger than the alternative path, L_0, the B spark is very short, and roughly proportional to L_0; but that when L is much smaller than L_0, the length of the

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B spark hardly depends upon the alternative at all, and is much the same whatever the nature of that path, or even if it is absent altogether. For sensitiveness, therefore, it is better to have L rather the bigger of the two. But then remember that all this only applies as to the case when the resistances concerned are sufficiently small to be neglected. It is not likely to apply, therefore, to long or badly-conducting circuits. For these we must proceed to a further approximation.

Second Approximation.

4. As a second approximation we had better take into account that effect of resistance which is likely to become important first.

Now, resistance has three main effects. First, it diminishes the value of n, thereby lessening the inertia part of the impedance; but since it increases C just as much, this does not affect the value of V_0. Secondly, it increases the damping coefficient and more rapidly brings down the current amplitude, so that if the B spark does not jump until after the accumulated momentum of several oscillations, it is likely, by reason of damping, to be shortened. Its third effect is an increase in the total impedance by reason of the R_0 term.

Of these three effects, the first scarcely affects V, the last tends to increase it; only the second acts so as to make V smaller with increasing resistance. Hence any diminution of V which may be actually observed to accompany an increase of R_0 must be due (so it would appear) to an effect of the damping term, involving the coefficient m.

Let us see what this term becomes in any very short time, say at the end of a complete oscillation period T—

$$m\,T = \frac{2\pi m}{n} = \frac{\pi (R + R_0 + A)\sqrt{S}}{\sqrt{\{(L + L_0) - \tfrac{1}{4} S (R + R_0 + A)^2\}}} \quad . \quad . \quad . \quad . \quad (5)$$

$$\simeq \pi (R + R_0 + A)\sqrt{\left(\frac{S}{L + L_0}\right)}.$$

For this to be of any effective magnitude, S and one of the R's must be great, but the L's have most effect when they are small; in fact, their smallness may easily imperil the oscillatory character of the discharge, and may end by making $m\,T$ infinite or worse.

Third Approximation.

5. If there is the least tendency for m to become comparable in size with n—that is, for the oscillation-period to be appreciably lengthened by the resistance, or damping, co-efficient—there is a fourth effect which may possibly have to be taken into account, viz., this :—

The equation (2) is by no means a complete expression for the resistance of a conductor to currents of all frequencies of vibration; it is only accurately true for infinitely rapid vibrations. So soon as n falls below a certain magnitude, a much more complicated expression has to be employed, viz., as Lord Rayleigh has shown,

$$\frac{R}{r} = \text{real part of } \frac{J_0\sqrt{\left(-\frac{4 n l \mu}{r}\right)}}{J_0'\sqrt{\left(-\frac{4 n l \mu}{r}\right)}} \quad . \quad . \quad (6)$$

where R is the resistance of a conductor to currents alternating $\frac{n}{2\pi}$ times a second, and r is its ordinary resistance to steady currents; l is the length of the conductor, and μ its magnetic permeability; J_0 stands for Bessel's function of order zero, and J_0' for its first derived function.

For $n = 0$ the value of the right-hand side is 1. For $n = \infty$ it becomes infinite, being equal to

$$\sqrt{\left(\frac{n l \mu}{2 r}\right)}.$$

Now, although this last expression may be used as a good approximation to the right value of the resistance ratio for very great values of n (and it is what we have used so far), yet if there be any decrease in the frequency of oscillation below a certain ill-defined value, the more complicated expression must be used to calculate the effective resistance, and it will have a smaller value.

The effect of high resistance may thus, in a curious way, diminish total impedance, and so tend to make the B spark actually shorter for a resisting material than it is for a better conducting one, especially in the case of a long circuit of not very high conductivity—a circuit, that is, in which resistance is an important portion of total impedance; while its damping effect, by bringing down the violence of the current oscillation, tends still further in the same direction.

Notice further, that the expression for R, besides the length of the conductor and its ordinary resistance, contains the magnetic permeability of its substance; and thus the effective resistance or throttling part of total impedance for an iron wire is considerably greater than for a non-magnetic substance of the same dimensions and specific resistance, while the inertia portion is much the same. Hence it would appear possible that iron wire used as alternative path is liable in certain cases to give a shorter B spark than such substances as copper on the one hand or lead on the other.

The whole thing could be easily calculated out and exhibited in curves or numbers if only a table of Bessel's functions were available.

I hope the recently appointed British Association Committee on Mathematical Tables will speedily see their way to calculating and issuing these much-needed tables. Meanwhile, I do not lay any stress on this, what I have called, "fourth effect" of resistance; I merely note it as *possibly* acting in the direction suggested, and anyhow not to be lost sight of when the second approximation is used.

6. Lastly, there is a fifth effect, which I may as well also note, though it is probably too small to have much practical bearing. It depends on the value of the inductance of a conductor being affected by the mode of distribution of a current throughout its substance. With steady or slowly changing currents the current is distributed uniformly all over the cross-sectional area of the conductor, and accordingly the self-induction of a single circular loop of length l, made of non-magnetic wire whose circumference is c, is

$$L = 2 l \left(\log \frac{8 l}{\cdot 7788\, c} - 2\right). \quad . \quad . \quad . \quad (7)$$

But very rapidly-varying currents are concentrated near the outer surface of their conductor, and hence the constant under the logarithm has to be modified for them, until in the limit it is unity; so, when n is very great,

$$L' = 2 l \left(\log \frac{8 l}{c} - 2\right), \quad . \quad . \quad . \quad . \quad . \quad (8)$$

and this is slightly smaller than the preceding value; but I doubt if the difference is great enough to be noticeable.

I now propose to record and examine in detail some experimental results, with a view to ultimately seeing how far the above attempted theory is really applicable to them.

The Sunbeam Lamp.—This lamp appears to be making rapid progress, and has displaced both the arc lamp and the small sixteen candle-power incandescent lamp in many places. Messrs. Sydney F. Walker and Olliver, of Cardiff, have had a 500 candle-power lamp running at Bodringailt Colliery, in the Rhondda Valley, since last November. The Powell Duffryn Company have also made use of them at several of their collieries, with uniform success. Several of the large collieries in the counties of Durham, Northumberland and Cumberland have adopted them in place of arc lights, and in particular they have been adopted all through by the Ebbw Vale Company, at their Victoria Ironworks, to replace the arc lamps previously used there.

The Protest against the Competitive Examination System.—Among the signatures appended to the protest which appears in this month's number of the *Nineteenth Century* against the system of competitive examinations we notice those of Lord Armstrong and Profs. Dewar, Dittmar and Hicks.

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THE DEPTFORD CENTRAL LIGHTING STATION.

We now supplement the description of this undertaking which appeared in our last issue with a sketch plan of the ground floor, and with some views, engraved from photographs, showing the present state of progress. From the sketch plan it will be seen that there is room towards the river to erect a second battery of boilers of 40,000 horse-power, and, although this is not shown, an equal space is available on the opposite side for increasing the dynamo and engine plant to the same extent. We may add that the whole area of the ground floor is covered with a layer of concrete 4ft. in thickness, and the walls are in many places 6ft. thick. Some 8,000 cubic yards of concrete and about 33 million bricks have already been used, besides several thousand tons of iron.

LAYING THE FOUNDATION STONE OF THE BRADFORD CENTRAL STATION.

(FROM OUR OWN CORRESPONDENT.)

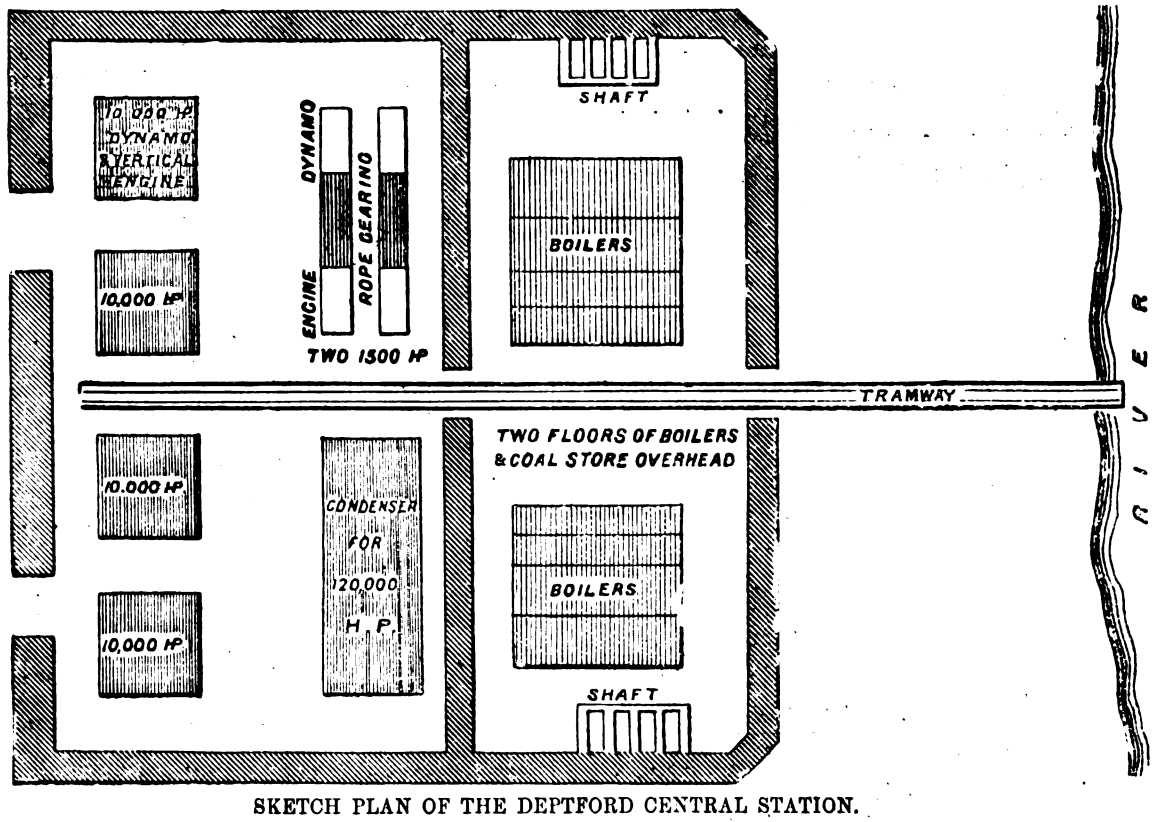
The foundation stone of the generating station* now in course of construction at Bolton-road, Bradford, for the supply of electric light to the central portion of Bradford was laid on Friday last by Alderman Frederick Priestman, chairman of the Electric Lighting and Gas Supply Committees. The object of the scheme is to supply the electric current to consumers occupying premises in Market-street, Kirkgate, and other streets in the centre of the town by means of a system of underground wires. The generating plant which is to be used for the present consists of three complete sets of boiler, engine, and dynamo machines, each equal to 150 horse-power indicated, and the contract for its supply and erection has been undertaken by Messrs. Siemens Brothers. The current will be carried from the dynamo-house by two main cables in brick or composition trenches, one along Market-street as far as the Town Hall, and the other through Kirkgate and Darley-street to the Markets and Free Library, the arrangement being such that a service can be attached at any particular point. The buildings are being arranged so that if necessary a rapid extension may be made so as to meet any sudden demand. There were present at the ceremony the Mayor (Alderman Morley), the Town Clerk (Mr. W. T. M'Gowen), Alderman F. Priestman, Mr. D. Barker (deputy-chairman of the Electric Lighting and Gas Supply Committees), Mr. C. Sowden, Mr. F. W. Hill, Mr. R. Shackleton, Mr. John Wright, Mr. R. W. Silson, Mr. John Vior, Mr. W. Priestman, Mr. Brewer, Mr. Empsall, Mr. J. Cooper, and Mr. J. Akam, members of the Town Council; the Rev. Canon Bardsley, D.D.; Mr. David Swallow, gasworks engineer; Mr. James N. Shoolbred, C.E., the engineer of the works, and others.

Mr. Barker (deputy chairman) deposited under the stone a box containing copies of local newspapers and a London newspaper, together with a short description of the works and current coins of the realm.

The MAYOR, in calling upon Alderman F. Priestman to lay the stone, said that that gentleman had been chairman and vice-chairman of the gas committee for about ten years, and any work which he undertook was always done most thoroughly. The electric lighting scheme was no ordinary undertaking, and he ventured to say there was only one man in the Council who could have approached it with the ability with which it had been inaugurated (hear, hear). It gave him immense pleasure to present, on behalf of the gas committee, to Alderman Priestman a trowel and mallet with which to perform the ceremony.

The Rev. CANON BARDSLEY having offered prayer,

ALDERMAN F. PRIESTMAN proceeded to lay the stone. Having discharged this task, he said the Mayor had told them the reason why the Corporation had determined to lay down electric plant. Briefly, the reason was that they had determined that there should be no king in Bradford but the Corporation. After thanking the gas committee for their handsome gift, he said he should have been pleased if that committee had seen its way to ask down some eminent electrician to perform the ceremony; but as he had been asked unanimously he could only say that he appreciated the honour in a very high degree, and was proud to have his name so prominently associated with this new enterprise—an enterprise which was destined to become a great commercial industry, and in which Bradford had the proud distinction of being a pioneer. He had been asked when the works would be ready. He was sorry not to be able to give a definite reply. Owing to circumstances over which the Corporation had no control the works were not begun as early as they ought to have been, the intention having been to finish them by the 1st of October. They had been unable to get powers from the Government authority sufficiently early to enable them to accomplish this; but no time had been lost since leave to construct was granted, and they were now in a forward state. The buildings would probably be ready for the roof in ten days or a fortnight, and the other departments of the work were approaching completion. The chimney would be the last, but that need not necessarily prevent them from commencing. Nearly all the cables were in Bradford, and he anticipated that they would begin to lay them in a week or ten days. He was told that the engines and dynamos were nearly finished. The works would be ready for a start early next year, and Mr. Shoolbred hoped to be able to deliver a supply in the middle of December. Another question which had been asked was whether the Corporation intended to light the streets by electricity, and in answer to that he had to say that such was not



SKETCH PLAN OF THE DEPTFORD CENTRAL STATION.

* For description of the Schmidt-Douglas Central Station, see *The Electrician*, January 6, 1888, p. 204.

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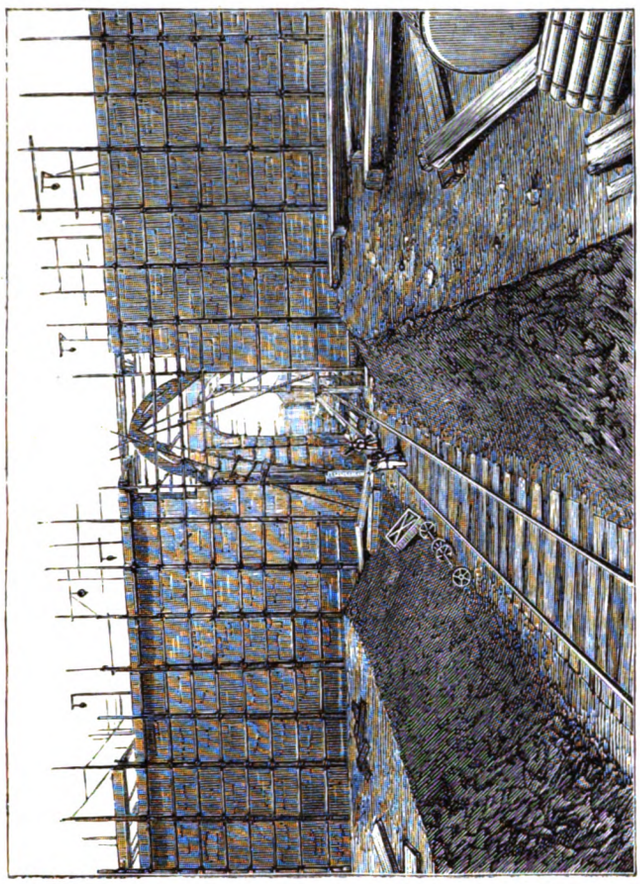
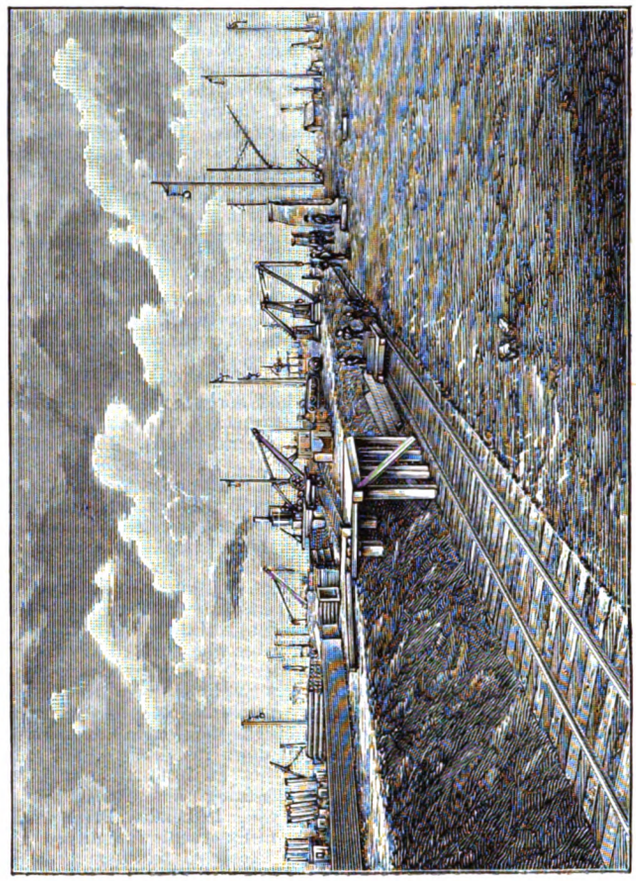
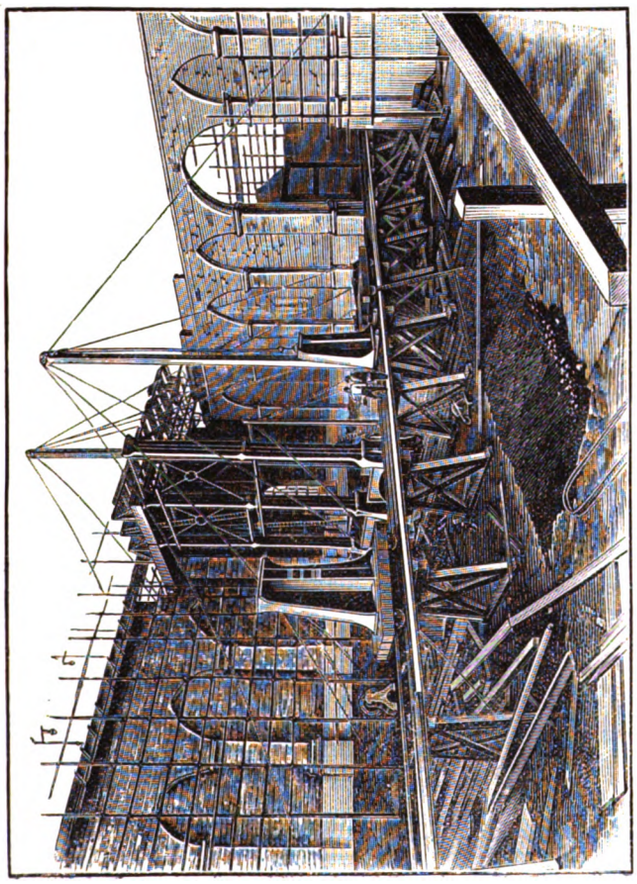
THE DEPTFORD CENTRAL LIGHTING STATION.



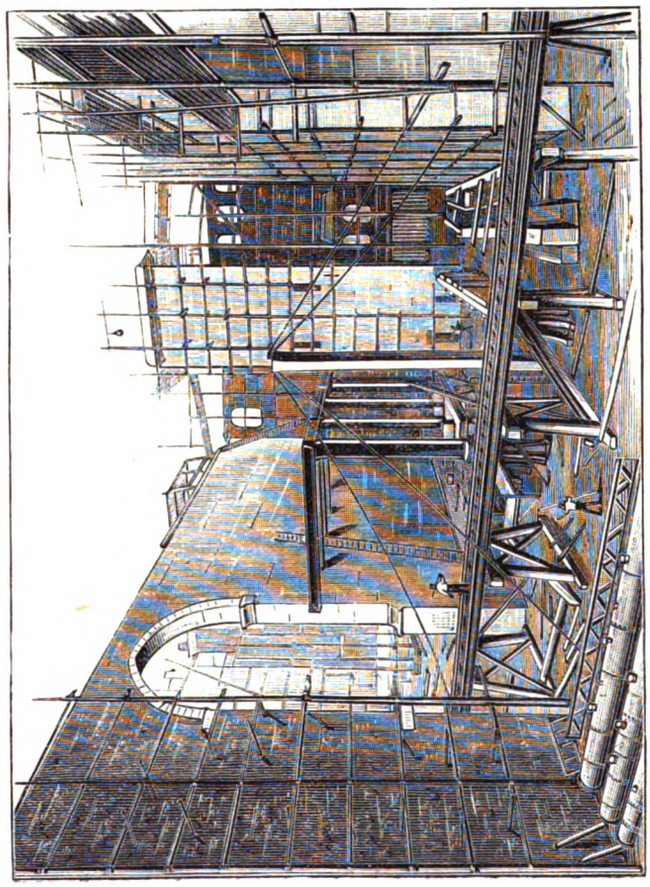
FROM THE RIVER, LOOKING AT NORTH WALL OF BOILER HOUSE.



FROM NORTH WALL OF BOILER HOUSE, LOOKING TOWARDS WHARF.



ENGINE ROOM, LOOKING NORTH-WEST.



INTERIOR OF THE BOILER HOUSE, LOOKING WEST.

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their intention. It would not be to the interest of the ratepayers that they should do so until their gas works were found to be too small for the demand made upon them. It might, perhaps, be a proper thing to light such places as Forster-square by means of electricity. Some people had got the idea that it was intended to carry the light to Allerton. It must have been because his friend Mr. Sowden was taking such an active interest in the affairs of Allerton, where the gas was so dear and the rates so easy (laughter). There was no intention to do more at present than light the central portion of the town. As to the price to be charged he might say that the committee did not intend to supply either lamps or fittings, and it would be for the consumers to make their own contracts with electricians, of whom there were many in the town. The Corporation would not do more than supply and charge for the current, and it would be charged for by meter, or by the number of arc lamps to be supplied. If consumers would tell Mr. Shoolbred the number of lamps they wished run he would probably be able to give them an idea of the cost. Some discussion had taken place as to the desirability of having the cables overhead or underground. They had decided, and he thought very wisely, to place them underground. There was some danger in fixing heavy cables to chimneys, and, moreover, the Corporation had refused to allow other people to construct overhead wires. There was something like a war going on as to the respective merits of alternate and continuous currents. It was something like the old battle of the gauges, and, as in the case of that contest, he thought the present discussion would very soon be decided by experience. The system which they had adopted was that of the continuous current. He was sorry to say that up to the present time there had not been an application for current for electric motors. He believed the electric motor would be found to be a most convenient method of running light machinery which was only wanted to run for a few minutes at a time. Another question which had been asked referred to meters. It was said that great improvements had taken place with regard to the construction of electric meters, and that they had been brought to a considerable degree of perfection as measurers of the electric current. There was one which he believed was absolutely correct, and a gentleman in Bradford was engaged in making another, and there was every reason to believe it would be a success. There could be no doubt that he was on the right track. It might impart confidence to those who doubted whether Bradford had done right in pioneering the electric light if he were to say that during the last three or four months there had been a very great extension in this direction. The electric lighting acts had been much improved, and the public had gained great confidence in the electric light. In Bradford a large number of people had put down installations, not only in their mills, but in houses. He had got an installation in his own house, and had parted with all his gasfitings and chandeliers. The light was of immense superiority over gas. In London, Brighton, Eastbourne, Hastings and Leamington, and many other towns, private installations were being put down, and Mr. Shoolbred told him that many municipal authorities were adopting the new method of lighting, and companies were obtaining powers for supplying other places. Electricians were busy all over the country, and there was a great demand for electrical appliances of all descriptions. He congratulated Bradford on having let their contracts so early as they did, because he believed it would be much more costly to let the same contracts at the present time. He thought they might look forward to the time when their works would be very largely extended (applause).

Mr. BARKER proposed a vote of thanks to the Mayor and to Ald. F. Priestman, which was seconded by Mr. JOHN WRIGHT, and carried with acclamation.

A similar compliment was paid to Canon Bardsley for his presence, and the proceedings then concluded.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

SECTION II.—ELECTRO-MAGNETIC FIELDS.

(Continued from page 766.)

134. *Electro-Magnetisation of Short Iron Rod.*—The necessary apparatus having been explained, we shall detail the method of taking observations, to show the gradual magnetisation of a short iron core placed within a coil of wire through which definite currents are passed. Referring to the apparatus, as arranged in Fig. 112, the magnetometer and galvanometer must first be levelled and adjusted in position till their respective pointers coincide with the zero marks on the scales. If the controlling magnet is employed with the graded galvanometer described in para. 132, it must first be removed several feet away while the instrument is being levelled and adjusted to zero. The latter is effected by turning the instrument round until the pointer is at zero, and the levelling is effected by the two screws seen in the figures. The controlling magnet is then placed in position, and if not in the plane of the meridian will deflect the pointer a little away from zero. To rectify this the adjustable screw on the arm F of the needle box is turned until the pointer is restored thereto. By a measurement, taken immediately before the readings, the controlling magnet used was found to reduce the sensitiveness twenty-one times (n). Its field at the needle was therefore (para. 132)

$$H(n-1) = \cdot 18 \times 20 = 3 \cdot 6 \text{ C.-G.-S. units.}$$

The first thing to be done is to put two or three different strengths of current through the coil alone, and read the corresponding deflections on the two instruments. From these observations, when plotted on squared paper, it can be seen what must be deducted from the readings taken with coil and core together to give the true magnetic effect of the core. Having done this, the current is switched off and the core inserted into the coil.

The core used in this experiment was a cylindrical rod of unannealed iron, 10 centimetres long and 4·3 millimetres diameter. Its sectional area was therefore

$$\frac{\pi d^2}{4} = \cdot 7854 \times \cdot 43^2 = \cdot 1452 \text{ square centimetres,}$$

and its volume $= \cdot 1452 \times 10 = 1 \cdot 452$ cubic centimetres.

The length of the core being only some 23 times its diameter, there was considerable demagnetising effect. The core being shorter than the coil, care was taken by measurement to push it into an exactly central position in the coil. The latter being held down by a clamp this operation could not shift its position.

Now it is important to notice at this point whether the magnetometer is deflected; if it is, the core has some traces of magnetism which should be removed before commencing the test. This may be done by heating it and then allowing it to cool while lying horizontally in an east and west direction; or a few light taps at the end while held in the same position will generally suffice.

The resistance switch is now turned so as to put the greatest amount of resistance in circuit, and the current is then put on. Both magnetometer and galvanometer deflections must now be read as each successive reduction is made in the resistance, and the same jotted down in two vertical columns. Some of the readings are here appended, the galvanometer deflections being divided into columns corresponding to the position of the needle-box on the platform when the respective readings were taken.

Magnetometer Deflections.	Galvanometer Deflections.					Ampere-turns.
	4	8	16	32	Reduced to 32	
17	35¼	—	—	—	282	4512
2	—	—	—	5	5	80
14	—	—	—	20	20	320
38	—	—	23½	—	47	752
72	—	—	45	—	90	1440
102	—	35½	—	—	142	2272
113	26¼	—	—	—	210	3360
126	33	—	—	—	264	4224
131	41¾	—	—	—	334	5344

It is convenient afterwards to reduce them all to their value at position 32. At this position, with the controlling magnet in use, the current is equal to

$$(\cdot 18 + 3 \cdot 6)\frac{D}{32} = \frac{D}{8 \cdot 47} \text{ amperes,}$$

where D is the deflection reduced to position 32, and 3·6 (as given above) is the field of the controlling magnet, which was used throughout. The number of turns on the magnetising coil being 135, we get the number of ampere-turns by multiplying the current by this number—that is,

$$\text{ampere-turns} = \frac{D}{8 \cdot 47} \times 135 = 16 \text{ D.}$$

The deflections reduced to position 32 and multiplied by 16 give, therefore, the magnetising forces in ampere-turns, these values being worked out in the last column of the above table.

The curve in Fig. 115 is plotted on squared paper from the readings. The horizontal ordinate is divided off in divisions, each representing 1,000 ampere-turns, and the above values marked off accordingly. On the vertical ordinate it is more convenient to plot the magnetometer deflections first, which

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are proportional to the field produced by coil and core together, as we have to subtract the effect of the coil before we can estimate the magnetisation of the core, and this is most readily done by plotting the deflections. This gives a straight line

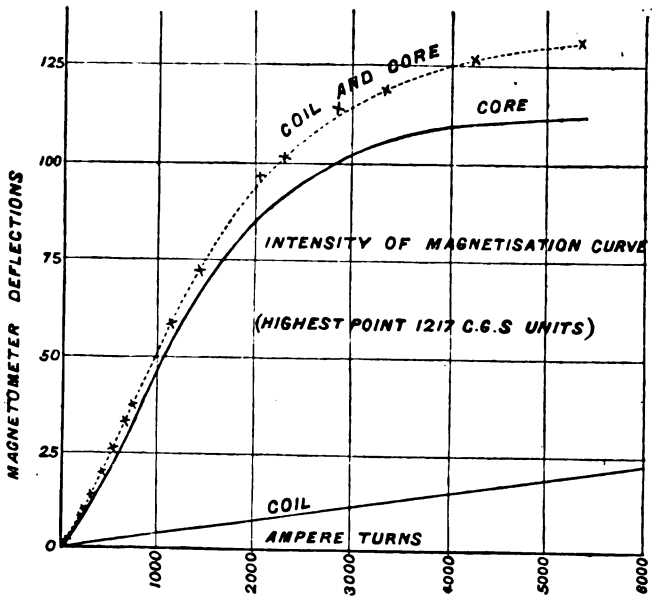

FIG. 115.

for the coil alone, and a regular curve (shown dotted) for the variation in external magnetic field of the coil and core together. Taking now a point on the horizontal ordinate for any given number of ampere-turns, the height of the vertical line from this point to the straight line of the coil must be subtracted from the height of the vertical line from the point to the dotted curve; this gives one point on a new curve which represents the effect of the core alone. This operation having been repeated for several points on the base line, we get a corresponding number of points on the new curve, which may then be connected by a line, giving the curve shown. By inspection of this curve we can see what deflection the magnetometer would have indicated had it been acted upon by the core alone. Calling this angle of deflection α, the tangent of which, as before explained, is equal to the deflection divided by 100, we may find the intensity of magnetisation of the core cerresponding to any given point in the curve by

$$I = \frac{\text{moment}}{\text{volume}} = \frac{r^3 H \tan \alpha}{1{\cdot}452} \text{ C.-G.-S. units.}$$

Now $$r^3 H = (20^2 + 5^2)^{\frac{3}{2}} \times {\cdot}18 = 1577,$$

and $$\frac{1577}{1{\cdot}452} = 1086.$$

Therefore, $$I = 1086 \tan \alpha.$$

Take the highest point in the curve; the deflection is 112, and therefore

$$I = 1086 \times 1{\cdot}12 = 1217 \text{ C.-G.-S. units.}$$

Values of I can be worked out in this way for any other point on the curve. It should be noticed, however, that the shape of the magnetisation curve is the same whether we plot strength of pole, moment, intensity of magnetisation, or deflections on magnetometer due to core, since all these quantities are proportional to one another. Similarly, the curve will be the same whether the magnetising force is plotted in ampere-turns or C.-G.-S. units.

The foregoing example is detailed with the view of furnishing the student with material sufficient to guide him in observations and calculations of his own. Experiments made on however small a scale, the results of which are reduced to known units of measurement, are the best means of acquiring cleaar conception of terms and their relative values. Near the higher part of the curve, although the readings were taken as rapidly as possible, the current perceptibly warmed the coil and core, and this may have prevented the iron acquiring a higher magnetisation. The fact of coils becoming heated when large currents are used is a bar to obtaining more than a few hundred C.-G.-S. units of magnetising force this way. We have previously shown (para. 130) that the magnetising field in C.-G.-S. units produced in the interior of a long narrow coil is equal to

$$\frac{\text{ampere-turns}}{\text{length of coil (centimetres)}} \times 1{\cdot}257;$$

and therefore, in the case before us, in which the coil is 1ft. (30·48 centimetres) long, the magnetising force per 1,000 ampere turns is

$$\frac{1257}{30{\cdot}48} = 41{\cdot}24 \text{ C.-G.-S. units;}$$

and, therefore, for, say, 6,000 ampere-turns, which is about 200 ampere-turns per centimeter length of coil, and not far from the maximum exciting power possible to use with one layer of wire, we obtain a magnetising force of only $41{\cdot}24 \times 6$, or about 250 lines of force per square centimetre in the coil. If the number of layers of wire is increased, the current put through cannot be as strong as through a single layer, since the radiation of heat is slower, and a limit of exciting power is soon reached probably not much above 300 ampere-turns per centimetre length of coil. This prevents the investigation by the magnetising coil method of the direction taken by the magnetisation curve under very high magnetising forces—that is to say, whether it ever reaches a maximum height beyond which no additional force will increase it, and if this condition of things (which means *absolute* saturation of magnetism) does take place, whether the curve continues horizontal or shows an inclination to descend. If these points, which are of the greatest interest, are to be determined, recourse must be had to some other method of magnetising, the iron, by which powerful fields can be brought to bear upon it.

Immediately on reaching the highest current considered safe for the insulation, the resistance was increased again, step by step, and readings taken on both instruments as before. This gave the descending curve of magnetisation which followed pretty closely the shape of the ascending curve, but at some distance higher from it. The residual magnetism in the core was calculated by the above formula from the magnetometer deflection after the current was switched off. This deflection being 10, the residual magnetisation was

$$I = 1086 \times {\cdot}1 = 108 \text{ C.-G.-S. units.}$$

This is only 9 per cent. of the total magnetisation acquired, and is due to the demagnetising effect of the core on itself, already spoken of.

In order to prove that the magnetometer has worked all right during the set of readings taken, as soon as the residual magnetism has been measured the core should be withdrawn from the coil and placed at a distance, upon which the needle of the magnometer should return accurately to zero. We shall next consider the magnetisation of a wire of annealed iron, of sufficient length to render the demagnetising effect inappreciable.

(To be continued.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, November 5th.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting. A Paper will be read on "The Practice of Foundry Work." By Mr. H. Ross HOOPER.

TUESDAY, November 6th.

ROYAL VICTORIA HALL.

7:30 p.m. Lecture. "Speech-Recording Machines." By Mr WM. LANT CARPENTER, B.A., B.Sc.

THURSDAY, November 8th.

SOCIETY OF TELEGRAPH-ENGINEERS.

8 p.m. Ordinary General Meeting. "On Ocean Temperatures in Relation to Submarine Cables." By Mr. WM. LANT CARPENTER, B.A., B.Sc., Member.

SATURDAY, November 10th.

PHYSICAL SOCIETY (London).

3 p.m. "On the Coefficient of Mutual Induction of a Helix and a Coaxial Circle." By Prof. J. V. JONES.

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The Electrician.

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,, Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
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THE DIRECTORY FOR 1889 IS IN PREPARATION.

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THE INDEX TO VOLUME XXI.

The Index to Volume XXI. will be issued (Gratis) with the Number for November 9th.

THE ELECTRICAL TRADES.

The project which was set on foot just before the summer holidays, in order to obtain for the electrical trades of this country a corporate representation in the LONDON CHAMBER OF COMMERCE, has met with such general support that last week we had the satisfaction to announce the actual formation of the new Section, and the election of its working committee. The task of the organising committee—that is to say, of the original promoters of the scheme—has been neither light nor easy. Some of the difficulties which presented themselves when the more ambitious idea of establishing a separate and independent society, advocated in these columns, re-appeared in connection with the later alternative, but have happily been over-

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come. Patience and a little diplomacy have contributed to this end, no doubt; but probably the best friend to the general understanding has been the existing Rules of the CHAMBER on which the new Section had to be constituted, and which afford adequate guarantee that it will not exceed the functions which an organisation of that kind is intended to discharge. It was remarked by one of the speakers at the meeting that all past attempts to form an electrical association had failed chiefly because of the difficulty of formulating its functions. We should rather say that the difficulty was in reconciling various and sometimes conflicting views as to what those functions ought to be. Some diversity of opinion was manifested at the first meeting of the Section; but, as the same speaker observed, it was fortunate that they had in the London Chamber of Commerce a constitution and set of rules, based upon a wide experience, under which it was easy to see what questions were proper for discussion and what were not. The steadying element supplied by an influential body at its back will be of inestimable service to the Electrical Trades Section in the earlier stages of its career, and will undoubtedly contribute to its harmonious working hereafter.

We have on a former occasion expressed our opinion as to two or three delicate questions which some of the members desired should form part of the Section's programme. That they have been publicly mentioned and criticised is not at all to be regretted. Probably they will be followed by other suggestions which a little discussion may prove to be inexpedient or altogether impossible. Very soon the members will discover common grounds on which their united interests may take their stand; and it is no objection to a scheme of usefulness that it cannot be utilised in any and every imaginable direction. If wages, and prices, and contracts may not be fitting subjects for adjudication by a trade body, there are plenty of other subjects which are fitting; and if we are asked to name them, we need only point to the various Chambers of Commerce in London and the provinces as sufficient evidence of their utility. What has been good for other trades will be good for electrical and allied trades, which, after long feeling the need for it, have formed a combination to promote and defend their industrial welfare. No more categorical statement of its aims is at present necessary or desirable.

Nearly two hundred members of the trades represented have already sent in their names to the LONDON CHAMBER OF COMMERCE for enrolment on the new Section, a number which at this stage must be considered highly satisfactory, and which it is confidently predicted will soon be largely augmented. At the meeting which we reported last week the working committee, consisting of thirty-three members, was elected. We believe the names will command general confidence, and they certainly possess the merit of being the freely elected representatives of the whole body. It seems necessary to explain that the number was determined by the general Rules of the CHAMBER, a larger committee of forty-eight being permissible only when the strength of the Section reaches a higher figure than it does at present. This being the case, it was necessary to apportion the representatives as nearly as practicable to the number of members in the several sub-sections; but in some instances this object has been sacrificed to the desire to have on the working committee certain members whose presence would be valuable to it, although the sub-sections to which they strictly belonged were disproportionately weak. We published the full list in our last week's issue, and we think that a fair examination of the names will do away with the objection raised against their distribution by our correspondent Mr. J. B. VERITY, whose letter appears in another column. It is true that it does so happen that all the sub-sections save one are represented by one-third of their respective members, whilst the exception, representing electrical manufacturers and contractors, is assigned less than one-seventh. The anomaly, if it is felt to be one, can be remedied when the committee is brought to its full strength; but meanwhile the matter is in the sub-sections' own hands, and nobody can seriously suspect them of having purposely slighted the very strongest and most important of their number.

On some other points raised in Mr. VERITY's letter we would venture to make a few observations, not because of the intrinsic gravity of his complaints, but because they have evidently weighed with him in determining to hold aloof from the scheme, at all events for the present. Mr. VERITY is perhaps not alone in his misgivings as to the future conduct of this newly organised body, and we should like if possible to allay them. At the outset, however, one obvious retort may be made by the promoters: "If you apprehend mischief, why don't you come and prevent it?" If staying away would hinder what we dislike or misdoubt, the case might be different; but staying away will do no such thing; the association is an established fact, and those who study their own best interests will do wisely to frankly take part in it, and try to guide and direct it in the right way. As to the rest we have as little reverence for the ballot as Mr. VERITY himself; but it has its useful side in commercial and social affairs; and if the CHAMBERS OF COMMERCE are responsible for the Rule which he disapproves, his only chance of modifying it is by becoming an active member. Similarly, if there is the smallest danger of the Committee dwindling into a "family party," the best possible way of averting it is to step in and take a chair at the gathering. We entirely share Mr. VERITY'S candid view that no intention of establishing a trade clique is at present apparent; but if suspicion and hesitancy on the part of many members of electrical trades should prevail in keeping them aloof, there is no telling what the inside organisation might degenerate into. Several electrical interests—conspiciously those of the Telephone companies—are very inadequately represented at present in the general body of membership. To them and to all such we would say, Make haste to join this combination: with you it cannot fail to do you much good; without you it may do you some harm.

MEAN INTENSITY OF MAGNETISATION OF SOFT IRON BARS OF VARIOUS LENGTHS IN A UNIFORM MAGNETIC FIELD.*

BY A. TANAKADATÉ.

The series of experiments now to be described on the mean intensity of magnetisation in soft iron bars of various lengths has been carried out in the Physical Laboratory of Glasgow University, and in accordance with Sir William Thomson's instructions.

The experiment consisted in subjecting the piece of iron to different strengths of magnetising field, and in measuring the magnetic moments thereby acquired. The amount of residual magnetism was also observed by reducing the field to zero after each magnetisation.

The magnetising field was obtained, as usual, by means of an electro-magnetic solenoid, consisting of fine insulated copper wire wound upon a brass tube. The length of the wound part of the tube was 11·9 centimetres, and the total number of

* Paper read before the British Association meeting (Section A) at Bath, September, 1888.

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turns was 13,158, so that the magnetic field due to one ampere was $4\pi 13158/11{\cdot}9 \times 10 = 1309$ in C.-G.-S. units, neglecting the effect due to the broken ends. The current through the solenoid was varied by inserting resistances by steps; its strength was measured by observing the difference of potentials at the terminals of the solenoid by means of one of Sir Wm. Thomson's graded potential galvanometers.*

The solenoid was laid at right angles to the magnetic meridian, and in the prolongation of the axis of this solenoid was placed a reflecting mirror magnetometer. Under this circumstance, the deflections of the magnetometer consist of two parts—one due to the solenoid and the other due to the magnetised iron in it. The first of these was taken account of by making a separate observation on the magnetometer deflections without the iron in it before each experiment.

The iron pieces were cut into required lengths and were heated to redness in a gas flame and slowly cooled; the oxide coating formed on the surface was removed by rubbing with emery paper, except in the experiment represented in the curve II.

The mean intensity of magnetisation was obtained by dividing the magnetic moment of the bar by its volume, the calculation being as follows:—

Let $2l$ = length of the bar.

d = diameter of the bar.

r = distance of the bar's centre from centre of the magnetometer needle.

H = the intensity of the horizontal component of the earth's magnetic field (assumed to be ·152 in C.-G.-S. units).

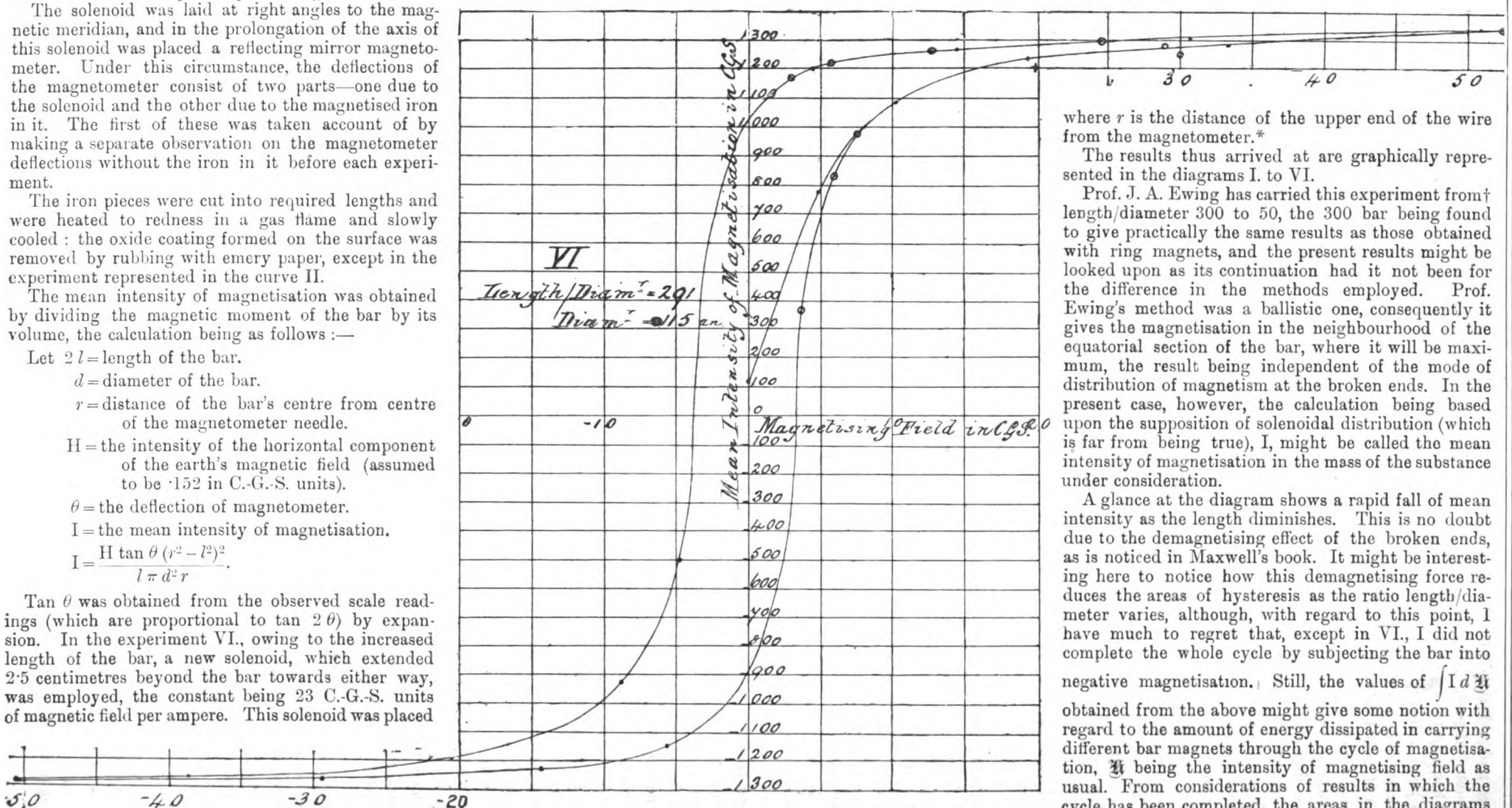
θ = the deflection of magnetometer.

I = the mean intensity of magnetisation.

$$I = \frac{H \tan \theta (r^2 - l^2)^2}{l \pi d^2 r}.$$

Tan θ was obtained from the observed scale readings (which are proportional to tan 2θ) by expansion. In the experiment VI., owing to the increased length of the bar, a new solenoid, which extended 2·5 centimetres beyond the bar towards either way, was employed, the constant being 23 C.-G.-S. units of magnetic field per ampere. This solenoid was placed vertically due west of the magnetometer, the upper end of the iron wire being slightly above the level of the magnetometer. The calculation for the mean intensity in this case was

$$I = \frac{H \tan \theta \, r^2}{\frac{\pi}{4} d^2 \left(1 - \frac{r^3}{(r^2 + l^2)^{\frac{3}{2}}}\right)},$$



where r is the distance of the upper end of the wire from the magnetometer.*

The results thus arrived at are graphically represented in the diagrams I. to VI.

Prof. J. A. Ewing has carried this experiment from† length/diameter 300 to 50, the 300 bar being found to give practically the same results as those obtained with ring magnets, and the present results might be looked upon as its continuation had it not been for the difference in the methods employed. Prof. Ewing's method was a ballistic one, consequently it gives the magnetisation in the neighbourhood of the equatorial section of the bar, where it will be maximum, the result being independent of the mode of distribution of magnetism at the broken ends. In the present case, however, the calculation being based upon the supposition of solenoidal distribution (which is far from being true), I, might be called the mean intensity of magnetisation in the mass of the substance under consideration.

A glance at the diagram shows a rapid fall of mean intensity as the length diminishes. This is no doubt due to the demagnetising effect of the broken ends, as is noticed in Maxwell's book. It might be interesting here to notice how this demagnetising force reduces the areas of hysteresis as the ratio length/diameter varies, although, with regard to this point, I have much to regret that, except in VI., I did not complete the whole cycle by subjecting the bar into negative magnetisation. Still, the values of $\int I \, d\mathfrak{H}$ obtained from the above might give some notion with regard to the amount of energy dissipated in carrying different bar magnets through the cycle of magnetisation, $\mathfrak{H}$ being the intensity of magnetising field as usual. From considerations of results in which the cycle has been completed, the areas in the diagrams I. to VI. will be seen to be something like one-third of the whole area. The areas computed from these diagrams are given in the table and in Fig. VII.

* The resistance of the solenoid was 406·5 ohms at 50° F., and was assumed to be constant throughout the experiments; as the temperature of the room was never far from that temperature, and the strength of current was never greater than $\frac{1}{10}$ ampere at the most, the error arising from the variation of resistance due to that of temperature could not have been anything serious.

* This experiment VI. is not strictly comparable with the other five, not only on account of the difference in the methods employed, but also on account of the difference in the specimen of iron used.

† *Phil. Trans.*, Part II. 1885.

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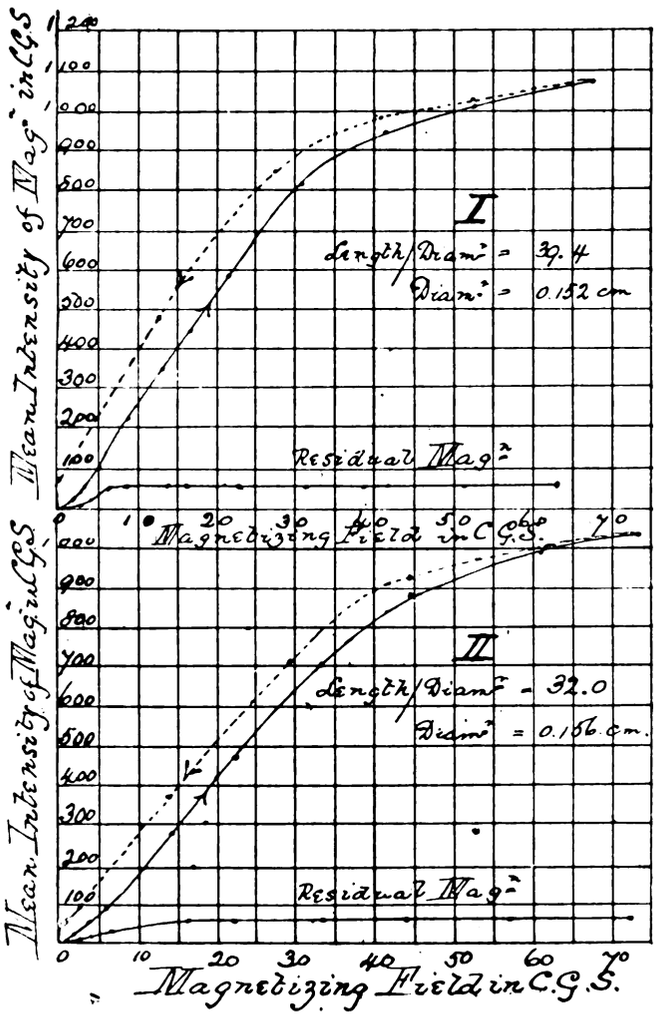
The last column of the table gives the probable rise of temperature of the iron, due to one complete reversal of magnetisation, supposing the whole energy dissipated is used in heating the iron.

Reference No.	Length.	Diameter	$\frac{\text{Length}}{\text{Diameter}}$	$\int_0^{10} I\,d\mathfrak{B}$.	$8\int_0^{10} I\,d\mathfrak{B}$.	$8\int_0^{10} I\,d\mathfrak{B}\,/\,J\rho p$.
						deg.
I.	6 cm.	·152	39·4	5,560 ergs.	16,680 ergs.	$4{\cdot}73\times10^{-4}$ C.
II.	5 ,,	·156	32·0	4,770 ,,	14,310 ,,	4·05 ,,
III.	4 ,,	·152	26·3	2,964 ,,	8,892 ,,	2·52 ,,
IV.	3 ,,	·152	19·7	1,378 ,,	4,134 ,,	1·17 ,,
V.	2 ,,	·153	13·1	930 ,,	2,790 ,,	0·79 ,,
VI.	33·4 ,,	·115	291·05	—	*18,450 ,,	*5·25 ,,

* This is the whole area of cycle $\int_{-31}^{31} I\,d\mathfrak{B}$.

In connection with the present results I beg to mention some results of mine which were obtained in 1883 in Japan.

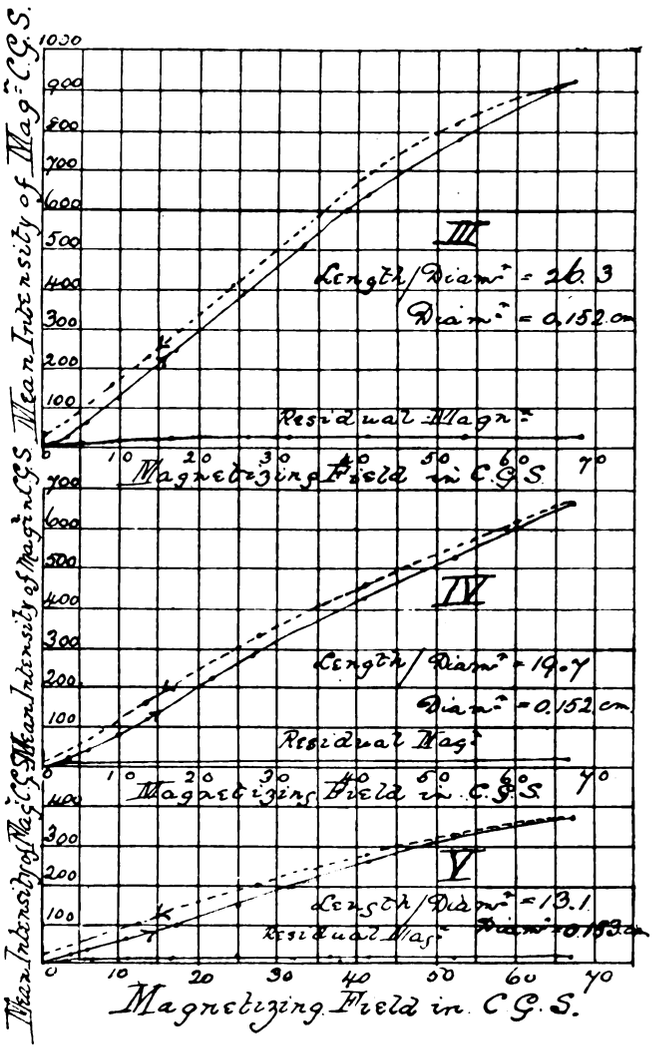


The experiment was carried out in the Physical Laboratory of the then Tokyo Daigaku. It was very similar to the present one in its nature; conducted, however, in a different way so far as the magnetising field was kept constant while the mass of iron magnetised was increased by steps.

The arrangement of the magnetising solenoid and the magnetometer was the same as in the present experiment. The dimensions of the solenoid were:—Length, 9·25 cm.; external diameter, 2 cm.; internal diameter, ·86 cm.; number of turns of wire per centimetre, 132·6. The length of soft iron wire was 9 cm., and its diameter 1 mm.

In the first experiment the magnetising field of 46 in C.-G.-S. units was kept constant, and the soft iron wires were put into the solenoid one by one. At first these wires were sucked into the solenoid very vigorously, and the magnetometer readings were very nearly proportional to the number of wires in the solenoid. But when the number of wires was about 10, some of the wires began to throw themselves out of the solenoid, and even when pushed in again with the finger would jump out upon its removal. They were, however, capable of being kept in their normal position by a careful adjustment. Obviously every one of the wires is under two forces—one, that due to the solenoid, tending to keep the wire in; and the other, that due to the magnetism of its fellow wires, tending to push it off; consequently, when the latter becomes greater than the former the wires will be in unstable state (such a state might be imagined to be taking place between parts of a solid bar). It is interesting to see that after this event the magnetometer readings fall rapidly short of being proportional to the number of wires in the solenoid; and after the number was increased to about 25 the magnetometer readings remained practically constant, even if the wires were increased to as much as 41.*

The diagrams represent the results of this experiment. Curve VIII. shows the increase of magnetic moment due to



the increase of iron wires, and curve IX. the mean intensity of magnetisation in the whole substance of the iron.

Similar experiments were made for the constant magnetising fields, 50, 11, 5·5, 2·75 C.-G.-S. units. These are drawn in arbitrary scales, for the want of the original notes at the present. By comparing these, however, with the curves for field = 46, one can form a fair estimate of what they would be in C.-G.-S. units. It thus appears that we may roughy obtain the moments in C.-G.-S. by multiplying the number in the y – ordinate of curve X. by 6·7; and the mean intensity of magnetisation by multiplying the numbers in y – ordinate of curve XI. by 10.

From the curves I., II., III., IV., and V., I construct the following curves of mean intensity of magnetisation as a func-

* After the number of wires was increased to 38 the wires did not jump out even if slightly disturbed from the normal position. But I could not tell whether this was a magnetic effect, or simply a mechanical one due to the increase of friction.

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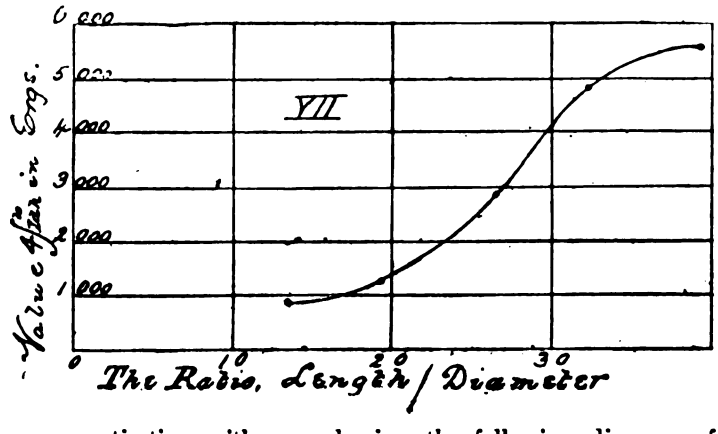
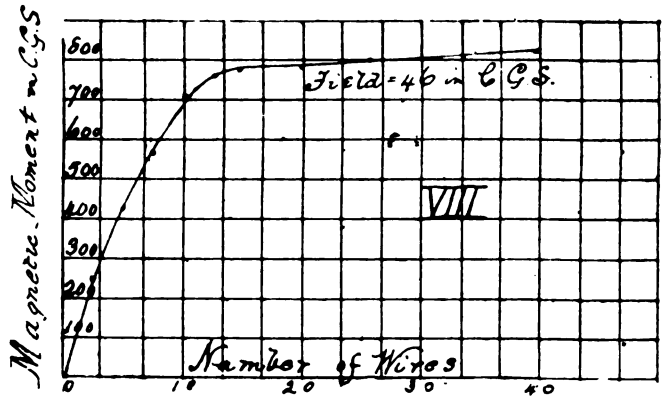
tion of the ratio length/diameter of the bar for different magnetising fields. From the curves we see that the mean intensity of magnetisation falls very rapidly as the ratio length/diameter diminishes. As this ratio increases the curves will bend towards the x-axis, and will ultimately be parallel to it as long as the magnetisation of ring magnets is finite.

As a means of comparison I construct from the curves of

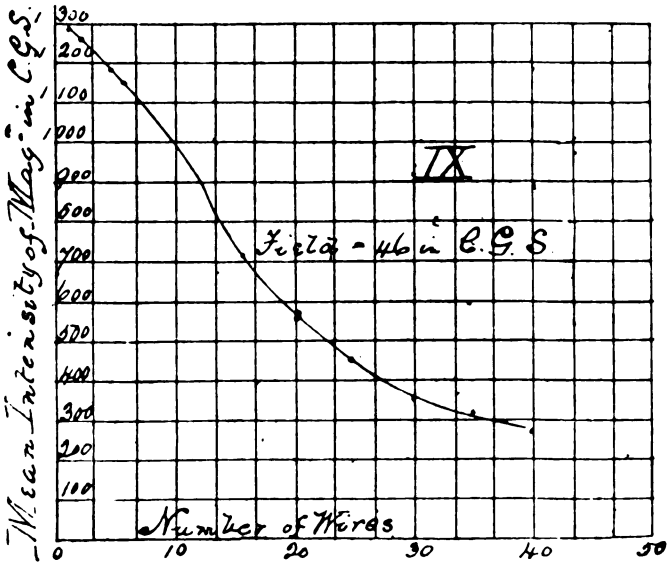


magnetisation with several wires the following diagram of mean intensity of magnetisation as function of

$$\text{length}\Big/\sqrt{\text{sectional area}}\ \frac{4}{\pi};$$

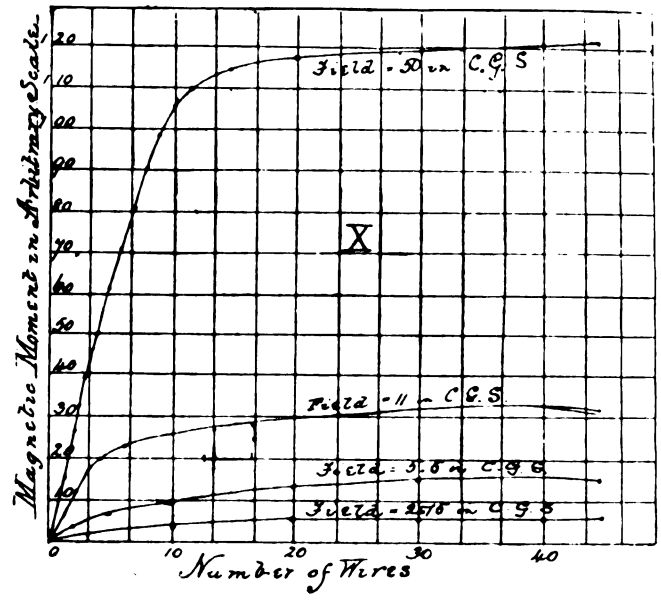


that is, what the ratio length/diameter would become had those wires been moulded into a single cylinder at each step

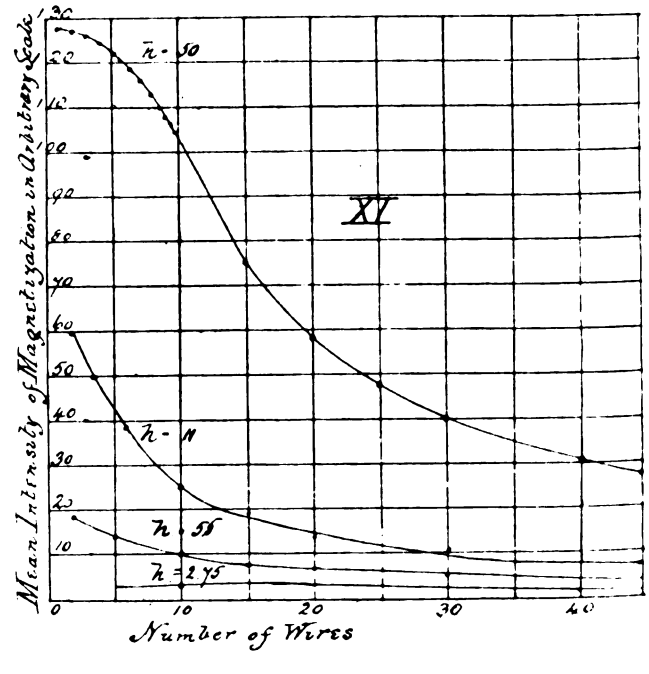


instead of being separate wires side by side, as in the actual case. By comparing this with the curve XII. we see that they both show that for a very flat plate the mean intensity will be extremely small; also for the case of separate wires the bend of the curve occurs earlier, *i.e.*, for less value of length/diameter

From the way in which the curves VIII. and X. tend to be asymptotic, it would seem that the induced magnetic moment in a soft iron bar is not increased by increasing its thickness beyond a certain proportion of its length. These curves, however, are in reality obtained from experiments made on bundles of wires of given length, with various thicknesses of the bundle. Thus there may be material difference between this case and



the case in which an actual solid bar of given length is made to vary in its thickness. We have no experiment of this latter case, but if we assume that when similar bars of the same magnetic substance are placed in uniform magnetic fields of the same intensity, both of them will give the same amount of the mean intensity of magnetisation; or, in other words, if we suppose the intensity of magnetisation in uniform magnetic field to be independent of the absolute sizes of the bars, and merely dependent upon the shape and nature of the magnetic substance, then we can trace the increase of magnetic moment



due to the increase of section in a bar of given length, from the data we have in the curves I. to V. To do this we have to reduce the bars to some common length, and find their several diameters, which will make their shapes similar to the original ones. Taking this common length to be be 1 cm., and finding the diameters and volumes which each of the bars

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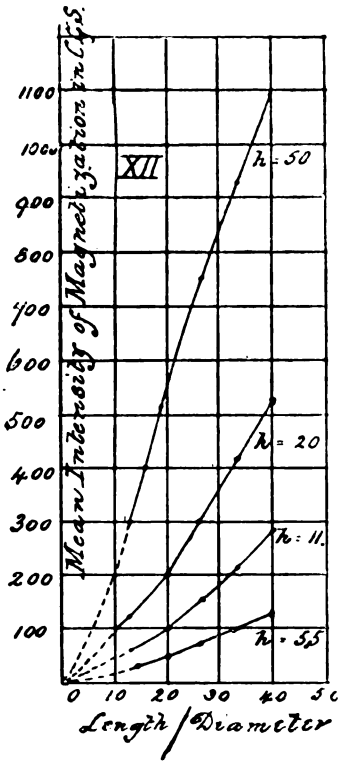
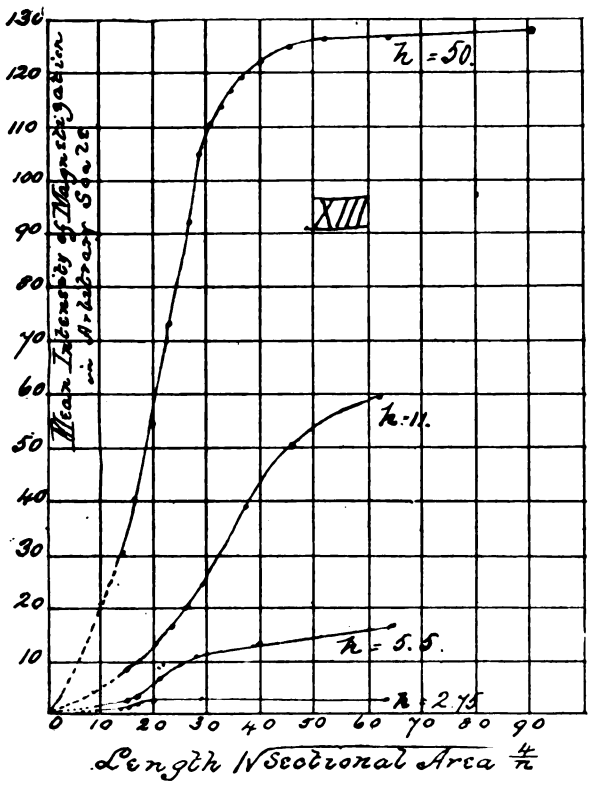
would come to have, we obtain, from the table given on page 825 :—

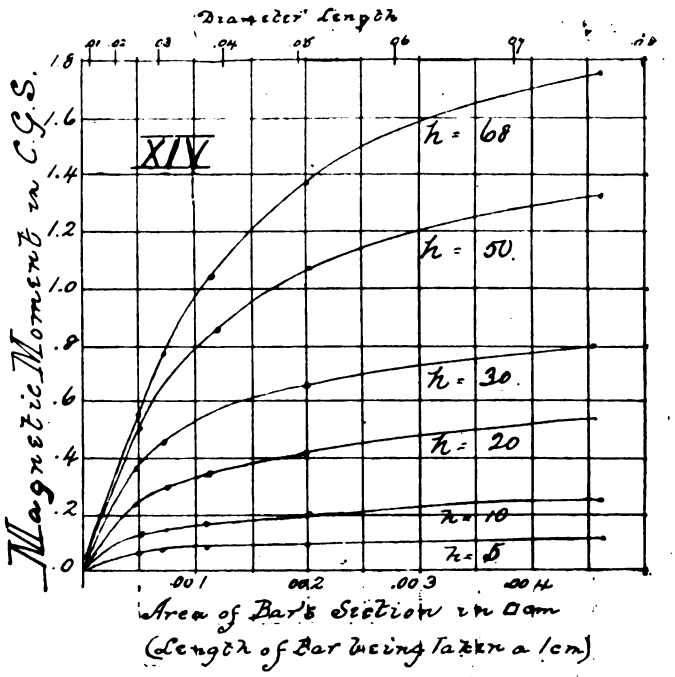
Reference number.	Reduced diameters.	Reduced volumes.
I.	·0253 cm.	·00051 cu. cm.
II.	·0312 ,,	·00077 ,,
III.	·0380 ,,	·00114 ,,
IV.	·0507 ,,	·00203 ,,
V.	·0765 ,,	·00457 ,,





To find, now, the induced magnetic moment due to any field in any of the reduced bars, we have to take the mean intensity of magnetisation corresponding to that field, from the particular curve which belongs to the original bar, and multiply that intensity by the reduced volume. The following diagram (XIV.) shows the increase of magnetic moment due to the increase of the section of soft iron bars deduced in this way. On the top of the diagram numbers indicating the ratio diameter/length is placed for convenience of reference. The moment here being given in C.-G.-S. units for bars of one centimetre long, we can find the moment of induced magnetism due to any field for a soft iron bar of any given dimensions, supposing magnetisation to be independent of the absolute size of the bar. For this purpose we have to take the moment corresponding to the particular ratio diameter/length of the given bar, and the particular field required, and multiply that moment by the cube of the length—that is to say, within the limits to which the experiments extend.

The curves are similar in character to those obtained with bundles of wires, only they are not so decidedly asymptotic as the latter. We cannot, however, draw a definite conclusion as



to the real difference between the two cases, on account of the difference of the specimens of the wires employed. From both sets of these experiments we see that, after the diameter is about $\frac{1}{15}$th of the length of the bar, there is not much increase of moment due to the increase of the thickness of the bar; that is, the induced magnetic moment will be practically independent of the mass of iron.

This statement, paradoxical as it sounds, is not much to be wondered at, if we consider that when the bar becomes very thick the substance of the bar itself will be forming a kind of internal armature to the free ends of the bar. Thus, it seems likely, where thick bar magnets are used in practice, that there may be found waste of material of iron, although in many cases different shapes and the presence of external armatures will modify the condition from the case of the experiments described.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October 20th*, 1888.

Some interesting changes have been announced this week in the relationships between the Westinghouse and Sawyer-Man interests. The new agreement which has been entered into between the Westinghouse Company and the Consolidated Electric Light Compeny of this clty gives to the former, it appears, absolute control of the latter's patents and property. The Consolidated Company and the Sawyer-Man Company have been carrying on a big lamp factory at Twenty-third

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Street in this city, and the Westinghouse people have had another factory at Pittsburg, manufacturing lamps of their own on Sawyer-Man patents. It is stated that under the new arrangement the Westinghouse Company is to enjoy control of everything, and in return the Consolidated Company is to receive $150,000 per annum every year during the continuance of the contract. This sum, it is reported, will amount to a guaranteed dividend of 4 per cent. per annum to start with, and as soon as certain matters and claims are adjusted it will represent 6 per cent, and in addition thereto the Westinghouse Company agrees to pay one cent. for every Sawyer-Man lamp sold. There are, it is understood, about 150 stockholders in the Consolidated Company to whom the enjoyment of regular dividends will be at once an unfamiliar and welcome sensation, as that company has been at considerable expense in carrying on its business and fighting for its patents. The Westinghouse Company further contracts to subscribe for unissued stock of the Consolidated Company amounting to a par value of $125,000, the Consolidated Company's nominal capital being $250,000.

It appears from this arrangement that the old company will have little to do, their business being taken over completely for incorporation into the Westinghouse system; but a further announcement is made that the Sawyer-Man Company will be the exclusive agent for apparatus of the Thomson-Houston Company under certain conditions, and for certain territory. The wording of the announcement is not so clear as it might be, but it is gathered that a very large portion of the incandescent work of the Thomson-Houston Company, whether for isolated or central plants, and whether with direct or alternating current, will be attended to by the Sawyer-Man Company. There is considerable discussion in electrical circles this week over the terms of the agreement, and as time goes on the situation will be clearer, and we shall know more definitely as to the relations to exist hereafter between the Westinghouse and Thomson-Houston Companies, which are thus, apparently, brought closer together by the absorption of the whole Sawyer-Man property by the former.

Some idea of the magnitude of the work carried on in central stations in this country may be formed from the description of a big electric light switch-board appearing in the electrical journals this week. The board in question has been built by Mr. Foree-Bain, of Chicago, for New Orleans, for the Fort Wayne Jenney Station there. The board is 12ft. high and 21ft. long, and has a capacity for 75 dynamos and 30 circuits. Every precaution seems to have been taken to ensure the safety of those handling the circuits, and to provide against fire. No metal of any kind is to be seen on the front of the board, and the terminals are attached at the back, being enclosed in a test proof case. The terminals are made in the shape of a spring jack, and are plugged into by harpoon plugs, through rubber bushed holes in the front of the board. Each spring jack is provided with openings for two plugs, the object being to allow the insertion of a temporary plug in the process of switching, so that a dynamo or circuit may be added to or taken from any other without opening the circuit. The dynamo wires enter the board at the top and the circuit wires from the bottom, being firmly attached to their jacks by means of half inch bolts with checknuts and washers. An ammeter is provided for each circuit, and a lightning arrester with fusible blow-outs is placed on each side of every circuit. The absolute condition of every line can be read at a glance by the superintendent or electrician. This board, although so large, is probably not the biggest in this country, as it is equalled by other electric light boards to be found in such cities as New York and Philadelphia, but it appears to be a good example of advances made in this line of work. The New Orleans Company, to whom the board has been sent, have a valuable franchise for the lighting of the whole city, which takes, I believe, in the neighbourhood of 2,000 arc lights.

From time to time I have made allusion to the work which has been done by the Lighthouse Board to light up Gedney's Channel, at the entrance of New York Harbour. Some time ago it occurred to Lieut Com. Mackenzie that a buoy lighted by electricity might be of great service, and one was placed near the lighthouse depot at Tompkinsville, S.I., experimentally. Good results were obtained, and it was determined to light up Gedney's Channel with electricity, the lamps being connected with the shore by cable. One of the notable advantages in such a system recommending it to the authorities was that if a gas buoy was used and were sent adrift by collision with vessels or with ice, it would still keep alight and prove more dangerous than useful. Mr. Mackenzie and Lieut. J. Millis proceeded, therefore, to equip the channel with six spar buoys, each connected with the station and the shore through special conductors and cables, the water serving as the return. These spar buoys are of juniper, 50ft. long and about 1½ft. in diameter. Each of them is attached by heavy iron rings to sinkers at the bottom of the channel, so that they may swing freely with the motion of the sea. The cables from the shore run out in two groups of three, and then each individual conductor is carried up each spar buoy in a slot, which is covered up after the insertion of the wire, and at the top of the buoy is the lamp. The light itself is a special Edison lamp, giving 100 candle-power, protected by very thick plate glass, which in turn is shielded by a skeleton jacket of metal, likely to afford protection against ice or anything of that kind. The lights are placed three on each side of the channel, and are red and white. The buoys float in 35ft. to 45ft. of water; they thus provide means for the navigation of the channel in the darkest night and stormiest weather. The light will, of course, be under control from the station on shore, where there is a very compact and neat plant in duplicate, so as to provide against every possible emergency of mishap or breakdown. The Bishop gutta-percha cables have been furnished to special specifications, to run out from the shore in two lengths of 15,000ft. or 16,000ft. of three-conductor cable, and in six unequal lengths of single-conductor cable. The total cost of the plant is put at about £4,000, and it is believed by electricians that the plan devised by the two officers named will prove very successful, being far more effective than any other system that has been mentioned. It is amusing to note, however, that this improvement, like all others such lately introduced in New York waters, has met with opposition. One complaint was made in the daily papers, that as each of the buoys will weigh 125lb., it would be dangerous for any vessel running in before a gale to dash against one of them. This letter, apparently from one who ought to be experienced, altogether ignores the fact that the buoys will yield to the slightest pressure, being constructed with that end in view, and takes it for granted that the captain of the vessel or officers and men on duty would be so blind as to be unable to see these six lights of 100 candle-power, until they had actually rubbed the nose of the ship against them. As has been pointed out by one of the electrical papers here, it was this sort of criticism that was levelled against the big electric light torch at Hellgate, as well as against the electric lights in the torch of the statue of Liberty, and those which have been used so long and with such good results in illuminating the big Brooklyn Bridge. The lights on the bridge are at the present time the object of special attack, though they certainly will not be removed, as it would be easy to screen them, so as to prevent their light shining upon the waters; but the joke of the matter is that the pilots of the city's fire boats of their own volition have just sent in a letter to the management of the bridge stating that they experience no inconvenience whatever from the electric lights on the bridge.

The station equipped by the Julien Electric Traction Company for the Fourth Avenue Tramway in this city presents many points of interest. The plant is intended to have a capacity for keeping ten new cars in regular operation, and many methods have been adopted for the convenient and expeditious handling of the batteries, which are the main consideration in a plant of this character. The generating plant comprises two steel boilers; two straight-line engines, each developing 70 horse-power; and two United States dynamos, each of 190 amperes, at 300 volts, or 57,000 watts each. The E.M.F. of the dynamos, however, is variable from 250 to 300 volts, in order to adjust itself to the varying condition of the batteries during the time of charging. The batteries are charged in series, so as to obtain perfect uniformity throughout the whole. For the purposes of charging, the cells, as they are taken from

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the car which has been doing its duty, are placed upon low trucks, which are then wheeled alongside each other, and are connected in series to the charging circuit. There is a very ingenious economy of space in the station by arranging the dynamos on a solid platform immediately over the engine, each belted to separate counter-shafts, from which each dynamo is driven directly. A small repair shop is also neatly worked in, suspended on a platform at one side of the station, out of the way; and an overhead railway leading to it allows of any part of the equipment to be taken to the tools without any trouble. The generating plant is also made to drive a 6 horse-power Baxter motor, which performs a variety of duties in a very effective way. Distilled water for the batteries is obtained by drawing steam from the boilers and forcing it through lead coils placed in the feed water tank, where it is condensed and drawn off; thus waste of heat is prevented, as the heat drawn from the water in the course of condensation serves to warm up the feed water on its way to the boiler. Each car is provided with two sets of batteries, each having a capacity of 125 ampere-hours. With these the car makes three round trips, or a distance of 33 miles, though much longer runs could be made if it were desired on the same battery capacity. One of the troubles in charging storage batteries has been skilfully overcome. As is well known, it has always been more or less troublesome to connect up the cells, and in the present instance, instead of soldering to the plates the long leaden strips which are generally used, and are bent over to form the connection, a copper cartridge shell, filled with mercury, is placed at the centre of the strips, connecting the positive and negative plates of the contiguous cells. This copper shell is housed in a short length of rubber tubing, and embraces also a stout insulated copper connecting wire. The whole point is covered with insulating paint. By these arrangements all metallic surfaces are enclosed, and the connecting wire is so firmly gripped that it cannot slip out in any way, although whenever it is desired to make any change or combination in a group, a blow of the hand will remove the connecting wire by raising it out of the metallic cups. The device works freely, rendering it easy at any time to replace one cell or set of cells by another. The connection is a good one, avoiding the introduction of internal resistance into the battery circuits, and at the same time is such as to be unaffected by the acids, which too often are very troublesome in this respect. This station, which has just gone into operation, is of considerable interest from the fact that it is the first of the kind in this country, and that many of the problems presented have been worked out in an original manner.

It is amusing sometimes to see how much of politics creeps into the affairs of our electric light companies and enterprises. It is no fault of the companies, who simply have to take things as they find them, and make the best of it. Your readers will already have formed some idea of the manner in which the Board of Electrical Control in this city has been connected more or less from its very start with the political fortunes and ambitions of various men, and perhaps they will not be surprised to learn that over in Brooklyn a not dissimilar state of affairs exists. For a long time past the local Edison Company has been working hard to get a franchise enabling it to lay its wires and begin business. The aldermen have stood in the way, however, and have been openly accused of working in the interests of the Citizens' Company, which does all the electric lighting there, and has a good grip on the business generally. To offset this local opposition, the Edison Company carried its case to the State Legislature, and secured special legislation. This in turn was vetoed by the Governor, and thus the matter was referred back to the Board of Aldermen. The matter came up for consideration again this week, when the Mayor of the city urged the subject on the attention of the aldermen, and then one of the men who had been strongest in opposition came forward, at the Governor's instigation, it is alleged, with a resolution, which was unanimously adopted, to the effect that the Edison Company should be given permission to lay its conduits and wires if it began the work in ten days. The company will now go ahead. I judge from the things which we see in the English papers occasionally that the progress of the electric light is beset by like difficulties in England.

CORRESPONDENCE.

LIGHTNING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The interesting phenomenon observed by Mr. Boys and by Mr. W. P. Adams, and recorded by them in your two last issues, suggests a case of discharge by overflow. I mean that the upper layers of the atmosphere—the region of virtual high conductivity (really weak dielectric strength)—may have discharged down to the cloud until that overflowed to the earth. Or it might be that the flash from cloud to earth so lowered the potential of the cloud as to permit a discharge or set of discharges from the high-potential regions above. I should thus regard it merely as a case of a couple of sparking intervals in series.

Many things seem to suggest that it is the upper layers of atmosphere that are primarily charged, and that clouds are either conducting protuberances or else stepping stones; probably sometimes one, sometimes the other.

Mr. Boys would, perhaps, say whether there was anything in his observation irreconcileable with this simple idea.

I may take this opportunity of remarking how much work can be done at meteorological stations and observatories in the matter of accurately observing and recording lightning; photographic records, obtained by proper appliances for distinguishing multiple from successive flashes, being, of course, superior to all others.

An experimental lightning conductor on a flagstaff near every meteorological observatory would also be a most desirable addition. It need not be associated with danger; a system of fuses or cut-outs, or an east and west steel bar, might be used to record the passage of a flash, and the rod need not be examined until after the cessation of violent disturbances. By having the conductor of different thickness at different parts one could learn what size is really likely to be melted. One could also arrange so as to gain information about side-flashes.
—Yours, &c., OLIVER J. LODGE.

ELECTRICAL THEORY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have prevailed on Prof. Poynting to let me send you the enclosed two letters, wherein he continues the discussion of electrical theory begun in Section A at Bath. It must be understood that the letters are merely hasty epistles, not intended for publicity; but Prof. Poynting's ideas are so original and weighty that one is glad to extract from him, when possible, a casual contribution to a discussion, as well as one of his sledge-hammer communications to the Royal Society. I hope that this may be the means of extracting a reply or a criticism more competent than anything of mine would be.—Yours, &c., OLIVER J. LODGE.

"Dear Lodge: I thank you very much for the copy of your exceedingly interesting account of Electrical A. Perhaps my gratitude would be best shown by silence, but I am tempted to show my appreciation by asking you to help me with some difficulties.

"My first difficuly is as to the interpretation of Hertz. You say—though, I think, Fitzgerald is responsible for the statement—that ether is a demonstrated fact. I do not see how Hertz adds to our certainty. Is not our belief in ether due to the fact that light takes time to travel in interplanetary spaces, where we cannot put enough matter for it to travel by, so that we have to imagine something else for it to use. The fact that the velocity of light is nearly the same in vacuo and in gases, and not widely different in denser substances, of course supports the view that on the earth it also uses ether. Hertz shows that there is an 'interference' in electro-magnetic disturbance which we can only (at least, with our present knowledge) put down to wave motion travelling with a definite velocity which he finds equal to that of light. Hence these disturbances probably make use of the same ether. Does this prove its existence any more? I should expect a sceptic to ask why may not electro-magnetic disturbance make use of air, since

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Hertz carried out his experiments in air. I could only reply to the sceptic that he was a very disagreeable person.

"Secondly, Thomson's 'Simple Hypothesis' Paper* appears to be a very serious attack on Maxwell's theory; in fact, on reading it over carefully, I can only come to the conclusion that it would lop off not only Maxwell's excrescences but his whole theory. According to the concluding sentence of § 4, ('each component of electric current at any point is equal to the electric conductivity multiplied into the sum of the corresponding component of electrostatic force and the rate of decrease per unit of time of the corresponding component of velocity of liquid in our primary') the current $u = C\left(-\frac{d\Psi}{dx} - \frac{du_1}{dt}\right)$; which = 0 if C the conductivity = 0, so that Maxwell's f (his 'displacement' current) goes altogether. The x component of Maxwell's E.M.F. will contain a term $-\frac{\mu}{4\pi}\frac{K}{}\iiint\frac{d^2P}{dt^2}dx\,dy\,dz$, since Maxwell's u = Thomson's $u + \frac{K}{4\pi}\frac{dP}{dt}$, where P = E.M.F. along x. This has no representative in Thomson. Thus with a homogeneous but leaky condenser with no connecting wire, we have, according to Maxwell, total current = 0, for leak is made up for by yield of displacement;

$$\therefore\ P = -\frac{dV}{dx},$$

where V is potential due to electrification in plates.

"According to Thomson, u is to be taken as rate of leak, and is positive,

$$\therefore\ P = -\iiint\frac{du}{dt}\frac{}{r}dx\,dy\,dz - \frac{dV}{dx}.$$

"According to Maxwell there is no magnetic effect, since total current = 0.

"According to Thomson—using his notation—x component of magnetic force $u_2 = \frac{dw_1}{dy} - \frac{dv_1}{dz} = -4\pi\nabla^{-2}\left(\frac{dw}{dy} - \frac{dv}{dz}\right)$ from Thomson's equation (7), *i.e.*, if ∇^{-2} and $\frac{d}{dy}$, &c., are transposable.

"But $u = KP$, $v = KQ$, $w = KR$,

$$\therefore\ u_2 = -4\pi\nabla^{-2}\left(\frac{dR}{dy} - \frac{dQ}{dz}\right)$$

$$= -4\pi\nabla^{-2}\left\{\frac{d}{dy}\iiint\frac{dw}{dt}\frac{}{r}dx\,dy\,dz - \frac{d}{dz}\iiint\frac{dv}{dt}\frac{}{r}dx\,dy\,dz\right\}$$

the term in V disappearing. This is awful; but I see no reason to suppose that it vanishes. If it does not vanish, then the existence of magnetic effect would decide against Maxwell.

"Thirdly, I note on p. 10 of your sketch that Rowland and Fitzgerald consider that electrostatic potential is not propagated by end thrust, and you remark that it is the magnetic potential which travels, generating the electrostatic potential as it goes along. I think I remember that you have expressed the view that potential energy must undergo a kind of conversion, and that unless it be born again as kinetic energy it can in no wise go forward on its journey.† With strained solid waves it looks as if it were so, though it is, I think, possible to regard both energies as going forward linked together, yet retaining their individuality. And if potential energy is, after all, kinetic, but of another kind, it is conceivable that they should keep their separate identities. But with electrostatic and electromagnetic strains, which is potential and which kinetic? I know it is usual to call the magnetic kinetic; but if we had started with permanent magnets, and travelled by means of magneto-electric machines to our present knowledge of electric phenomena, I expect we should now be discussing the propagation of magnetostatic potential and magnetoelectric potential, and we should, perhaps, consider the former generated by the latter. This is really the view I take, or, rather, I think both are true. It seems to me that the sideway propagation of electric induction is accompanied by (let us drop 'generated by') magnetic induction, and equally the sideway propagation of magnetic induction is accompanied by electric induction. The two go together when a disturbance is propagated. In a steady state they do not, *i.e*, if we can separate them from each other; at least I do not see how otherwise to interpret the results I have obtained (*see* pp. 284-5 of Paper referred to below). This brings us back to the old point whereon we have differed before. It would be better to give in like the unjust judge for the sake of peace and quietness, and to ward off any more such letters as this.

"I have been going again through a Paper 'On Connection between Electric Current and Electric and Magnetic Induction' (*Phil. Trans.*, II., 1885), in which I tried to work out the equations to the magnetic field on the supposition of this sideway propagation. Ψ ceases to be troublesome, and both electric and magnetic inductions are propagated at the same rate; indeed, they are by Maxwell's equations, though I do not think he ever definitely worked this out. I cannot see any point, in the assumption to begin with, or in the subsequent reasoning, where I have gone astray. If you have any time to spare, would you look at the Paper, pp. 277-281, and 294-300? The rest is not essential, though on 301 I show that Maxwell, pure and simple, gives the same results.—Yours, &c.,

"J. H. POYNTING.

"Mason College, Birmingham, October 12th, 1888."

The following extract from my note in answer may be inserted, in order to make the next letter clear:—

"As regards the proof of the ether, I confess I did not quite see FitzGerald's point as to why Hertz's experiments rendered the existence of ether any more certain; but knowing that I had felt it thoroughly established long ago, I supposed I was not a good judge. Of course he must appreciate all the stock arguments about air, &c., not transmitting transverse disturbances, and about neither it nor glass transmitting anything at the speed 3×10^{10}, &c. And Hertz's experiments only seemed to me to *prove* that electro-magnetic waves existed and travelled at the same speed, thus practically proving that light is electro-magnetic waves, and establishing Maxwell's theory.

"This seems to me far more important than proving once more the existence of ether. At the same time I feel sure FitzGerald has some point. It may be only that an electro-magnetic ether has been proved, and thus the action-at-a-distance-Germans confounded. He spoke as if he meant more than this. Perhaps I have to that extent misrepresented him in my 'sketch.' How does it strike you?

"With regard to Thomson's Paper, it is certainly very anti-Maxwellian, but I believe it only represents a transition stage through which he was somewhat rapidly passing, and through which he may now have almost passed. I certainly do not know now where he is.

"Is it not that finding that displacement currents have no magnetic effect, therefore he ignores them? But then have they no magnetic effect? In some cases they cannot have, for electrostatic displacement is of the nature of an 'expansion,' as Clifford called it; there is no 'spin' about it.

"I cannot find Thomson's Paper this minute to refer to, but I have it somewhere. I will look it up again in the light of your remarks."

After referring to my reply, Prof. Poynting writes, in a second letter:—

"About the ether, I should entirely accept your interpretation of Hertz. I should think, as you say, that Fitzgerald was aiming at believers in action at a distance, and probably he knew where to have them in showing that there is an electro-magnetic medium.

"You say, with regard to Thomson's Paper, 'Is it not that, finding displacement currents have no magnetic effect, therefore he ignores them? But, then, have they no magnetic effect? In some cases they cannot have.'

"It is just here that I find the supposition of transverse propagation of electric strain accompanied by magnetic induction so clarifying to my ideas. If the magnetic effect is the whirling of the machinery which is sending electric strain energy onwards, the machinery cannot know whether the energy is going to be dissipated in a Prony-brake-like wire, or whether it is going to increase the electric strain, so pro-

* Reprinted in *The Electrician*, Sept. 14, p. 605.

† *Phil. Mag.*, October, 1879, p. 281, § 11; June, 1881, p. 534; and June, 1885, p. 486. I do not regard this as a "view," however, but as a proved truth.—O. J. L.

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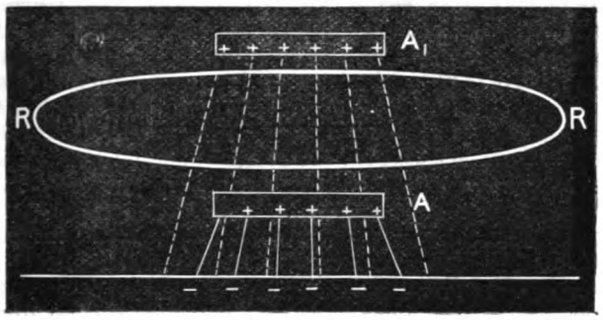
ducing a 'displacement current.' To use an illustration, I regard a re-entrant line of magnetic force as a kind of ring of Custom House officers registering the amount of electric strain sent in per second (they are porters as well), and they do not know what will happen to the energy. They will register just the same whether the imports are for immediate consumption or go to add to stock. Of course, they will take no account of shooting stars, balloons, or destruction of stock already within the ring; which, being interpreted, is that the line integral of the magnetic force ($4\pi i$, isn't it?) will not be affected by lines of electric force other than those coming in or going out through the boundary. For instance, if A moves through the ring R R to A′ (see figure) conveying a charge, hardly any lines of electric force will cut the ring R R, yet the number of lines through it is increased. And it will not be affected by induction which dissipates itself *in situ* as in a leaky Leyden jar, where the energy changes to heat without moving. I do not know of any other case, but,



being utterly ignorant of pyro-electricity, I imagine it might supply a case of establishment of electric induction without motion of the energy and without magnetic effect.

"Yours, &c., J. H. POYNTING."

"18th October, 1888."

ELECTRO-CALORIMETRY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is curious that Mr. Evershed, in his criticism (*The Electrician*, October 19th, p. 773) of our method of determining specific heats should have selected as the only point of attack precisely that portion of the arrangement which has been employed by every experimenter who has used coils in series. His remarks must therefore be understood as applying to the work of Joule, Pfaundler, and others, as well as to our own experiments. Mr. Evershed's contention that there is a condition of unstable electrical equilibrium when two resistances having positive temperature coefficients are joined (*in series*) to the same battery, we, nevertheless, will not attempt to deny, but he will admit that since the rate of losing heat in the hotter coil is greater than in the cooler one, a balance between the rates of heating and cooling is possible. The familiar example of copper leads carrying strong currents from the outside of a room where the temperature may be that of freezing point to the much hotter interior of the room is a case in point. A more important illustration is the use of incandescent lamps in *parallel*. Here, since carbon has a *negative* temperature coefficient, the condition is one electrically unstable.

We will next consider what influence the variation of the resistance of the coils will have upon the accuracy of our electro-calorimetrical determinations. In the process of heating a liquid by passing a current through a wire the latter must necessarily be at a much higher temperature than the liquid. In our experiments a sample of the wire to be used for heating purposes was covered with paraffin and placed in water, and a current of such a strength was passed through it as just to melt the paraffin, the water remaining entirely unagitated. The current actually used for heating the contents of the calorimeters was only about half this strength, and, moreover, the calorimeters were shaken up thoroughly during the process of heating, so that we may safely infer that the mean temperature of the wire was at the outside not more than 20°C. above the temperature of the water.

The ideal of accuracy to which we are endeavouring to attain is one part in ten thousand, and for a variety of reasons we do not think it is possible to secure much greater accuracy than this. Now what latitude does this permit us to employ in the temperature difference between the two coils? Platinoid formed the material of the wire, the temperature coefficient of which is, say, ·02 per cent. per degree, so that even if there was a mean temperature difference of the heating coils of 0·5°C., the result would only be effected to the ten-thousandth part. So far as Mr. Evershed's contention goes, we might in *directly balancing* water with, say, alcohol, avail ourselves of a temperature difference of as much as half a degree without sensibly affecting the results. But we do not *directly balance* one liquid with another, but employ the far preferable plan of using *a method of substitution*. Water in calorimeter A is balanced with water in B, then with the same heating current passing for the same time the same water in A is balanced with the liquid in B. As the final temperature of the water and liquid when properly balanced only differ by at most $\frac{1}{50}$°C., the condition, then, that has to be satisfied is *that the wire in B when traversed by the same current as before for the same time shall have the same mean temperature to half a degree, whether it is employed in heating water or its calorimetrical equivalent of the liquid.* Since the agitation is perfect we have no hesitation in saying that this condition is more than fulfilled.

The gist of our answer to Mr. Evershed's criticism is that the method of substitution does not imply equality of heating in the two calorimeters. The more complicated arrangement that he proposes would, therefore, in any case be unnecessary for our purpose.—Yours, &c.,

WILLIAM STROUD,
October 29th, 1888. W. W. HALDANE GEE.

This opportunity may be taken to correct several misprints that appeared in the published abstract. They occur on p. 706 (*The Electrician*, Oct. 5th), and are as follows:—

2nd	line from top,	*for* platinised	*read*	platinoid.
31st	,,	,, σ	,,	θ
32nd	,,	,, meters	,,	meter
32nd	,,	,, m	,,	m_1
33rd	,,	,, d	,,	σ
36th	,,	,, $d\theta', d'\theta$	,,	$\theta', d\theta'$
39th	,,	,, +	,,	−

THE OSCILLATORY DISCHARGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following extract from the "Scientific Writings of Joseph Henry," and dated June 17th, 1842, may be of interest to your readers at the present time:—

In magnetising needles by the electrical discharge the needles were always magnetised in a direction conformable to the direction of the electrical discharge, but by employing very fine needles he obtained several changes in the polarity of the needles by merely increasing the quantity of electricity, while the direction of the discharge remained the same. He continues:—"This anomaly, which has remained so long unexplained, and which at first sight appears at variance with all our theoretical ideas of the connection of electricity and magnetism, was, after considerable study, satisfactorily referred by the author to an action of the discharge of the Leyden jar which had never before been recognised. The discharge, whatever may be its nature, is not correctly represented (employing for simplicity the theory of Franklin) by the single transfer of an imponderable fluid from one side of the jar to the other; the phenomena require us to admit *the existence of a principal discharge in one direction, and then several reflex actions backward and forward, each more feeble than the preceding, until the equilibrium is obtained.* All the facts are shown to be in accordance with this hypothesis, and a ready explanation is afforded by it of a number of phenomena which are to be found in the older works on electricity, but which have until this time remained unexplained."

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A little later, in the same Paper, he gives an explanation of the reversal of polarity of the needles by the oscillatory discharge.—Yours, &c., A. D. RAINE.

City and Guilds of London Institute,
South Kensington, Oct. 25, 1888.

THE ELECTRICAL TRADES SECTION OF THE LONDON CHAMBER OF COMMERCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Now that the result of the election of the working committee of the Electrical Trades Section is known, I should be glad if you would allow me, as one of those who have not yet joined, to make a few remarks.

I was invited by Mr. Crompton to attend a preliminary meeting on the subject held last July, but was unable to attend, and strain of work has hitherto prevented me from an opportunity of urging a different mode of election and constitution of the working committee.

The success of such a scheme as this must depend on the strength of the committee and the feeling that it is an adequate representation of those supporting it. What brought about the present formation was a general feeling of its necessity among the trade, not the professional side of the electrical world at all, but the manufacturers, the contractors, those who by able management and enterprise have been the means of establishing the numerous factories that will in the future enable England to take a foremost place everywhere for her electrical goods.

The telegraph companies, goodness knows, have succeeded in the past well enough without any electrical section at the London Chamber of Commerce, so have the telephone companies, and it was not to meet the wants or demands of these corporate bodies that the present section was formed or was ever likely to be proposed.

And yet what do we find on analysing the list of members and their representation on the committee? Telegraph companies 14 memberships, 5 on the committee; telephone companies 9 memberships, 3 on the committee; electricity supply companies 16 memberships, 6 on the committee—a representation in every case of one-third. For the electrical manufacturers and contractors—those on whom the success of the scheme depends, in fact, without whose support it must remain a dead letter—there is a representation of less than one-seventh: 94 memberships, with 13 on the committee.

It must be apparent that this is wrong, and on increasing the committee up to the allotted 48 it should be borne in mind.

Now, as to the election of the committee, could not this be improved on by the adoption of some such plan as Mr. Mr. Ritchie's scheme for the election of County Councillors—two-thirds of the committee to be elected by the enfranchised subscribers of their guinea, and one-third to be elected by the committee, with a view to strengthening themselves by the addition of able and useful men in the electrical world?

This would be an admirable corrective to a ballot of this kind, and has many advantages.

The two-thirds of the committee to be ballotted for should be principally drawn from the electrical manufacturers, who, as I have already demonstrated, must be the heart and soul of the thing if it is to be any good. A further selection could then be made from gentlemen connected with the telegraph, telephone and electricity supply companies (preferably officials rather than directors), from consulting engineers and others prominently connected with electrical matters, who express their willingness to give suitable time to the work. The selection could be varied every year, and the services of many might be secured who would not feel disposed to put themselves up for invidious distinctions by balloting. The committee would thus have a useful power of obtaining the services of those whose useful knowledge, whether on technical matters, commercial subjects, or the ethics of fire risks, would be of service to them, and at the same it would restrict the committee to those who are able and willing to attend.

It might be argued that this would lead to exclusiveness and to the formation of a clique; but with this I disagree. On carefully scrutinising the list of those already elected it will be seen there are many who from their very positions and their numerous important duties will find it impossible to attend, and therefore the business will be left in the hands of the few, which in the other mode of election would not be the case.

On mentioning this I was told (of course by an irresponsible person, so there is no need for an official disclaimer), "All the better, then a few of us can work it."

Now if there be one thing that will alienate the support of the electrical trade more than another it would be a feeling that the committee is "worked" by a little family party. If it be borne in mind that many of the most prominent members will not attend for reasons before-mentioned, a careful and thoughtful scrutiny of the elected might show that such a feeling is not altogether without foundation.

I do not, however, believe there is any such intention, and such could be readily defeated if only all the members of the committee would attend.

I am pleased to see, at any rate, two of the electrical journals represented, who, in fact, should be *ex-officio* members of the committee. As the means of disseminating all that is interesting and instructive to the trade they constitute an enormous power, and it is important that they should be well in touch with everything that goes on, and identified with every movement of this kind. The success of the present undertaking depends now on the working committee; I and many others who have not yet joined are waiting events. If it is to be the means of airing individual interests, of coercing master and man, or of interfering and generally busy-bodying with matters foreign to it, then it will drift for a time and sink away; but if it can succeed in cementing and protecting trade interests and diminishing trade burdens, it will have fulfilled a duty that for my own part I regret the Society of Telegraph-Engineers and Electricians, with its prestige and position, did not some time ago recognise and undertake.—Yours, &c.,

JOHN B. VERITY.

King-street, Covent Garden, Oct. 29, 1888.

TELEGRAPHY WITHOUT WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In February, 1885, I published what experiments I thought necessary to explain what I meant by "Induction and Conduction," my object being to show in what way a current of electricity would affect a good conductor, or one sufficiently bad to be called an insulator or non-conductor. In one of these published experiments I said: "The experiment from which the results here shown were obtained was as follows:—An uninsulated iron tank 6·5 feet long, 5 feet wide, and 3·5 feet deep, was filled with water (about 676 gallons), and the surface divided off into sections of one square inch by means of the arrangement already described. The two ends of a battery of twenty Leclanché cells were attached respectively to two circular copper plates 3·5 inches in diameter, and immersed six inches below the surface of the water, and 3·3 feet apart. The two exploring wires in connection with the galvanometer were ·038 inch in diameter, and insulated so that only a cross section of each wire would be in contact with the water. The ends of these wires were fixed parallel to each other half an inch apart, and so arranged that the uninsulated ends should be immersed below the surface of the water in each test. These two wires, so fixed and immersed, were moved in each section, until the position of maximum potential was obtained. In this manner I was able to trace some of the lines of polarisation into which the current divided itself, not only from its original source, but also its unerring return to the same."

I also stated my views upon the same subject as follows:—"Messages by electrical signals have been sent and correctly received through a submarine cable two thousand miles in length, the earth being one half of the circuit, by the aid of the electricity generated by means of an ordinary gun cap containing one drop of water; and small though the current emanating from such a source naturally was, yet I believe it not only polarised the molecules of the copper conductor,

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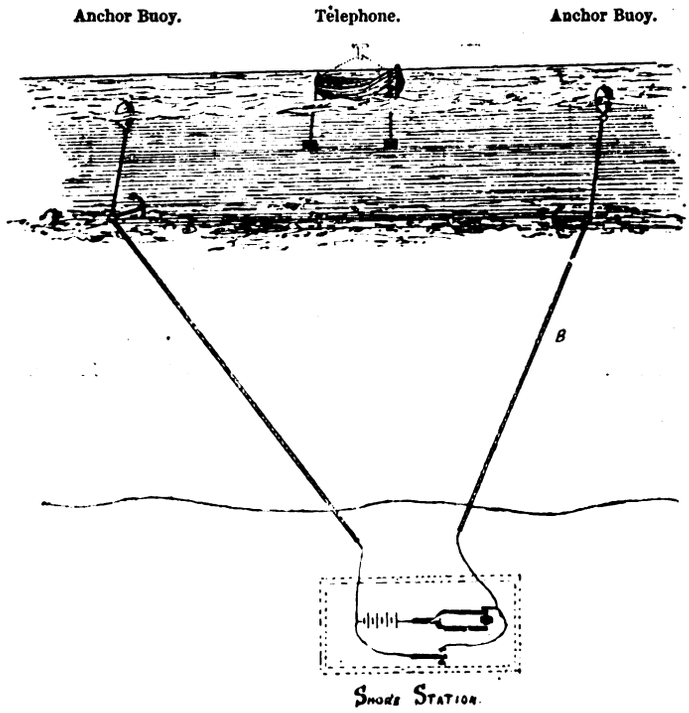
but also in the same manner affected the whole earth through which it dispersed on its way from the outside of the gun cap to its return to the water it contained. I further believe that the time will come, perhaps sooner than may be imagined, when it will be possible to detect even such small currents in any part of the world, in the same way that it is now possible to do in comparatively small sections of it."

For researches of this description it is necessary to employ as sensitive an instrument as it is possible to obtain, to pick up, so to speak, such minute currents. Now there is that wonderful instrument the telephone. I say wonderful advisedly, for, as far as I know, it is not to be equalled for the simplicity of its mechanical construction and the ease with which it can be manipulated; and yet it is so peculiarly sensitive. I have therefore used it in most of my experiments as the receiving instrument, although, of course, there are other well-known instruments that could be employed, as all depends upon the potential of the current to be detected. The sending arrangement was either an ordinary Morse key, so manipulated for a long or short time as to give the necessary sounds in the telephone to represent dots and dashes, and being so interpreted, the senders' meaning was clearly understood; or a double key and two pieces of mechanism, giving dissimilar sounds, were employed with good results. I gave much time and thought to the subject, the results of each experiment giving me so much encouragement to proceed; and of the many experiments made I select the following, as I think it will clearly illustrate my system for telegraphing to a distant point not in metallic connection with the sending station, noticed by you in a recent number of your journal.



A wooden bathing hut on a sandy beach made a good shore station, from which were laid two insulated copper wires, 115 fathoms in length, marked respectively A and B. Sections of the wires were twisted round anchors, as shown, their position being marked by buoys, as indicated, about 100 fathoms apart in a direction N. and S.; midway between the two a boat was anchored with a copper plate hanging fore and aft about 10 fathoms apart, and consequently about 45 fathoms from either end of the anchored shore wires. This boat represented the sea station, and, owing to the state of the sea, a very wet and lively one it proved; therefore, taking this fact into consideration, together with the crude nature of the experiment, in this arrangement it was remarkable with what distinctness and ease messages were passed. The last message sent from shore was: "Thanks, that will do; pick up anchors and return to shore." To this the reply came from the boat, "Understand," and they then proceeded to carry out instructions.

It was slack low water during the laying of the wires, but a strong flood tide was running from N. to S. during the experiment; the sun was shining, but there was sufficient wind from the E. to cause big white crested waves to scamper to the shore; in fact, when I saw how difficult it was for even experienced beachmen to manage the boat in such a sea, I repented of the persuasive powers I had used to induce the men to undertake the work. It was too rough to proceed further with the experiments, as I intended; but still, I had learnt more than sufficient to convince me of the practicability of the system for various purposes, and particularly for telegraphing in the way described.—Yours, &c., WILLOUGHBY SMITH.

THE "MANN" TELEPHONE EXCHANGE SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In an article by Mr. J. Munro, in your issue of Oct. 19, some mention is made of my circuit line systems for telephonic intercommunication, used in Dundee and in other centres of the National Telephone Company's system.

Will you allow me, through the medium of your well-known paper, to make a few statements with regard to this system?

It is always described as an adaptation of the "Law" system. As a matter of fact, when I devised this system, in the spring of 1882, I had not seen or heard of the Law system.

The only similarity between the two systems is that an extra calling wire is made use of.

There is no difficulty in applying this system to the largest towns except the expense, which is always great when an old system has to be replaced by a new.

The National Telephone Company's *employés*, who have used this system, advise its adoption in large centres.—Yours, &c.,

J. J. MANN.

11, Chatham-buildings, Manchester, Oct. 27, 1888.

"REMARKS ON SOME OF OUR TELEPHONE SYSTEM."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am obliged to your correspondent "A.S.T.E. and E." for his correction with regard to the Edinburgh poles. The first call offices were opened in London during 1888.—Yours, &c.,

J. MUNRO.

Edinburgh, Oct. 30.

LECTURE ON ELECTRIC LOCOMOTION: PAST AND PRESENT.

On Friday evening last at University College, Nottingham, Dr. J. A. Fleming delivered a public lecture on "Electric Locomotion." The large theatre of the College was completely filled with an attentive and appreciative audience.

The chair was taken by Mr. Alderman Lindley. The CHAIRMAN, in a few preliminary remarks, recalled to the recollection of the audience that Dr. Fleming was the first Professor of Mathematics and Physics in the College on its opening in 1881, and had since that time devoted entire attention to the subject of electrical engineering.

Dr. FLEMING began by a very brief review of the progress of the art of electrical illumination since the date of the opening of the University College in 1881. Passing to the proper subject of his discourse, he proceeded to explain by numerous lantern views, and by experiment, the electrical transmission of power. Amongst other illustrations, a small hand Gramme machine was joined up to a small model of an old-form Edison dynamo placed at the opposite end of the lecture table. On working the winch of the hand Gramme the Edison machine was made to rotate and lift a weight to the ceiling. The audience had thus before them the whole process. In addition a number of machine tools were shown working. A large shearing machine was shown cutting bar iron, being driven by a motor operated by current from the College dynamo, and a lathe was worked in a similar way. The subject of tramcar traction was next treated. The early efforts of Field, Edison and Daft in electric locomotion were fully described and illustrated by lantern photographs, and the more recent work of Sprague, Short and Nesmith, as well as that of the Daft, Thomson-Houston and Van Depoele Companies described. The details and mode of working of the Portrush and Bessbrook tramways, by Siemens and Hopkinson, and the Brighton and Blackpool tramways, were illustrated by views and diagrams, and the storage battery mode of working,

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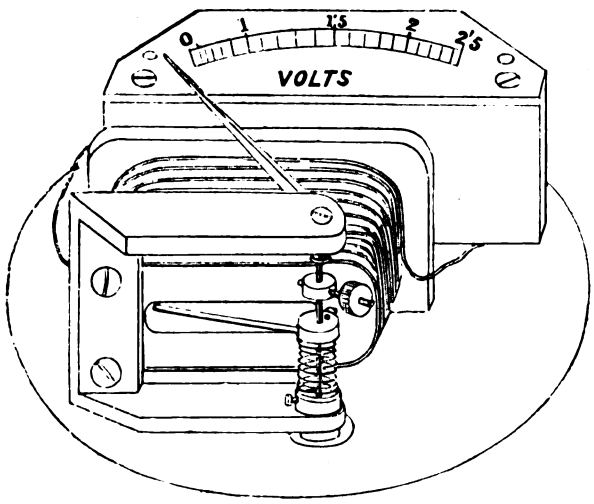
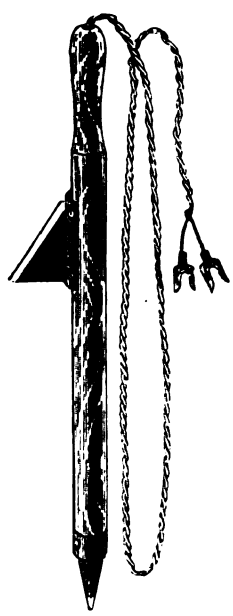
as adopted by Reckenzaun and others, explained. Some details of cost of working, as derived from data of the Richmond Sprague railway, were furnished. The hope was expressed that the successful operation of some 40 to 50 actually existing tramways and the projection of many more in the United States would stimulate English tramway directors to vigorous action in this matter. The details of the methods of working by overhead and conduit-laid conductors was explained, and also the comparative merits of the parallel and series system of working cars dwelt upon. The comprehension of the lecture was greatly facilitated by the numerous photographs shown on the screen by the fine optical lantern of the College. In conclusion, the lecturer urged upon his audience the necessity for a still greater fostering in this country of purely scientific research, seeing that it is upon the basis of an accurate knowledge of scientific principles that practical engineers are alone able to erect the structure of applied science. A hearty vote of thanks to the lecturer brought the evening to a close.

DRAKE AND GORHAM'S LOW-READING VOLTMETER.

We have received from Messrs. Drake & Gorham a sample of their new low-reading voltmeter, which we illustrate diagrammatically





below. It is specially designed for use with secondary batteries, reading, as it does, from 0·5 to 2·5 volt. It is accompanied by a special connecting spear for rapidly making contact to the two lead poles of a cell with one hand, the voltmeter being held in the other. The needle system is balanced and controlled by a spring, so that the instrument can be read in any position among others. There is one little point of constructive detail which, we think, is novel, viz., that should the spring get a little strained, as sometimes occurs, this being, of course, shown by the pointer not standing at zero when on open circuit, it may be at once corrected by turning a screw at the back. The resistance for a 2·5-volt instrument is about 13 to 14 ohms, which is low for such a small size. It is made for Messrs. Drake and Gorham by Messrs. Nalder Brothers and Co., of Westminster.

WARING'S LEAD-COVERED CABLES.

The system of insulation and protection adopted by the Waring Electric Cable Company, of Pancras-lane, E.C., which is illustrated below, has already stood the test of several years' experience in the United States, and the results obtained would seem to have been of a highly satisfactory character in every department of electrical industry to which they have been adapted. Many of our readers will have seen specimens of these cables at the American Exhibition last year, and will therefore be familiar with the fact that the external sheathing is of lead. Hitherto, however, little or nothing has been made known in this country with regard to the dielectric. This is a hydro-carbon compound of highly-insulating qualities, which is obtained from the destructive distillation of petroleum. It is remarkably durable under the greatest extremes of heat and cold. It is even said that the copper conductor may be made red hot, or the lead casing may be raised to the melting point without injury to the insulation, and without allowing the conductor to shift from its proper position. This property should render the material very valuable for the insulation of leads in stoke-holes, and alongside of steam pipes, &c.

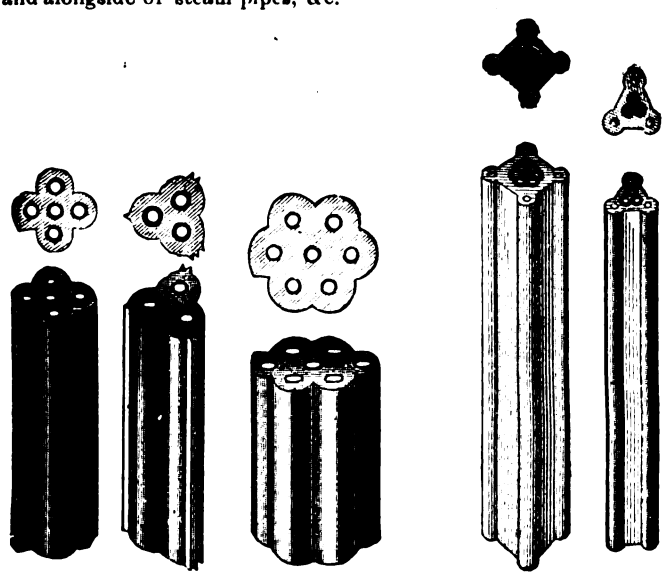


Fig. 1A. Fig. 1B. Fig. 1C. Fig. 2A. Fig. 2B.

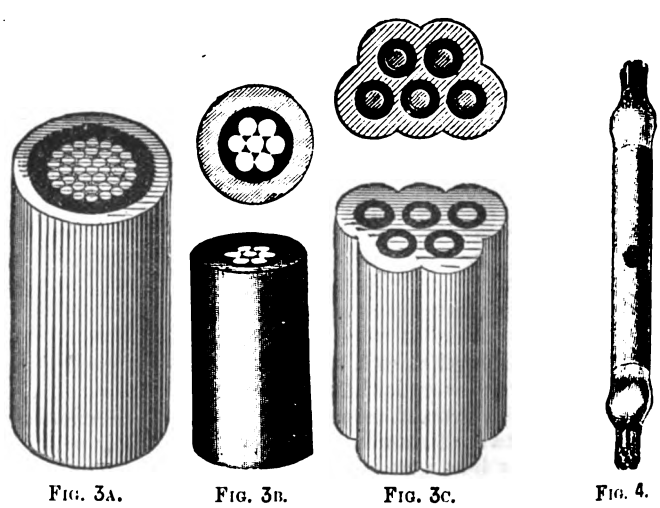


Fig. 3A. Fig. 3B. Fig. 3C. Fig. 4.

The external coating of lead is laid on without any joint, the cables being furnished in lengths of from 1,000ft. to 2,400ft., according to the number of conductors. For telephonic purposes "anti-induction cables" are supplied, in which each conductor is wholly surrounded by the lead. Some of them are illustrated in Figs. 1*a*, 1*b*, 1*c*. For telegraphic purposes the conductors are more usually bunched together, as in Figs. 2*a*, 2*b*. Figs. 3*a*, 3*b*, 3*c* show types of cable suitable for electric lighting. A very light single-wire cable is furnished for house-wiring. One great advantage possessed by the types of cable in which each conductor is separately sheathed in lead is that a ready means is afforded for identifying any one wire at any point. For this purpose one of the ribs is made with a

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square edge, and by counting from this round to the right or left any other conductor can be designated.

The lengths are united by a simple joint made as follows:—The cable joints are first stripped of the lead, the insulation removed, and the wires substantially joined and soldered. Each wire joint is then wrapped with the Waring insulated tape, and this served with strips of lead to preserve the metallic continuity of the casing. A sleeve of lead pipe, previously slipped over one of the ends, is then brought up over the joint, both ends dressed to fit the cable, and solder wiped joints made, as shown in Fig. 4. The sleeve being tapped near the centre is then filled with insulation and closed. In America many of these cables have been laid in the ground without other protection than a slight wooden troughing.

SOME OBJECTIONS TO THE OVERHEAD CONDUCTOR FOR ELECTRIC RAILWAYS.*

BY MR. M. B. LEONARD, OF RICHMOND, U.S.

Of all the valuable Papers read before the Institute probably none has excited greater interest than Mr. Sprague's admirable contribution on "Electric Railways, the Solution of the Municipal Rapid Transit Problem,"† in which the advantages of electricity in practical operation have been so well set forth as to convince the most sceptical of its superiority over all other methods of traction for this class of traffic. To electrical engineers this comparatively new application of the electric current is one of the most important questions that have come before them, and should be carefully studied in all its details, so that the defects and objections may be pointed out and guarded against, and the most perfect methods evolved as speedily and fully as possible. A point of the utmost importance is the necessity for first-class workmanship.

While it has been successfully demonstrated in the city of Richmond that electric traction is really the solution of the rapid transit problem, and we have felt in the increased value of real estate and the growth of our city in population and reputation the substantial benefits resulting therefrom, I have considered from my daily observation of the operation of this electric road that the overhead wire system cannot be made a perfect or ideal method of operation under all circumstances because of the defects inherent in such a method. But that it will serve as a pioneer in the new field, and will be supplanted in time by a more perfect system, I have not the least doubt, and in the following remarks I will endeavour to show some of the objections that have come to my notice, although there may be others that have escaped my attention, owing to the extreme reticence of all parties connected with the enterprise, doubtless from business reasons.

Of the three most commonly used, the overhead system appears to be the favourite, the latest report of electric street railways in operation in America showing that out of a total of forty-three not less than thirty-six are using the overhead system, and that at least thirty now under construction have arranged to do so. Doubtless the smaller cost, as compared with the other two, was an important factor in deciding so largely in favour of the overhead conductor.

As used in Richmond, the details of operation have been shown so fully and clearly in Mr. Sprague's Paper that it is unnecessary to repeat them here, beyond stating that the rail and earth system is adopted in connection with the overhead wire. During the seven months of active operation of the Richmond Union Passenger Railway many thousands have been successfully transported every day, and at a very much lower cost than could possibly have been done by horse-power, owing to the excessive grades encountered; but the defects of the overhead system are now becoming more apparent as the plant suffers its material depreciation, and we are now in a better position to judge of its value as a permanent institution than we could possibly have done heretofore.

It is an undisputed fact that the encumbering of the streets with the poles required for the overhead system is one of the most serious objections to its use. Although they are hid to a large extent in many places by the shade of trees and foliage, yet on the main streets of our cities, where this system is most likely to be used, they are not only a grevious eyesore, but also increase the liability to accident from runaway horses and other causes. Their appearance would not perhaps be so offensive were it possible for them to maintain an erect position, but on account of the weight of the trolley wires and the pressure of the trolley, the tops of the poles are constantly pulled together, notwithstanding they may have at first been raked in the other direction, and thus the unsightly effect is augmented. Those of us who are acquainted with telegraph line construction can appreciate the great leverage exerted by a heavy strain on the top of a pole twenty-five or thirty feet high, unsupported by guys or otherwise, and will readily understand that it is only a question of time before the poles must be reset or replaced with heavier ones. This has been especially the case on the curves where the strains have been greatest, in some instances approximating a pull of 650lb.; nor does the network of wires, span, trolley, guard and curve, inspire the public with any feeling of toleration for the disfiguring of its streets, but must hasten the time when the clamour for underground wires will compel their removal.

But to my mind the most serious objection is the employment of the bare trolley wire carrying a current of 500 volts and about 90 amperes, which I consider not only dangerous to life on account of the frequent breakages of the wire, which on one occasion last spring in falling struck and killed a horse, but also in damage to property by fire. It is claimed that the use of guard wires will always prevent the possibilities of such an occurrence; but the guard wires did not obviate the burning and melting of the telephone wires when on one occasion the breaking of an exchange telephone pole threw them across the trolley wire, and it was necessary to shut down the railway to prevent the entire destruction of the exchange, and possibly the firing of the subscribers' instruments and houses.

That the trolley wire is liable to breakage at any time has been shown twice during the past week, to the interruption of travel and dissatisfaction of the public; while not so very long ago the wires over one of the curves were pulled down on top of the car by the trolley catching in it, and travel was entirely suspended on that part of the line for one or two days. A very serious defect in the use of the bare trolley is the difficulty of securing proper insulation. Thus far porcelain knobs seem to have been found best adapted for this purpose, and the leakage resulting, especially in damp or rainy weather, must be considerable on the whole length of the line, and must cause a large waste of current. This is probably the reason why it has been impracticable to run over about 30 cars at one time out of the 40 with which the road is equipped, and would seem to indicate a very large loss of energy. In view of the fact that porcelain insulators have been long ago condemned for telegraph purposes, where a comparatively small current is used, it seems strange that they should have been adopted as the best means for securing insulation in circuits of such high potential as are employed on the Richmond road.

The trolley itself seems to be a clear source of trouble and difficult to manage properly. As has been shown, it consists of a grooved wheel at the end of a counterbalanced pole held by a spring against and making contact with the underside of the working conductor. In rounding curves it must be carefully watched by the car conductor to prevent its leaving the trolley wire, and thus stopping the car, and at night extinguishing the lamps, which has proved exceedingly disagreeable to the passengers, while on busy days it has seemed necessary to put a third man on at each car at additional expense for the sole purpose of attending to the trolley. Sometimes the trolley pole has broken, or the springs holding it against the wire have given way, stopping further progress of the car, or requiring a man to stand on the car-roof holding the trolley-pole against the wire until the repair sheds were reached.

One of the most unsatisfactory features about the arrangement of the Richmond road is the ground circuit, not only because of the difficulty of getting a good ground, which has in this case only been accomplished by connecting the track with the whole gas or water works system of the city, to the detriment of our exchange telephone system, but the fact is that it is necessary to have a clean track to work on, otherwise vivid flashes of electricity will appear, to the terror of the horses in the vicinity and damage to the motor; or should it happen that there is a sufficient quantity of dirt on the rail, it will cause a higher resistance than the potential of the current can overcome, and, of course, stop the car. Should the motor man get off to push it over the dirt and fail, as sometimes happens, to switch off the current from the motor, the full current on the line will pass through it just as soon as a good contact is made, and the result is a burnt armature and a disabled car. This seems to have been particularly the case during the recent stormy weather, when I am informed that the number of available cars for traffic on the road was reduced to about ten. Possibly the saturation of the motor by the rain, and the effect of lightning on the trolley wire, had also something to do with the case. Owing to the reticence of the *employés* above referred to, it has been difficult to ascertain just what damage has been caused by lightning striking the trolley wires and injuring the motors, but that there has been serious trouble from this source I have no doubt. The very best forms of lightning arresters have not proved sufficient to prevent injury to electric light dynamos where insulated wires are used in the outdoor circuits, while the bare wire used for the working conductors on overhead electric traction systems must always render them more susceptible to trouble from this direction.

After setting forth the difficulties which have been shown in the practical operation of the most extensive system of electric traction in the world, it gives me pleasure to direct attention to the remarkable behaviour of the Sprague motors under all the conditions to which they have been subjected for the past seven months, which has been indeed remarkable. No load has been too heavy and no grade too steep for them to ascend. Perhaps the severest test they ever received was on the night of July 4th in bringing the crowds from the new Reservoir Park, when the ordinary open cars carried over one hundred passengers and the closed cars over seventy-five each, so many in fact that the axles of one or two of the cars broke down under the load, all of which must be exceedingly satisfactory to the inventor, and places the Sprague motor at the very head of the many excellent types or forms that have been devised at home and abroad.

The objections referred to above apply equally as well to all forms of overhead systems except where a second wire is used for a return instead of the track and earth, and also where the trolley pole is discarded for the movable trolley. But the increased number of aerial wires required as well as the heavier fixtures needed to sustain them render these systems just as objectionable.

We are very anxious to see the effect of ice, sleet and snow upon the operation of our road, as it has not yet passed through a winter in complete running order. A heavy sleet storm has often prostrated our telegraph lines, and I see no reason why the overhead electric railway wires would be exempted from similar trouble, nor why the covering of the rails by ice and snow will not render it difficult to make a sufficient contact to operate the line successfully, not to speak of the loss of current by leakage or escape from the trolley wire, but I have no doubt that the ingenuity of those who have overcome all the problems encountered in opening up with such success the Richmond Union Passenger Railway, will be sufficient to insure its continued operation in spite of wind and weather, and to no one more than myself will this be gratifying, since it was through my efforts that attention was first directed, some three or more years ago, to the splendid opportunities for electric traction that Richmond presented;

* Paper read before the American Institute of Electrical Engineers.

† See *The Electrician* of July 6th, p. 285, and Aug. 3rd, p. 409.

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although I am free to confess that my inclinations were towards the application of the storage battery, which obviates all the troubles and defects developed by the overhead systems, and against which no more serious objections seem to be brought than the extra weight caused by the batteries and the greater first cost as compared with the aerial systems, all of which, it appears to me, are more than counter-balanced by the difficulties and annoyances in the systems just described.

The very satisfactory results obtained in the operation of the new electric storage cars on the Fourth Avenue Railroad in this city, as well as by Mr. Wharton in Philadelphia, M. Huber in Hamburg, and elsewhere, prove, as I have believed, the storage battery to be the only ideally perfect system of electric traction for municipal purposes.

COMPANIES' MEETINGS.

The Brazilian Submarine Telegraph Company.

The thirtieth ordinary general meeting of the shareholders of this Company was held at Winchester House, Old Broad-street, on Wednesday last, the Right Hon. Viscount Monck presiding.

The SECRETARY (Mr. Richard Collett) read the notice convening the meeting, and the minutes of the twenty-ninth ordinary general meeting, held on the 9th of May last, which were confirmed and signed as correct. The report of the Directors was taken as read.

The CHAIRMAN said it was now his duty to move the adoption of the report. He hoped they would allow him to say that among the duties of this kind which he had to perform there was none that gave him more satisfaction than that of meeting the shareholders in the Brazilian Submarine Telegraph Company. He had now been their chairman for fourteen years. The Directors had managed, he thought, to conduct the business of the Company to the satisfaction of the shareholders. At least they had always expressed it so, and therefore it was a great source of gratification for him to meet them again. He had not a great deal to say on that occasion. The nature of the report, which he hoped would give them satisfaction, was such as to preclude any necessity for argument on his part. He would give a short account of their transactions since their last meeting. They had had a great deal of repairs to do, as they knew, to the Lisbon-Madeira and the Madeira-St. Vincent cables. There were faults in both of those sections, which they had effectually removed, and he was happy to tell them that now the cables tested as well as when first laid down. A fault had been detected in the Lisbon-Madeira cable early in the half year, and for some time they were under the impression that there was a second fault, which, as far as they could locate it, was near Lisbon. They were rather nervous about it, as there were several cables in the sea close by Lisbon. They were afraid that if compelled to repair in that locality they might fall foul of some other cable near. However, they took out the fault that they knew of, and were able to localise the other fault close in shore near Madeira, and had removed it, and the cable was now in perfect condition. The cost of effecting the repair had very largely increased their expenses in the half year. The cost of these two repairs was £7,908; but with that exception the expenditure had been pretty much what it had been the previous half year. The income, he was happy to tell them, showed a growing increase. The revenue for the half year under review was nearly £7,000 greater than that of the previous half year, and it was between £8,000 and £9,000 greater than that of the corresponding period of last year. He was glad to be able to state that the receipts since the end of the current half year showed an equal if not a larger increase. Under these circumstances they felt no hesitation in giving them a dividend of 7 per cent. per annum for the year, and place £30,000 to the reserve fund, which now amounted to £170,000. They had also paid off a considerable sum of the debentures—the money which they raised for the purpose of duplicating the cable—and he thought they might assume that in a very short time they would have paid off the whole of the cost of the duplication of the cable out of revenue by the repayment of the debentures. There were two subjects affecting their general condition which he desired briefly to allude to. One was in regard to the African Direct Telegraph Company, in which they had a considerable interest. They took that interest—as they were all aware, and as he explained at the time—more as a defence against the intrusion of any other people on their ground than as a mere pecuniary speculation. But he was happy to be able to tell them that it was likely to turn out very well for them. That Company now paid its expenses, as far as they were concerned, and he hoped that in the future it would be a source of gain to them, because there was a proposal for an alternative route by the West Coast of Africa to the Cape, which would not only enable the African Direct Company to pay itself, but would introduce a considerable amount of traffic to their own lines between Lisbon and St. Vincent. This would be a source of gain to them as well. The other subject on which he desired to say one word was their position in Brazil. They had been negotiating, as was well known, for a long time with a view to the strengthening of their position there. He was sorry to say that he was not yet able to announce to them the success of those negotiations. The Directors were doing their best for them; and he must ask them to prolong the confidence which they had already shown in the Board by not being too inquisitive with respect to those negotiations. It was a well-known fact that negotiations were not rendered easier by their terms being made known to the public, and, therefore, he would ask the shareholders to trust the Board to carry on those negotiations, which they would try to bring to a satisfactory conclusion. He concluded by moving the following resolution:—

"*That the report of the Directors and accounts to the 30th June, 1888, now submitted, be approved and adopted, and that a dividend be now declared of 3s. per share, making, with the interim dividends already paid, a total dividend of 6 per cent for the year ended 30th June, 1888, and also a bonus of 2s. per share in respect of the profits for the year ended 30th June, 1888, the said dividend and bonus to be respectively free of income-tax.*"

The VICE-CHAIRMAN (Sir James Anderson) seconded the motion.

Mr. HAWKES inquired why the Company did not hold among their investments Brazilian Government Stocks.

Dr. WEAVER asked whether the Directors considered £170,000 a sufficient reserve fund for the Company. He desired also to be informed whether in the opinion of the Directors the prosperity of the Company was attributable to any sudden change of trade, or whether it was owing to the general improvement of the country where they carried on their working.

The CHAIRMAN, in reply, said that the prosperity of the Company had been so gradual and progressive that in his opinion it was derived from the general advance of commercial prosperity in South America. The amount of the receipts every year since the line was opened were given in the reports, and it would be seen from them that the Company's progress had been gradual and progressive, and he should therefore say it was owing to the fact he had stated. With regard to the £170,000, he must admit at once that he did not think it was a sufficient reserve fund, but they were increasing it as fast as they could, even in opposition to some gentlemen who wrote him privately saying that they would prefer larger dividends. He had, however, all his life been the advocate of a large reserve fund in such cases. It had been their policy to limit the investments to English and Colonial securities. He then put the motion, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. FREDERICK YOULE, Sir Thos. Fairbairn, Bart., was re-elected a Director, as was also Mr. Henry D. Gooch, on the motion of the CHAIRMAN, seconded by the Hon. ST. JOHN F. BRODRICK, M.P.

Dr. WEAVER next moved, and Mr. HAWKES seconded, the re-election of Mr. Henry Dever and Mr. John Gane as auditors of the Company.

The motion was agreed to unanimously.

On the motion of Dr. WEAVER, seconded by Mr. GEO. ANDREWS, a vote of thanks was accorded to the Chairman and Directors.

The CHAIRMAN, in acknowledging the compliment, assured the meeting that the Directors would do their best in the future as they had done in the past to promote the interests of the Company.

The proceedings then terminated.

Edison and Swan United Electric Light Company (Limited).

The fifth annual general meeting of this Company was held on Tuesday, at the Cannon-street Hotel, under the presidency of Mr. James Staats Forbes.

The SECRETARY (Major S. Flood Page) having read the notice convening the meeting the report of the Directors was taken as read.

The CHAIRMAN said: Gentlemen, I think I had better begin by referring at once to the figures of the balance-sheet and profit and loss account. I will deal first with the debit side of the balance-sheet, which represents, as far as substantials are concerned, no change whatever. It shows that the subscribed capital is exactly as it was, but there has been an alteration in the method of stating it in the accounts, and there is a printers' error in that revised statement. It speaks of 5,000 "A" shares of £5 each, fully paid, allotted to the Edison and Swan United Electric Light Company. It should read that there were 5,000 shares of this Company fully paid allotted to the Edison Company. 12,139 "A" shares of £5 each fully paid were allotted to the Swan Company—that was part of the purchase of their concern, just as the next item is part of the purchase of the Swan concern. The capital, therefore, seems to be exactly as it was. The item of sundry credit balances—meaning, in fact, what we owe to our creditors—amounts to £10,214, as compared with £5,799, so that we are in debt a little more. We need not, however, be alarmed at that, because the volume of our business in the year has been considerably greater than in the preceding year; and when you come to the other side of the balance sheet you find that whereas we are somewhat more in debt we have a very much larger amount of good debtors. The profit and loss account for the year shows a balance of £25,123, against £16 246 in the preceding year. That is a matter we shall have to talk of presently. On the other side of the account the cost of patents, goodwill, preliminary outlay, and loss on working, &c., as per last balance-sheet, stands at £300,814, and then there is the further expenditure thereon of £3,213, which brings up the amount to £304,028. But we have been enabled during the year to get rid of some of the bad bargains which came over to us on the union of the two companies by the sale of one installation and of some plant. That has reduced the total by £12,790, which, of course, is credited to capital in that item in the shape of diminution. There was a further item embraced in the general description of the £300,000 odd, namely, loss on working. I daresay, however, proprietors will remember that in the earlier years our working account, instead of showing a profit, showed a loss, and, in accordance with all sound dealing, we determined that these losses in earlier years must be redeemed out of the profits of later years until they disappeared. Happily now they have disappeared, because by diminishing the principal items from year to year by the profits made we have got rid, in fact, of the amount of accumulated losses in the earlier years. There is, therefore, £25,000 of profit in the present balance-sheet, so to speak, free of any claim of that kind. We are on our legs, therefore, as a money-earning concern. You see the item of freehold property. That stands at £27,991, against £13,691 in the last balance-sheet, so that that

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item has been swollen by £14,300, owing to the fact that we have paid off the mortgage on our property at Ponders End. When the balance-sheet of the previous year was made up we had £14,300 on mortgage, which we have paid off, and our freehold property stands at its real value. Besides Ponders End that entry contains some items with respect to a Green-street property and some property we have at Benewell. The next item of installations in progress stands at £1,867, against £2,794. That is an asset—a good asset—and means the payment we shall receive when certain works in progress are completed. The plant and stock stand at £35,390, against £30,045 in the preceding balance-sheet. We have, as I said before, increased very considerably the volume of our business, and we have had to increase the plant necessary to produce it. The item of office installation and furniture is diminished. We write that down from year to year, and it will disappear. Debtors stand at £24,864, against £12,946 in the preceding year. Cash at bankers and in hand stands at £23,028, against £14,174. These are the items of the balance-sheet, and they divide themselves quite naturally into two parts—there is the tangible thing which represents convertible property, and therefore money, and there are other things which represent the value of the patents, goodwill, trade mark, or whatever that thing is which enables people with a small outlay on plant or premises to make very large revenues. I make out that these latter balances, deducting the difference between what we owe and what is owing to us, amount to £104,000, which we look upon as tangible concrete assets in a going concern like ours. Coming to profit and loss account, we began on the 1st of July, 1887, with a stock of lamps, &c., at £12,868. We have spent during the year in wages, purchases of material, cost of installations, &c., £56,329 this year, against £37,159 last year. There has been much larger expenditure in wages and purchases of material, because our sales of lamps have been much greater. Salaries, directors' fees, rent, &c., stand at £7,393, against £6,917. Mr. Swan's salary is the usual amount. The item of depreciation of plant is £3,145, against £3,281, which means that we write off from year to year a very liberal sum from what may be called the using-up value of our plant. The item of Holborn-viaduct £2 041 means that we had a lease of certain premises on Holborn-viaduct taken over by the Edison Company, where there was an installation originally rather in the nature of an advertisement. The conditions of the lease were onerous, we did not want to continue it; it had a certain time to run, and we compounded with the owner of the property to get out of it at once. Therefore we escaped some onerous conditions that would have two or three years hence to be met. We have made a good bargain, and we have cleared out by paying the costs of getting out of it. We are quite clear of that, and it will involve no further liability. I referred to the fact that we had a large amount of money at our bank. The interest for the year comes to £294. Income-tax on profit, 1886-7, stands at £236, because our friends of the Inland Revenue Department do not understand setting off the profits of one year to cover the losses of another. They do not assess you to income-tax on a loss, but the moment you make a profit they do. There is thus a balance of £25,123 to the good. By sale of lamps, fittings, &c., and charges for work of other kinds, we have received £88,110 against really for the business of the previous year £65,736, although in the accounts of that year that sum is enlarged by a payment of Messrs. Woodhouse and Rawson for royalties of £4,217, which we recovered under the action, but which represents chiefly the royalties on lamps sold in the preceding year. I emphasise that to show that the increase of sales is the difference between £65,736 in the year 1887 and £88,110 now. There is a small running account for interest, £294 against £243. The stock on June 30 was £19,590. That enables me to call your attention to the fact that the stock brought forward last year on the 1st of July was only £12,858 in value, whereas the stock carried forward into the current year was £19,590, and that you will see bears the same proportion to the increased business done, and it arises from what I explained, I think, pretty fully last year—that this business cannot be carried on without a very large reserve of manufactured lamps in stock. A great number of varieties of lamps, to suit the wants of different customers, must always be on hand, so that you must end the year with a considerable amount in stock to meet the demand that may come up from day to day. If the sale of lamps in the year had remained stationary while the stock carried forward had increased it would have been an ill sign, but as it bears about the same proportion to the stock carried forward last year that the increased volume of business bears to the business of last year it is all right. The lamps are put down at approximately cost price. That is the whole story of the accounts, and that is all the story I should have to tell upon the accounts if I had not to come to the question of this balance of £25,123. Supposing we were absolutely free of all legal questions, there is no doubt whatever that on the working of our business for the year we have honestly earned a profit of £25,000, after charging the concern with every proper outlay, and being somewhat liberal in the case of the ordinary depreciation of plant, and so forth. But having left you there I will now go to the report. I have exhausted paragraph 2 by dealing with the accounts. That paragraph is very brief, and states that the sale of lamps has progressed in a satisfactory manner during the year. The volume of the Company's business has increased, and has resulted in a credit balance of £25,123. Now that is putting into concrete words my explanation of the accounts themselves. Then come paragraphs 3, 4, and 5. They are all part of the same story. This time last year we were living in the belief that our patents were not only decided on appeal in the action "Woodhouse and Rawson," but that they were invulnerable. Since then our illusion has been somewhat disturbed by the fact of the action brought by the Brush Company, or in a suit in which they were interested, in which the whole case of these patents had to be reconsidered. It is an illustration of the law of patents that while Mr. Justice Kay decided upon the Cheesborough patent confirming the decision already given in Woodhouse and Rawson's suit, his opinion of the Edison patent was different to that of the prior Courts, both of First Instance and Appeal, upon the Edison, and that he has declared to be invalid. The Cheesbrough, which, after all, must be taken to be the key patent, even in the manufacture of the Edison lamp, is declared again to be a valid patent, while the Edison patent is declared to be invalid. That is the decision of Mr. Justice Kay. Our learned friends, the technical lawyers, whose minds are impregnated with all the minutiæ of these matters, and our technical advisers tell us that Mr. Justice Kay is very wrong. Upon that opinion we are going to appeal, and I am not going to predict what the result of that appeal may be. I can only tell you, what competent experts tell us, that there is every probability that Mr. Justice Kay's decision on that point may be reversed. I hope it will, although I am bound to say that I do not think it is a matter of primary importance that it should be, seeing that the Cheesbrough patent has been confirmed. I cannot say any more about it. It would be presumption on my part and that of my colleagues to express an opinion. We can only tell you what our advisers tell us—that they believe that there is reasonable ground for supposing that that decision is wrong. We shall soon know, because that matter is coming on very shortly. We promise in the report that it will be heard before Christmas, and I dare say if it is settled in our favour we shall eat our Christmas dinner with a little more heartiness. Whether or no it will not, I fancy, have anything like a disastrous effect upon the future of this Company. The Anglo-American Brush Company have brought actions in two suits. We refer to them in para. 6. Very little importance is attached to the first one; as to the second, on the matter of patents, who can tell? If anyone wants to know the enormous dangers that are inherent in patents he can read the proceedings in these two sets of actions. I do not know how it may come out. We are bound, if persons bring actions against us, to defend them; but our legal advisers tell us that we need not be in a state of great alarm. Here we are face to face with a profit legitimately made on the operations of the year, but with indefinite liabilities as to the costs and consequences of these actions. I do not want to alarm anyone, because I do not think myself that there is much ground for alarm; but what I would wish to impress upon the proprietors is this, the great imprudence and unwisdom of dealing with the profits of the year until questions so vital have been settled, because you see at once that though the ultimate consequence of the decision against us on the Edison patent on appeal might not be of great importance to us as lamp makers, the question of costs must be serious. Instead of having costs to receive we should have costs to pay, and to have costs to pay in these patent actions is a most serious thing. Our opponents are most ingenious people, and if their ingenuity can not only get the costs of the proceedings, but can land us in damages, I think it would be most unfortunate that we should have parted with the profits of the year pending such questions. We have considered this matter with very great care, with the assistance of our legal friends, and we shall recommend the shareholders to carry forward that £25,123 as a reserve, and not to distribute it. Then we come to paragraph 7, in which we say:—"Lord Thurlow's Amendment of the Electric Lighting Act of 1883 is leading to a considerable development of electric lighting, and to a corresponding increase in the Company's business." We have reduced our earlier aspirations to the humble *rôle* of lamp makers, and lamps cannot be burned without installations. We are very delighted to see others embark capital and energies into installation work, and it is very gratifying to us that the legislation of 1882—which was disastrous in its result by handicapping electric installations—should have been so far modified that an immediate start in the development of electric lighting has followed on an alteration of the Act. The alteration is very simple. Under the old Act it was provided that wherever public lighting was set up in any area the authorities might at the expiration of 21 years resume possession, so to speak, of the privilege, and take over the plant, &c., at a valuation—after 21 years' occupation. Now, 21 years run very rapidly away in this sort of thing. It takes several years, 8, 10 or 12, to get a thing like this to work, and the remaining period seems to practical men much too short to redeem the loss which must inevitably ensue from early losses and arrears, and the mere day-value of the plant and machinery when taken back by the authorities. There was not, in fact, time to redeem; but now Parliament, after a great deal of difficulty, has extended the period. You can imagine what the difficulty was when the gentleman who was responsible for this 21 years and for the Electric Lighting Act of 1882, was a man so eminent and practical as Mr. Chamberlain. He was President of the Board of Trade, and took very strong views indeed upon this subject, and he pointed to the water companies and the gas companies as a reason why the public should not be submitted to the same sort of tyranny and outrageous treatment as they had met with at the hands of these companies. Therefore he introduced very stringent terms as to the conditions for granting these privileges to electric lighting companies, and he gave a very short term or tenure of occupation. Now, even so great an authority as Mr. Chamberlain at last became convinced that the Board of Trade had gone a little too far, and the term has been extended to forty-two years. Anyone who has got to redeem anything will know what a vast difference there is between a redemption based on forty-two and twenty-one years. It makes perfectly easy and practical in the one case what was extremely difficult in the other. There is a rather important modification in the conditions on which the machinery is to be taken over. It is to be taken over at a valuation, but having reference to the fact that it is there ready to carry on an existing business. It is a little abstruse. Having had a great deal to do with arbitrations, I can say that the few words put into the Act as to extensions, &c., are very valuable, and they put a company, in the event of any authority resuming possession at the end of 42 years, in a much better case to put the valuation of their concern. There is no doubt whatever that the amendment of the Act has given an immediate impetus to the progress of this business. A

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large installation is going on at Deptford by the London Electric Supply Company. As a matter of fact, I know most of the people in that concern, and I know there is plenty of money in it, and I think also there is some ability in it. I see among other things predicted of it that between now and the winter of next year they will want 250,000 electric lamps. I dare say that the estimated requirement of 250,000 lamps for that Company may be a little exaggerated; but it may be taken as an evidence of what I have said, that the electric lighting business is going on, and I suppose if we can maintain our patents, as we can the Cheesborough, and as I trust we shall the Edison, but most of all, if we can maintain the character we have got of making the best practical lamp in the market, then I think we are likely to participate largely in this great progress, and, fortunately for us, our capital need not be materially enlarged to enable us to meet an enormous additional manufacture of those lamps. He concluded by moving the adoption of the report and accounts.

The DEPUTY-CHAIRMAN (Mr. Frederick Richards Leyland), in seconding the motion, expressed his concurrence in the remarks made by the Chairman as to the wisdom at the present moment of not dividing the balance of £25,000, but that it should be carried to reserve until the pending actions were settled.

Mr. DONOVAN asked the relation of the Company with the Manchester Edison and Swan Company.

The CHAIRMAN replied that the position of the Company with respect to the Manchester Company was that they held a number of the latter company's Deferred Shares. The Company stood in the same position to the Manchester Company that Mr. Edison stood to this Company.

The motion was adopted.

Mr. LEYLAND proposed the re-election of Mr. J. S. Forbes, who retired from the Board and offered himself for re-election. Mr. Leyland spoke in warm terms of Mr. Forbes' qualifications for the post, and of his invaluable services to the Company.

VISCOUNT ANSON, who seconded the motion, said that he fully endorsed all that Mr. Leyland had said respecting their Chairman.

The motion having been unanimously carried,

The CHAIRMAN, in acknowledgment, remarked that Mr. Leyland had spoken about him (Mr. Forbes) in rather too flattering terms. He might, however, re-echo those expressions, and with more justice, as applied to Mr. Leyland, who also offered himself for re-election. He, fortunately for the shareholders, had a class of experience in life which was very useful to them; and he was enormously interested financially in the prosperity of the Company. Those two things—self-interest and a keen appreciation of business—made Mr. Leyland more invaluable to them than he (the speaker) had been. He hoped, therefore, some shareholder would be glad to propose Mr. Leyland's re-election.

Mr. CROMPTON said he was very pleased to move that Mr. Leyland be re-elected a Director of the Company.

Mr. HENRY ROBERTS seconded the resolution, which the Chairman submitted to the meeting, and it was agreed to unanimously.

The CHAIRMAN then said that there was one other matter of business to be transacted, and that was the re-election, if thought desirable, of the auditors, who retired, Messrs. Quilter, Welton and Co. Good wine needed no bush, and Messrs. Quilter and Co. needed no remarks of his to commend them to the favour of the meeting.

Mr. GAY proposed the re-election of Messrs. Quilter, Welton and Co. as auditors.

Mr. LETTS seconded the motion.

The CHAIRMAN put the resolution to the meeting, and it was unanimously carried.

Mr. GAY then proposed a vote of thanks to the Chairman and the Board of Directors for their services to the Company.

The resolution having been duly seconded and agreed to,

The CHAIRMAN, in acknowledgment, said that he and his colleagues accepted with gratitude the shareholders' constant and repeated confidence. They had had that day a pleasanter meeting than had taken place for some time, and he thought that the circumstances fully justified it.

The meeting then separated.

Eastbourne Electric Light Company.

A meeting of the above Company was held on Thursday, Oct. 25, in one of the rooms of the Town Hall, Eastbourne. The Mayor presided, and about a dozen of the shareholders and Directors were present.

The MAYOR said that the Company commenced in a small way, and now had 1,700 lights at Eastbourne. The progress had not been very rapid, but rather slow and sure. The arc lighting had been the great bane of electric lighting; but this drawback was being gradually remedied. In the Town Hall the light had been in use for two years, and a more perfect system they could not have. The electric light, like all "new boys," was bound to be pitched into by the "old boys," but now the old boys were beginning to see that the new boy was not to be put down by mere bullying. The Mayor here read copious extracts from published articles on the new light, and said it had helped to advertise the town even as far as America. The clerk of the Kensington Vestry had also made inquiry in regard to the system of lighting at Eastbourne. At some length the speaker maintained that the supporters of gas lighting had unjustly criticised the new light. But some people seemed to think that the world was made for them, and them alone. They knew to whom he alluded. Having quoted copiously from letters in the local papers against the Electric Light Company, the Mayor disputed the idea that gas was the cheaper light in the long run. The gas company had challenged the Electric Light Company, or he (the Mayor) would not allude to the matter, as there was room in the town for both. By what right did the gas company pay 12½ per cent. dividend? Why not reduce the cost of gas? He contended that the town of Eastbourne had shown the people of London and of America what could be done with the electric light. For six years the company had worked for themselves and others, and had not complained when no dividend had been paid. But a dividend would soon be paid, and the shareholders of the Company, if they would bear with them a little longer, would see that the Directors were doing all they could for them.

The Mayor and Mr. J. G. Langham were re-elected as two retiring Directors, and the latter at some length reviewed the well-known facts of the introduction of the electric light into Eastbourne. He agreed with the Chairman that the Company had started with too little capital. He congratulated the town that the Company was sharp enough to get their wires down before the passing of the Act, so that now they could be independent of the Board of Trade.

After some complimentary remarks by Mr. Hammond on the working of the Company, and some severe strictures on the advocates of the gas company, the meeting closed with the customary vote of thanks to the Chairman.

LEGAL INTELLIGENCE.

The Maxim-Weston Electric Company.

On Saturday last the petition of Mr. H. Watt for a winding-up order came before Mr. Justice Chitty in the Chancery Division.

Mr. Romer, Q.C., and Mr. George Hart appeared for Mr. Watt, and Mr. Bryne, Q.C., and Mr. Gasdar for the company.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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Mr. ROMER said the petitioner claimed to be a creditor of the company for the sum of £784. 12s. 2d. On the 5th September this year he had served the statutory notice upon the company to pay that sum, and the company did not within three weeks pay it. He had also a claim against the company for £900 in addition, but that would not be gone into on this petition. The grounds of opposition were that in the first place the company disputed the debt; he should urge that it was not a *bonâ fide* dispute. Then the company said they had certain counter claims, which he urged were mere bogus claims put forward without any substantial grounds merely for the purpose of trying to prevent a winding-up order. Mr. Hugh Watt was formerly a director and manager of the company, but on the 4th of August, finding that he was unable to get on with the new directorate, he had resigned; and since that date he had had no connection with the company. Under these circumstances one would have thought that it was the duty of the directorate, if they had been able, to pay Mr. Watt; that they had not done so the learned counsel said was clearly due to the fact that they had no means to pay—in fact, at a meeting held on the 3rd of October the chairman of the company stated that unless they had further means there would have to be a winding-up order. Since the service of the notice, on the 5th of September, and till after the presentation of the petition, the petitioner's debt was not challenged in the slightest degree. There was really no *bonâ fide* dispute as to the debt. The reason why the company counter claimed was pretty evident. Mr. Watt had transferred certain shares, and they refused to register, and, as he urged, raised that claim for the purpose of preventing that registration. That, however, was the subject of a separate application. The present claim of £784. 12s. was for salary, rent, and other charges; the counter claim amounted to some thousands of pounds.

Mr. BYRNE, in reply to his lordship, said it amounted to £4,616, but there might be further claims.

Mr. JUSTICE CHITTY asked on what ground the counter-claim was made.

Mr. ROMER said it was found on general statements of misdealings which were unsupported, and general statements on information and belief which were denied. In reply to further questions of his lordship, Mr. Romer said notice of motion to compel the company to register the transfer of shares had been given before the Vacation Judge; the transfer of shares took place in July.

Mr. JUSTICE CHITTY suggested that the company should pay the amount of Mr. Watt's claim into court; that the petition should be dismissed, so that it should no longer hang over them; that an action should be brought by one of the parties; that the money deposited should abide the result of the action; and that the costs should follow the event.

Mr. ROMER said he was willing to agree to that, but it must not be paid in in the name of the company, because, having regard to the chairman's statement, which he had quoted, the company might be wound up. He suggested that the money should be deposited in joint names, and that a sum should also be deposited to abide the question of costs.

Mr. BYRNE said he did not admit the accuracy of the report of the chairman's speech which Mr. Romer had quoted. In the absence of the directors he could hardly assent to the proposal. This petition hanging over the company hampered them, and they were very anxious to get the matter settled.

Mr. JUSTICE CHITTY said that if they paid in the money as proposed (he did not say whether it should cover the whole sum, but at any rate it should cover a substantial part of the sum) the petition would go, and would no longer hamper them, and they would only be standing out of a sum of money until such time as they were able to try their actions. The money, of course, would have to be provided in such a way that Mr. Watt could get it, and that it could not be recovered back from him on some other petition.

Mr. ROMER: We shall be quite safe if it goes to a separate account.

After some further conversation, it was agreed that the company should pay £500 within a fortnight into a bank in joint names, that the petition should be dismissed when the money had been paid in, the petitioner having liberty to apply again if another petition for a winding-up order should be presented; that Mr. Watt should bring the proposed action within a week of the dismissal of the petition, and that the company should then counter-claim or bring a cross-action; and that Mr. Watt should have the costs of the petition if in the result he recovered £50 or over on the balance of account between the parties.

Mr. BRYNE having pointed out that the pending motion for the registration of shares would involve the whole question which would have to be determined in the action,

Mr. ROMER undertook not to go into the question of the debt upon motion, and that the motion should be confined to the question of waiver.

NEW COMPANIES REGISTERED.

AUTOMATIC ELECTRIC SUPPLY COMPANY (LIMITED).—This company was registered on the 22nd inst., with a capital of £25,000, divided into 25,000 shares of £1 each, to manufacture, buy, sell, and deal in automatic boxes, electrical or otherwise, machinery, appliances, and merchandise of all kinds, and generally to carry on the business in all its branches. The first subscribers are :—

	Shares.
William Graham Hannay, 28, Duke-street, W., secretary ...	1
George Edgar Way, 18, Gascony-avenue, N.W., merchant ...	1
Hamen Levites, 13, Hanway-street, W. ...	1
James Golding, 162, Major-road, Stratford, E. ...	1
Samuel J. R. Allen, 49, Endymion-road, Finsbury-park, N., clerk ...	1
August Serraillier, 29, Meek-street, West Brompton, S.W., electrician ...	1
Ernest Desborough Sale, 1, Nelson-street, Greenwich, S.E., clerk	1

Registered without special articles.

THE SOUTH AFRICAN LIGHTING ASSOCIATION (LIMITED).—Registered by Wilkins, Blyth and Dutton, 112, Gresham House, E.C., with a capital of £50,000 in £10 shares. Object, to supply gas, electric, or any other artificial light within Port Elizabeth and King William Town and elsewhere in South Africa, or any islands or countries near thereto. The first subscribers are :—

	Shares.
W. Cash, 90, Cannon-street, E.C. ...	1
E. K. Blyth, 112, Gresham House, E.C. ...	1
A. L. Don, Hillside, Stowbridge, N.W. ...	1
D. F. Goddard, St. Margaret's House, Ipswich ...	1
S. Cutler 11, Vanbrugh Park, Blackheath, S.E. ...	1
C. Woodhall, Palace Chambers, Westminster ...	1
J. Cloudsley, Stonebridge Park, Willesden, N.W. ...	1

There shall not be less than three nor more than seven directors of the company. The first directors shall be D. Ford Goddard, James Mansergh and William Woodhall, M.P. The qualification of a director shall be the holding in his own right of at least 50 shares in the capital of the company. The company in general meeting shall determine the remuneration to be paid to the directors for their services.

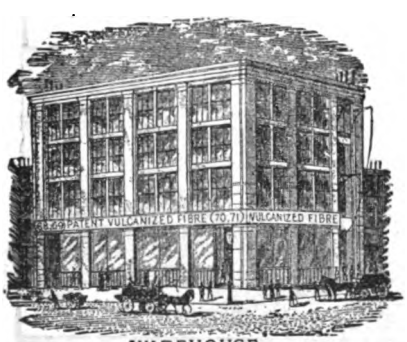
CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended October 26th, 1888, amounted to £5,151.

THE SCHANSCHIEFF ELECTRIC BATTERY SYNDICATE (LIMITED).—We are informed that Mr. David Marks has resigned the office of director of the Schanschieff Battery Syndicate, being about to proceed to Australia; and Mr. T. Grant Wells has been appointed secretary *vice* Mr. John Wright.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended October 26th, 1888, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £4,289.

THE NON-CONDUCTOR OF ELECTRICITY.



WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

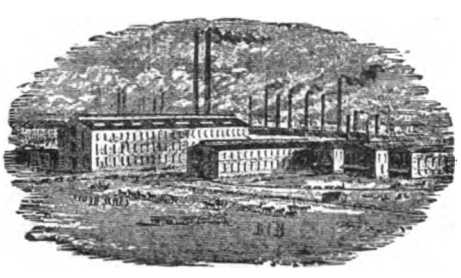
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.


FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

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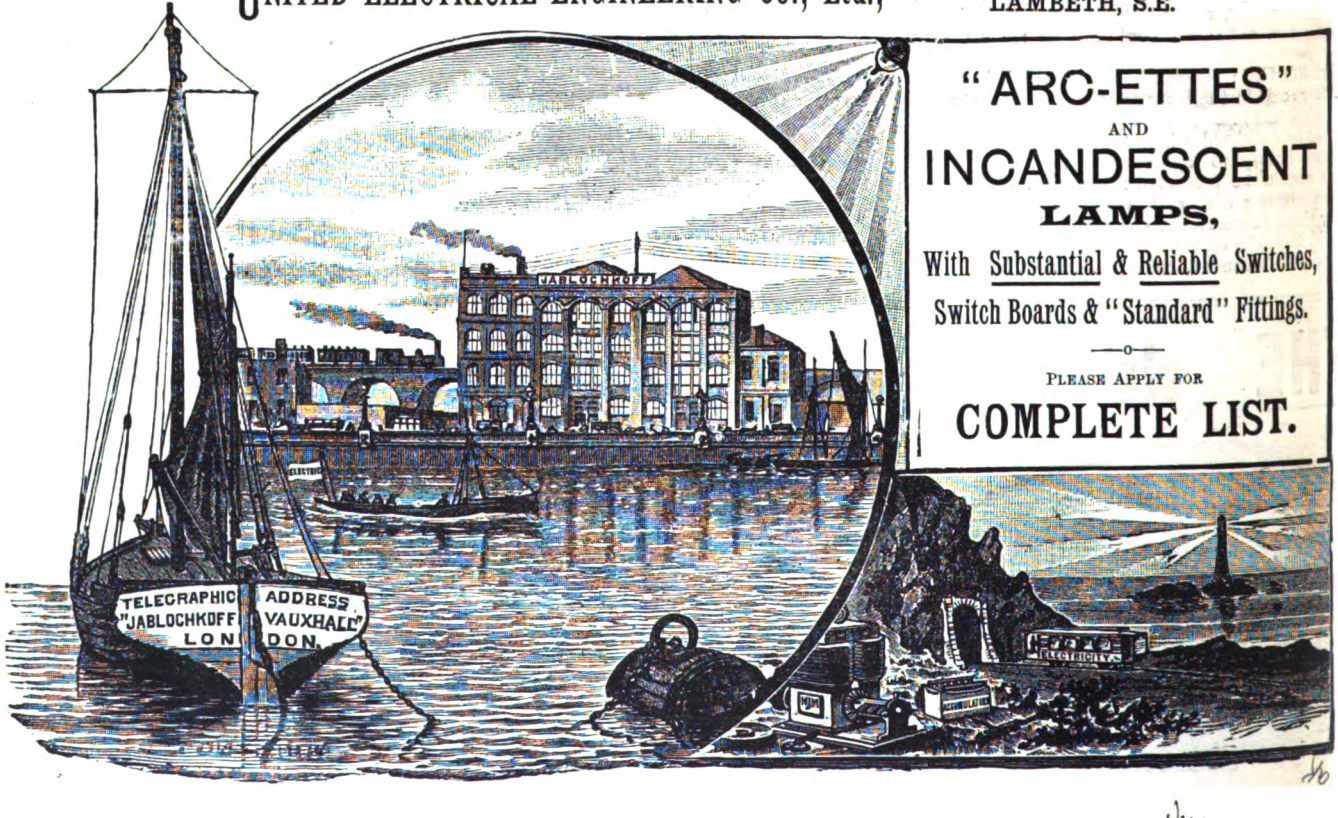
COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Price, Wednesday, Oct. 31, 1888.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Oct. 31, 1888.	
£			**TELEGRAPHS.**		£. s. d.		Highest.	Lowest.
1,770,360	Stock	5/0	Anglo-American ..... xd	47 48	2 17 3	Jan., Apr., July, Oct.	48	46⅞
2,614,820	Stock	10/0	Do. Preferred ..... xd	79 80	3 8 9	,, ,,	80⅜	78⅜
2,614,820	Stock	nil.	Do. Deferred	16 16½	...	February	16⅛	15 15/16
130,000	£10	3/0	Brazilian Submarine	13⅜ 13⅝	5 1 0	Mar., June, Oct., Dec.	13 9/16	13½
16,000	10	9/0	Cuba Submarine	13¾ 14¼	5 19 9	February and August	14 1/16	14
6,000	10	10/0	Do. Preference	18 19	5 5 3	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	3¾ 4¼	3 15 4	March & September	4⅛	4
6,000	5	5/0	Do. Preference	9 10	5 0 0	April and October ...	...	...
60,710	20	2/0	Direct United States ..... xd	9⅜ 10	4 0 0	Jan., Apr., July, Oct.	10	9⅞
380,000	10	4/6	Eastern	12⅜ 12⅝	4 15 1	,, ,,	12 9/16	12⅜
70,000	10	3/0	Do. 6 per Cent. Preference	14¾ 15¼	3 19 0	,, ,,	14⅝	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	3 18 0	February & August	...	...
250,000	10	2/6	Eastern Extension	13 13¼	4 18 1	Jan., Apr., July, Oct.	13¼	12⅞
22,050	10	8/3	German Union Telegraph and Trust	9 9½	7 7 4	January and March	...	...
179,177	10	3/0	Globe Telegraph and Trust	6⅞ 7⅛	4 18 3	Jan., Apr., July, Oct.	7⅛	6⅞
178,992	10	3/0	Do. 6 per Cent. Preference	14¼ 14½	4 2 9	,, ,,	14½	14¼
150,000	10	5/0	Great Northern	14 14½	5 3 5	Jan., July, and April	14½	14¼
17,000	25	37/6	Indo-European ..... xd	38 40	6 5 0	April and October	...	...
33,348	10	3/0	London Platino Brazilian	7 7⅛	...	May and November	...	...
9,000	8	4/0	Reuter's	7¼ 7¾	5 3 2	April and October ...	...	...
338,225	Stock	13½%	Submarine	135 145	10 0 0	February & August	...	...
30,000	10	6/0	West Coast of America	7¾ 8¼	6 1 3	January and July ...	8⅛	8 1/16
150,000	Stock	8%	Do. Debentures	117 121	6 12 3	June and December	...	...
88,321	10	nil.	West India and Panama	2 2¼	...	...	2⅛	1⅞
34,563	10	*10/0	Do. 1st Preference	12¼ 12⅝	...	April and October ...	12⅝	12¼
45,181	15	9/0	Western Brazilian ..... xd	13½ 14	...	March & September	14	13½
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	120 125	5 12 0	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	102 104	5 15 5	March & September	101¼	101
			TELEPHONES.					
224,850	14/0	£5 7s. % '87	Consolidated Telephone and Maintenance	9/16 11/16	5 10 0	Yearly	5/8	...
220,000	£1	2½% '87	Oriental (11s. paid)	5/16 7/16	3 9 0	... ...	7/16	...
80,000	5	10/0	United	13½ 13¾	5 9 1	June and December	13 9/16	13⅜
275,000	5	4/6	United River Plate	5⅜ 5⅝	...	July and January ...	5⅝	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	4¼ 4⅜	...	...	4 9/16	4¼
23,692	5	nil.	Do. (fully paid)	5¼ 5⅜	...	February & August	5⅜	5¼
79,934	5	nil.	Swan United (£3. 10s. paid)	2¼ 2⅜	...	...	2 1/16	2 1/16
312,000	¼	5% '86	Maxim-Weston	1/16 3/16	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	38½ 39½	6 1 3	March and July	39⅝	39
41,600	10	10/0	India Rubber, Gutta Percha, & Telegraph Works ...	16½ 17½	5 14 3	February & August	17⅜	17

* On account of arrears of dividend.

UNITED ELECTRICAL ENGINEERING CO., Ltd., 36, ALBERT EMBANKMENT, LAMBETH, S.E.



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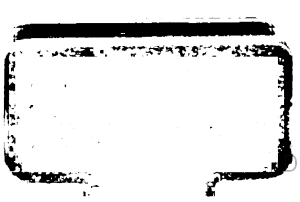

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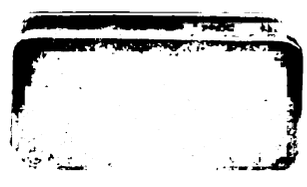

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